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FACULTY OF DENTAL SCIENCE
DHARMSINH DESAI UNIVERSITY

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- GLOBAL LEADERSHIP IN HUMAN DEVELOPMENT, EXCELLENCE IN EDUCATION AND HEALTH CARE.
- TO REDUCE MORBIDITY AND MORTALITY FROM ORAL AND CRANIOFACIAL DISEASES AND THERE BY INCREASE THE QUALITY OF LIFE.
- TO PROMOTE SUSTAINABLE, PRIORITY-DRIVEN POLICIES AND PROGRAMMES IN ORAL HEALTH SYSTEMS THAT HAS BEEN DERIVED FROM SYSTEMATIC REVIEWS OFBEST PRACTICES.
- TO REDUCE DISPARITIES IN ORAL HEALTH BETWEEN DIFFERENT SOCIO-ECONOMIC GROUPS WITHIN COUNTRY AND INEQALITIES IN ORAL HEALTH ACROSS COUNTRIES.

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- TO SPREAD EDUCATION GLOBALLY IN THE FIELD OF DENTAL SCIENCES USING EXISTING RESOURCES AND TECHNOLOGY.
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- TO PROVIDE NEED-BASED INFRASTRUCTURE AND FACILITIES TO THE STUDENTS AND STAFF.
- TO MINIMIZE THE IMPACT OF DISEASES OF ORAL AND CRANIOFACIAL ORIGIN ON HEALTH AND PSYCHOSOCIAL DEVELOPMENT. GIVING EMPHASIS TO PROMOTING ORAL HEALTH AND REDUCING ORAL DISEASE AMONGST POPULATION WITH THE GREATEST BURDEN OF SUCH CONDITION AND DISEASE.

VICE CHANCELLOR

I N D E X

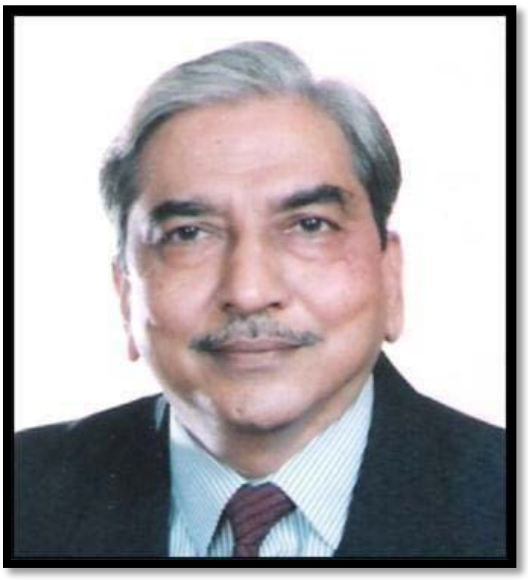
Page

Prosthodontics & Crown and Bridgework

Editor's Note:

Two articles from previous issue that is Volume X Issue 1, 2020 have been deleted due to conflict of interest. And the title of those articles is mentioned below:

Vice Chancellor's Message



Learning is the eye of mind. It is again a matter of pride, for Faculty of Dental Science to come up with yet another annual volume of Journal of Health Science enriched with scientifically reasoned articles. I extend my heartfelt wishes to the editorial committee. My blessings and support remain with the entire Faculty of Dental Science for continued growth.

Dr. H.M Desai

Vice Chancellor
Dharmsinh Desai University
Nadiad

Trustee's Message

***"Tell me and I forget, teach me and I may remember, involve me and I learn."*- Benjamin Franklin**

It brings me immense pleasure to see Faculty of Dental Science rendering good work with great team members thriving for growth. I congratulate the whole editorial team, faculty as well as students to come up with yet another annual journal. My heartfelt wishes, gratitude and support for the faculty's future endeavour.

Mr. Ankur Desai

Trustee
Dharmsinh Desai University
Nadiad

Dean's Message

"Wisdom… comes not from age, but from education and learning." - Anton Chekhov

Ever since the dawn of civilization, humans have been inclined toward knowledge. They have a quest to seek the truth that govern the way our world, our societies and our very own bodies organize, co-ordinate and work. Similarly, our faculty has been working endlessly as a team even in this time of Pandemic to contribute toward yet another volume of our Journal of Health Science, comprising scientifically based research as well as review articles with different case reports. I congratulate the entire editorial committee for coming up with another brilliant volume of our annual journal.

"It is during our darkest moments that we must focus to see the light."- Aristotle

Dr. Hiren Patel

Dean
Faculty of Dental Science
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From the Editor's Desk

"We all have dreams, but in order to make dreams come into reality, it takes an awful lot of determination, dedication, self-discipline and effort."- Jesse Owners

As we all know that research is an unending pursuit and always requires refinement and polishing, hence our journal offers avenue for researchers and practitioners to present contemporary issues and innovative ideas in our field. This journey that our entire faculty and editorial committee have embarked on this ever-changing world wouldn't be possible without everyone's dedicated contribution. I extend my deepest gratitude and thanks to my entire editorial team as well as the faculty and students for their continued contribution toward the journal's growth. I believe that with this continued dedication and effort, the journal will successfully attain its mission in offering good content.

"If you are not willing to learn, no one can help you. If you are determined to learn, no one can stop you" …

"Together we can" ….

Dr. Shalini Gupta

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AN ODYSSEY OF SCAR REVISION

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ABSTRACT

An inevitable consequence of trauma or surgery is scar formation. A modicum of entire treatment post-trauma is aesthetic reclamation of near normal state of tissues. Since last few decades aesthetic scar revision has become a drift. Self-image affects both self-esteem and self-confidence. These surgeries are hence highly requested by individuals. With non-medical individuals getting at par with different corrective surgeries via illusive internet-based knowledge, clinicians and surgeons alike should develop grasp onto newer and better techniques for revision and their limitations. This is necessary for patients' benefit and education. This review article aims at providing such information including past and present practices.

Keywords*: Scar revision, Scars, Incisions, Wound healing, Depressed scars*

INTRODUCTION

A scar is often defined as a fault or blemish resulting from some former condition, wound, sore or burn. Scar formation is an inevitable consequence of wound healing during which the traditional skin is replaced by a animal tissue. This tissue lacks the characteristics of the traditional uninjured skin [1].

To ensure the simplest possible scar outcome, preoperative incision planning, wound tension during closure, and postsurgical management are all critical. Appropriate patient counselling and assessment of expectations is additionally important because patients often believe that a scar are often "removed" [2].

ANATOMY OF SKIN AND HEALING

The skin consists of several layers: epidermis, papillary dermis reticular dermis, and hypodermis. The adnexal structures within the dermis (i.e, hair follicles, apocrine and ermine glands) function progenitor cell sources for epithelialization. When injury occurs within the deep reticular layer of the dermis is allowed to heal by secondary intention,

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more scarring usually occurs. Incisions through thicker skin tend to scar quite thin skin. Especially in thick sebaceous skin, incisions tend to scar easier [3]. Convex surfaces of the face, like the chin, cheek, forehead, and nasal tip, are more susceptible to hypertrophic, widened scars compared with other regions of the face. Areas in close proximity to mobile regions of the face have an increased risk to possess widened scars thanks to the continual pull on the incision. during this instance, taping the incision for several months after suture is removed may help reduce pulling on the incision because it matures, leading to a less widened scar [3].

SCAR TYPES

(A)Keloid or hypertrophic scar. The differences between a keloid and hypertrophic scar are listed in Table 1[4].

(B) Oblique scar in dermal depth with slanted contraction.

(C) Uneven sloping scar with various dermal depths.

(D) Iatrogenic step off scar from inaccurate apposition of skin edges.

(E) Trap Coro or pin cushioning scar from circumferential contraction.

Table 1: Difference between Keloid and Hypertrophic Scar [4]

Characteristic	Keloid	Hypertrophic scar
Stays in confines of injury	No	Yes
Precipitated by trauma	Not always	Yes
Area of occurrence	Area of little motion	Area of motion
Growth	For extended period	Regress in time
Symptomatic	Usually	Usually
Response to treatment	Poor	Good
Sodium (osmotic pressure)	Normal	Decreased
Magnesium (metabolic activity)	Increased	Decreased
Calcium (reflects collagen metabolism)	Increased	Decreased
Mucinous ground substance	Abundant	Scanty
Fibroblasts	Few	Numerous
Foreign body reactions	None	Frequent
Luxol fast blue collagen stain	Reddish	Blue
Mast cells	Increased	Increased
Pathogenesis	Unknown	Unknown
Contains myofibroblasts	No	Yes
Alanine Transaminase	Increased	Normal

Adapted from: Kelly A.P.(2008)Hypertrophic Scars and Keloids. In: Gloster H.M.(eds) Complications in Cutaneous Surgery. Springer, New York, NY. https://doi.org/10.1007/978-0-387-73152-0_8

ETIOLOGY AND PATHOGENESIS OF SCAR FORMATION

The healing process involves three primary overlapping phases:

1. Inflammation

2. Proliferation

3. Remodelling

Over the primary year, re-epithelialization from migration of stem cells, deposition of extracellular matrix and sort III collagen, also as remodelling with type I collagen replacement will determine the makeup of the ultimate scar. Wound strength follows a typical curve in a perfect situation achieving 60% of its original strength by 4 to six weeks and a maximum of 80% by 1 year. Any alteration of those phases from intrinsic or extrinsic factors also as discrepancy in surgeon technique may end in scarring variations [5].

The ideal placement of a scar would follow a natural skin crease or relaxed skin tension line (RSTL)(Illustration 1) to maximise imperceptibility and to attenuate the strain across the wound. it's prudent to permit the traditional scar an adequate amount of your time to realize its mature appearance before choosing surgical intervention. Hypertrophic and keloid scars, on the opposite hand, are candidates for earlier treatment [6]. Various scar assessment tools are mentioned in table 2[7-10].

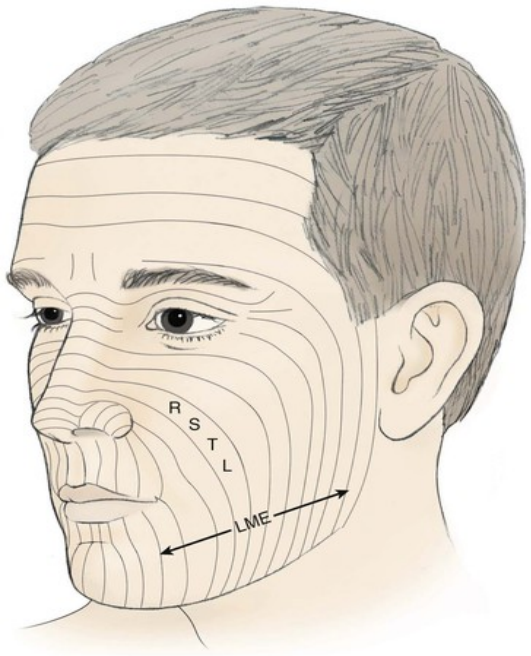

Illustration 1: Relaxed skin tension lines (RSTL) of face. Lines of maximal extensibility (LME) are perpendicular to RSTLs.

Table 2: Assessment of Scar	
Subjective methods	**Objective methods**
Vancouver burns scar assessment score — limited application to burn scars only [7]	Colour — spectrophotometry
Clinical scar assessment scale — validated compared to histological findings and is applicable to a wide variety of scars [8]	Vascularity — laser Doppler flowmeter
MCFONTZL classification — complex system of classification of facial lacerations [9]	Contour — optical or mechanical profilometers
Patient and Observer Scar Assessment Scale — it has both an observer and a patient scale [10]	Area — 3-D computer reconstruction of scanned images of scar
	Thickness — ultrasonography
	Tissue stiffness — anisotropy using non-invasive sound waves

SCAR REVISION MODALITIES

Illustration 2 gives an easy-to-follow algorithm for scar management.[11]

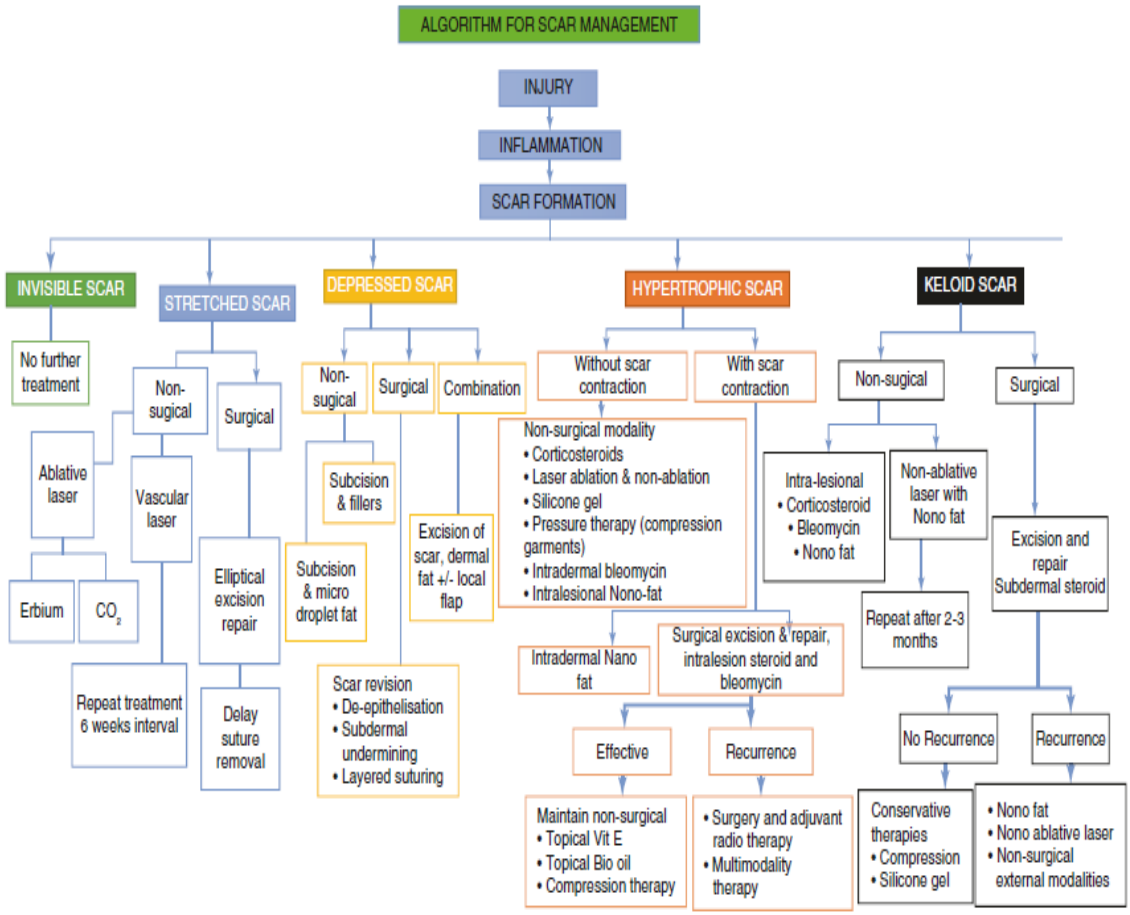

Illustration 2: Algorithm for scar management *Adapted from : Oral and Maxillofacial Surgery for the Clinician. Editors: Krishnamurthy Bonanthaya, Elavenil Panneerselvam, Suvy Manuel, Vinay V. Kumar, Anshul Rai. © The Association of Oral and Maxillofacial Surgeons of India 2021.*

TREATMENT

NONSURGICAL TECHNIQUES

Topical therapy

Hyperpigmented scars are often lightened by using hydroquinone, kojic acid, alpha hydroxyl acid, hydrocortisone and retinoic acid. Use of topical silicone gel or silicone sheet improves the contour, texture and therefore the colour of the scar. Topical application of mitomycin C 0.4 mg/ml and 1 mg/ml improves hypertrophic scar and keloid [12].

Cadet et al [13] conducted a randomized double blind clinical test with a placebo applied to at least one scar and topical silicone gel used on the opposite scar for two months. Twelve patients (for a complete of 24 surgical scars evaluated) were included within the study. General improvement of scars was reported by the patient, the surgeon, and supported pictures. No statistically significant difference was found between the group treated with silicone gel and therefore the group treated with placebo.

Intralesional agents

Intralesional corticosteroids:

They reduce scar formation by inhibition of inflammatory mediators, fibroblast proliferation, collagen synthesis (COL4A1 and COL7A1), TGFβ1and β2 and by enhancing collagen degradation. In hypertrophic scars, 0.1 ml of low dose (510mg/ml) triamcinolone acetonide is injected into the bulkiest area of the scar at 3weeks interval for a maximum of 6 injections and is started 1 month postoperatively.

This treatment doesn't decrease the width of the scar, but helps to flatten it. Adverse effects like hypopigmentation, atrophy, telangiectasia, delayed wound healing and scar widening has been reported in 63% patients. When utilized in combination with other modalities like 5flurouracil and pulsed dye laser, adverse effects thanks to corticosteroids were reduced [14].

Intralesional 5Flurouracil (5FU):

Intralesional 5FU has been shown to be effective in many studies, though most of those studies are of limited value thanks to lack of adequate controls. 5FU together with intralesional corticosteroids, radiation or pulse dye laser has shown good leads to hypertrophic scars. It acts by inhibiting fibroblast proliferation and expression of TGFβ1 induced type 1collagen gene in human fibroblast. Side effects are transient hyperpigmentation, sloughing, burning sensation and pain at site of injection [14].

Other intralesional agents:

Bleomycin, intralesional interferon, hyaluronidase, tretinoin and prostaglandins are used for scar modification. Various studies have shown the beneficial effects of injection neurotoxin type A (The dose range is from 2.5 to 100 units/cm3) in improving the result for facial scars. It acts by causing temporary muscular paralysis which decreases the strain vectors on the wound edges and helps in wound healing [14].

Laser

Lasers are a comparatively safe and non-invasive modality within the management of posttraumatic facial scarring when used appropriately. Lasers exert their therapeutic

effects through volumetric heating, selective photothermolysis, or frank ablation [15].

Non-ablative lasers

The flashlamp pumped pulsed dye laser (585 nm) decreases the redness of the scar by destroying the blood vessels and use of lower sub purpuric fluence (5.07.0J/cm2) stimulates collagen remodelling and softens the scar. Treatment should be initiated at the time of suture removal. Although numerous studies have reported its beneficial effects, majority of them lack a well-designed control [1,15].

Ablative laser resurfacing

Pulsed CO2 and pulsed erbium:YAG laser cause superficial scar ablation. CO2 laser induces collagen remodelling and wound contraction by 20-60%. Scar revision using ablative lasers can cause pigment alteration and scar deterioration from overaggressive treatment[1,13].

Tenzel et al did a split-face prospective, randomized study, to research the utilization of long pulsed 1,064nm Nd:YAG laser on patients with direct browplasty scars. They observed that the 1,064nm Nd:YAG laser provided significant improvement in scar cosmesis after direct browplasty, as rated by subject self-report, but not by masked observers, and appears to be a useful gizmo for increasing satisfaction among those dissatisfied with direct browplasty scars. Side effects included erythema, edema, and discomfort [16].

Dermabrasion

Dermabrasion may be a mechanical resurfacing technique typically performed with a diamond fraise aligned perpendicular to the scar and supply gentle feathering of surrounding tissue. Alternatively, dermabrasion could also be performed with a wire brush or manually with dermasanding. Technique involves removal of epidermis and some of the papillary dermis grossly visualized as pinpoint bleeding. The superficial reticular dermis is reached when a yellowish white color is encountered. Subsequent re-epithelialization occurs to supply smoother appearance of scars. Abrading into the reticular dermis may cause adverse scarring due to injury to adnexal structures [17].

Cryotherapy

Cryotherapy either alone or together with intralesional corticosteroids or surgical excision is employed within the management of hypertrophic scars and keloids. thanks to small sample size and inadequate controls the studies combining cryotherapy with surgical excision for hypertrophic scars and keloids are difficult to guage [12].

An uncontrolled study of 135 patients with 166 keloids showed improvement in 79.5% patients with 80% reduction within the volume of scar. Adverse effects like atrophic depressed scars and hypopigmentation were reported in 75% cases. Intralesional cryotherapy maximises the destruction within the deeper a part of the scar and minimises the damage to the epithelium [12].

Fillers

Synthetic mucopolysaccharide, calcium hydroxyapatite and bovine collagen are utilized in aesthetic surgery for voluminisation. They can be utilized in treating depressed scars. However, these

agents can't be utilized in a bigger quantity as they're going to cause subcutaneous nodules and inflammation, and in bovine collagen, there's 3% incidence of allergic history. There's also a requirement for repeat injection. Autologous fat has appropriated as a cloth of choice for filling [18].

Pressure therapy

It is a perceived therapy that there's positive evidence within the literature. the most important randomised trial showed no significant difference in scar reduction with pressure therapy in comparison to the controlled group [19].

Radiation

It is an efficient adjuvant to surgical excision particularly to keloid. The effect is caused by inhibition of proliferation of fibroblasts and neovascular blood formation, leading to decreased collagen production.

The highest cure rate is described during a single dose within 24 hours after surgical excision; however, further studies are needed to gauge the dosage and to get optimum results [11].

SURGICAL TECHNIQUES

Fusiform elliptical excision

The fusiform elliptical excision represents an easy method of scar excision, with the angles of the elliptical apices measuring 30° or less to stop the formation of the dog ear deformity. After undermining the encompassing skin to alleviate tension, multiple layers of closure are completed to accomplish adequate wound eversion [20].

Z-Plasty

It involves 2 equal and opposing transposition flaps that are raised and transposed along a shared axis. this system changes the direction of the scar, so it's more easily hidden within a border of facial regions or relaxed skin tension lines (RSTL). Common variants of the essential Z plasty include the planimetric Z plasty, double opposing Z plasty, compound Z plasty, unequal triangle Z plasty, and four flap Z plasty, z plasty serial or parallel. Unequal triangles, also referred to as the “half Z,” are often subtly altered into an S plasty to make flap tips that are less vulnerable to vascular compromise. S plasty is beneficial in areas with an altered dermis, frequently encountered in burns and skin grafts. [20]

W-Plasty

The W-lasty and the geometric broken line closure are methods of scar irregularization, predicated on the principle that irregular lines are less perceptible than linear scars. It is performed by creating opposing zigzag lines on all sides of the scar and to interdigitate them during closure. Ideally, the points of the resulting W shape run parallel to RSTLs or natural skin folds. The arms of the W should be approximately 5 mm long and angled between 60°and 90°. Excised scar is reapproximated with multiple layers of closure [21].

The Surgical ‘Dog Ear’

The closure of any circular or asymmetric wound leads to puckering or more than tissue referred to as dog ears. Tissue dynamics, wound geometry, surface contour, and surgical technique affect dog ear formation. Methods for correcting dog

ears include excision of the surplus tissue within the shape of a triangle, crescent or ellipse; excision of conical folds of tissue at the top, they're extensively described within the literature, but all of them cause wound extension.

In 2013, Grasseti et al [22] suggested a way to get rid of a dog ear. consistent with them the wound should be sutured until the elevation becomes pronounced. A hook placed within the end of the wound defines the extent of the dog ear. The elevation is then excised by creating a 90° incision at the top of the wound where the dog ear appears. during this way, a little triangular advancement flap is often raised upward or downward consistent with the skin region desired to be removed. This flap is brought across the wound in order that the skin excess is often cut straightforwardly. some of the flap is then removed to the extent required and therefore the 90° incision created will disappear also (Illustration 5) [22]. The 90° incision technique enables correction of a dog ear without either lengthening the wound or creating new scars, thus improving the aesthetic outcome of the procedure [22].

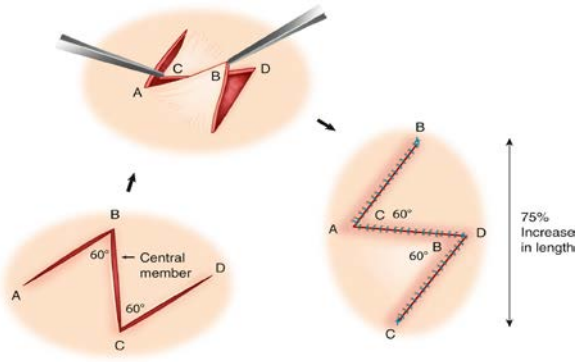

Illustration 3: Z-plasty technique [21]

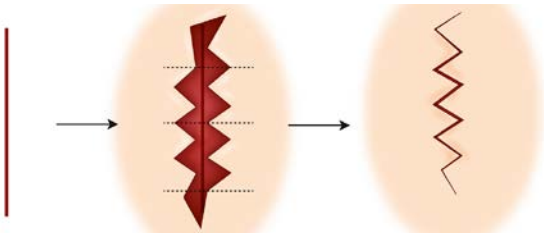

Illustration 4: W-plasty technique [21]

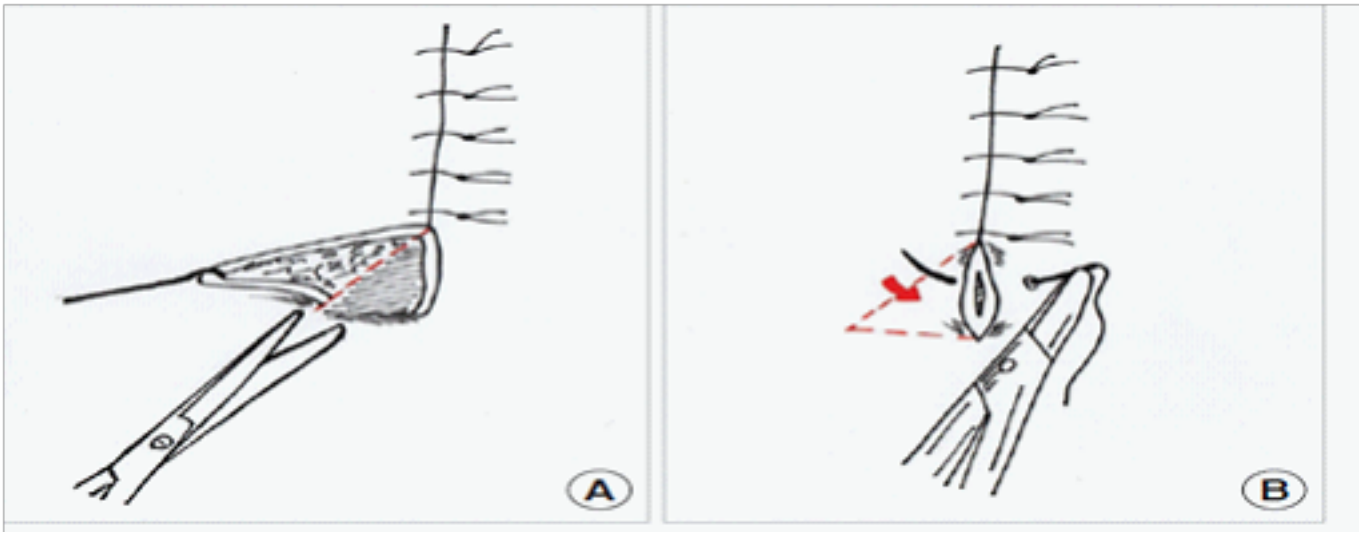

Illustration 5: A: Incision at a 90° angle to the long axis of the existing excision line to create a triangular advancement skin flap downward. As much of the triangular raised flap is removed as the correction requires. B: The 90° incision created disappears as soon as the skin has been sutured. The steep protrusion of the dog ear disappears without either lengthening the wound or creating new scars. The red arrow shows the direction of the flap advancement used for dog ear removal.[22]

SUMMARY

Scar formation may be a part of wound healing process. Facial scars are often aesthetically detrimental and affect social stigma. As facial surgeons, we'd like to realize ideal scars with natural contour, colour and limited distortion. it's paramount to recollect that scar management includes prevention, treatments during the healing period and definitive management once the scar has been established.

REFERENCES

1. Garg S, Dahiya N, Gupta S. Surgical scar revision: An overview. J Cutan Aesthet Surg 2014;7:3-13.DOI: 10.4103/0974-2077.12995
2. Lee Peng G, Kerolus JL. Management of Surgical Scars. Facial Plast Surg Clin North Am. 2019 Nov;27(4):513-517. doi: 10.1016/j.fsc.2019.07.013. PMID: 31587770.
3. Welshhans JL, Hom DB. Soft Tissue Principles to Minimize Scarring: An Overview. Facial Plast Surg Clin North Am. 2017 Feb;25(1):1-13. doi: 10.1016/j.fsc.2016.08.002. PMID: 27888887.
4. Kelly A.P.(2008)Hypertrophic Scars and Keloids. In: Gloster H.M.(eds) Complications in Cutaneous Surgery. Springer, New York, NY. https://doi.org/10.1007/978-0-387-73152-0_8
5. Newberry CI, Thomas JR, Cerrati EW. Facial Scar Improvement Procedures. Facial Plast Surg. 2018 Oct;34(5):448-457. doi: 10.1055/s-0038-1669400. Epub 2018 Oct 8. PMID: 30296796.
6. Watson D, Panuganti B. Treating Scars in the Auricle Region. Facial Plast Surg Clin North Am. 2017 Feb;25(1):73-81. doi:10.1016/j.fsc.2016.08.006. PMID: 27888895

7. Sullivian T, Smith J, Kermode J, McIver E, Courtemanche DJ. Rating the burn scar. J Burn Care Rehabil 1990;11:256-60.
8. Beausang E, Floyd H, Dunn KW, Orton CI, Ferguson MW. A new quantitative scale for clinical scar assessment. Plast Reconstr Surg 1998;102:1954-61.
9. Lee RH, Gamble WB, Robertson B, Manson PN. The MCFONTZL classification system for soft-tissue injuries to the face. Plast Reconstr Surg 1999;103:1150-7.
10. Draaijers LJ, Tempelman FR, Botman YA, Tuinebreijer WE, Middelkoop E, Kreis RW, *et al*. The patient and observer scar assessment scale: A reliable and feasible tool for scar evaluation. Plast Reconstr Surg 2004;113:1960-5.
11. Oral and Maxillofacial Surgery for the Clinician. Editors: Krishnamurthy Bonanthaya, Elavenil Panneerselvam, Suvy Manuel, Vinay V. Kumar, Anshul Rai. © The Association of Oral and Maxillofacial Surgeons of India 2021. https://doi.org/10.1007/978-981-15-1346-6
12. Rusciani L, Paradisi A, Alfano C, et al. Cryotherapy in the treatment of keloids. J Drugs Dermatol. 2006;5:591.
13. Cadet N, Hardy I, Dudek D, Miszkiewicz K, Boulos P, Nguyen Q, Wong J. Prospective case-control trial evaluating silicone gel for the treatment of direct brow lift scars. Can J Ophthalmol. 2018 Feb;53(1):29-33. doi:10.1016/j.jcjo.2017.07.017 PMID: 29426436.
14. Kadakia S, Ducic Y, Jategaonkar A, Chan D. Scar Revision: Surgical and Nonsurgical Options. Facial Plast Surg. 2017 Dec;33(6):621-626. doi: 10.1055/s-0037-1607446. Epub 2017 Dec 1. PMID: 29195243
15. Tripathi PB, Nelson JS, Wong BJ. Posttraumatic Laser Treatment of Soft Tissue Injury. Facial Plast Surg Clin North Am. 2017 Nov;25(4):617-628. doi: 10.1016/j.fsc.2017.06.012. PMID: 28941513.
16. Tenzel PA, Patel K, Erickson BP, Shriver EM, Grunebaum LD, Alabiad CR, Lee WW, Wester ST. Split face evaluation of long-pulsed non-ablative 1,064 nm Nd:YAG laser for treatment of direct browplasty scars. Lasers Surg Med. 2016 Oct;48(8):742-747. doi: 10.1002/lsm.22543. Epub 2016 Aug 9. PMID: 27505684.
17. Lighthall JG, Fedok FG. Treating Scars of the Chin and Perioral Region. Facial Plast Surg Clin North Am. 2017 Feb;25(1):55-71. doi: 10.1016/j.fsc.2016.08.005. PMID: 27888894.
18. Neissen FB, Spauwen PH, Robinson PH, Fedler V, Kon M. The use of silicone occlusive sheeting (Sil-K) and silicone occlusive gel (Epiderm) in the prevention of hypertrophic scar formation. Plast Reconstr Surg. 1998;102:1962–98.
19. Shokri T, Smith J, Ducic Y. Paradigms in Complex Facial Scar Management. Semin Plast

Surg. 2020 Nov;34(4):305-313. doi: 10.1055/s-0040-1721768. Epub 2020 Dec 24. PMID: 33380918; PMCID: PMC7759425.
20. Zito PM, Jawad BA, Mazzoni T. Z plasty. 2020 Nov 11. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2021 Jan–. PMID: 29939552.
21. Cerrati EW, Thomas JR. Scar Revision and Recontouring Post-Mohs Surgery. Facial Plast Surg Clin North Am. 2017 Aug;25(3):463-471. doi: 10.1016/j.fsc.2017.03.014. Epub 2017 May 30. PMID: 28676169.
22. Grassetti L. Lazzeri D. Torresetti M. Bottoni A.S. Di Benedetto G. Aesthetic Refinement of the Dog Ear Correction: The 90° Incision Technique and Review of the Literature. Arch Plast Surg 2013;40:268-269. http://dx.doi.org/10.5999/aps.2013.40.3.268.

OSTEORADIONECROSIS OF THE JAW- A VICIOUS SEQUELAE POST-RADIATION THERAPY

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ABSTRACT

Osteoradionecrosis (ORN) of the jaw is one of the most challenging sequelae of radiation therapy in head and neck cancer which is characterized by bone tissue necrosis and failure to heal over three months without any evidence of persisting or recurrent tumor. In most cases, it increases the challenge with the advancement of the condition. Out of all proposed pathophysiology theories, the fibroatrophic theory is most commonly accepted. Over the years several treatment options have been described including conservative management and surgical resection with reconstruction and more recently the use of antiradiation fibrosis drugs. This review article mainly focuses on understanding the condition of ORN and thereby considering the appropriate treatment options available for its effective management.

Keywords*: Osteoradionecrosis, radiation therapy, head and neck cancer, jaw.*

INTRODUCTION

In head and neck cancers, radiation therapy is most commonly used as supportive therapy for advanced cases and also as a go-to option for smaller yet unapproachable cancer cases. Osteoradionecrosis (ORN) of the jaws is one among the foremost severe and debilitating complications following radiotherapy for head and neck cancer patients.[1]

It is radiation-induced ischaemic necrosis of bone with associated soft tissue necrosis occurring within the absence of primary tumor, recurrence, or metastatic disease.[1]

In 1926, Eiving was the primary to use the term “radiation osteitis,” because the bone necrosis secondary to radiation. In 1974, Guttenberg proposed the term “septic ORN of mandible" to explain when the irradiated bone becomes necrotic and

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superficially infected, ending up with a high risk of involvement of deeper structures.

In 1989, Widmark et al. described ORN as "a non-healing mucosal or cutaneous ulcer with denuded bone, lasting for quite three months." In 1997, Wong et al. defined ORN as "a slow-healing radiation-induced ischemic necrosis of variable extent occurring within the absence of local primary tumor necrosis, recurrence or metastatic disease". The occurrence of ORN in irradiated patients has ranged from 4.7 to 37.5%, although intensity-modulated radiotherapy (IMRT) has reduced this prevalence.[3] ORN usually occurs between 4 months to 3 years following radiotherapy, but it has been reported to occur at any time during the patient's life. The prevalence of mandibular ORN is more as compared to maxillary ORN as it has comparatively poor vascularity and also the mandibular bone is denser. The incidence of ORN increases with the total dose of radiotherapy (> 66 Gy).[4]

Many factors predispose to the event of the ORN: tumor size and its position concerning the bone, treatment of the tumor (surgery, radiotherapy, and chemotherapy), the patient's age, and comorbidities. The incidence and severity of ORN increase with poor dental status, dental extraction sites, local trauma, and excessive alcohol and tobacco consumption.[4]

THEORIES AND PATHOPHYSIOLOGIES

Some theories are proposing that ORN isn't a primary infection of the irradiated bone, but rather a posh metabolic and tissue homeostatic deficiency created by radiation-induced cellular injury. Meyer proposed the classic triad sequence of pathogenesis as radiation, trauma, and infection but further evidence suggested that micro-organisms appear to act more as surface contamination instead of infective agents and that spontaneous ORN may occur without alveolar trauma such as dental extractions.[5]

In 1983, Marx's noticed the radiation effects on the tissue level are endothelial death, hyalinization, and thrombosis of vessels. Bone osteoblasts and osteocytes become necrotic. Periosteum, mucosa, and skin also become fibrotic, with markedly diminished cellularity and vascularity of the connective tissue. He concluded that hypovascular-hypoxic hypocellular tissue was formed after radiation, and ORN resulted from the loss of reparative and artificial function that cause chronic non-healing wounds with metabolic demands outstripping supply due to persistent hypoxia.[6]

In 2004, Delanian and Lefaix introduced the 'fibroatrophic theory' of ORN in which radiation-induced fibrosis of both soft and hard tissue was thought to result in chronic non-healing wounds in previously irradiated bone. Fibroblast activation and dysregulation are the cornerstones of this theory.[7,8] [Illustration 1]

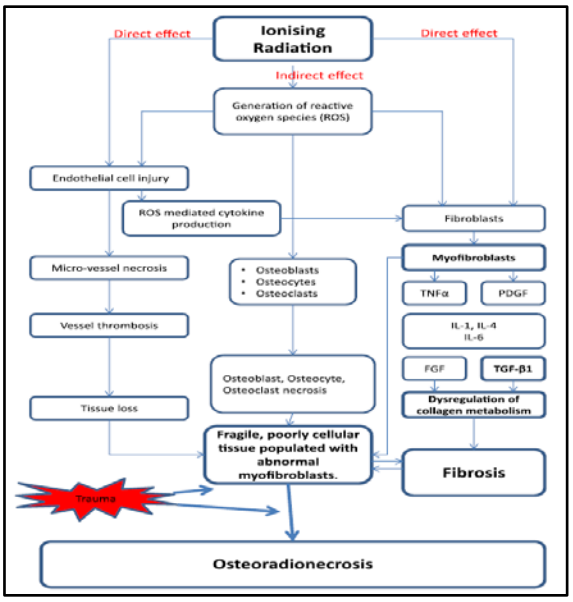

Illustration *1*: The ionizing radiation-induced fibroatrophic process.[8]

CLASSIFICATION OF ORN

There are multiple staging systems for ORN supported either clinical, radiological, or treatment modalities. Marx's initial classification system was widely used but was limited because it was based on clinical response to a specific treatment, namely hyperbaric oxygen therapy (HBOT).[9] Epstain et al. gave classification based on imaging and clinical findings of ORN.[10] Glanzmann and Grätz classified ORN stages according to the duration of bone exposure and treatment necessity.[11] Schwartz and Kagan proposed the classification supported clinical and radiological findings to classify the extend of necrotic bone involvement.[12] Notani et al. divided the cases into three grades supported the extent of the ORN lesion associated with the alveolar canal.[13] [Table 1]

Reference	Stages	Basis of stage
Marx 1983	I-III	Based on response to hyperbaric oxygen therapy I: 60 dives- full mucosal coverage. II: Sequestrectomy & 60 dives- full mucosal coverage. III: Pathologic fracture, Orocutaneous fistula, radiographic evidence of resorption to inferior border. 30 dives & resection.
Epstein et al. 1987	I-III	Based on imaging and clinical findings I: Resolved or healed ORN. II: Chronic (>3 months), persistent, non-progressive ORN. III: Progressive, active ORN.
Glanzmann and Gratz 1995	I-V	Duration of bone exposure and treatment necessity I: Bone exposure without signs of infection and persisting for at least 3 months Duration of bone exposure and treatment necessity. II: Bone exposure with signs of infection or sequester and without the signs of stage III-V. III: Bone necrosis treated with mandibular resection with a satisfactory result. IV: Bone necrosis with persisting problems despite mandibular resection. V: Death from ORN.
Kagan and Schwartz 2002	I-III	Based on imaging and clinical findings I: Superficial involvement of the mandible only. II: Localised involvement of the mandible. III: Diffuse involvement of the mandible.
Notani et al. 2003	I-III	Based on imaging and clinical findings I: ORN confined to alveolar bone. II: ORN limited to alveolar bone and/or the mandible above level of mandibular canal. III: ORN extended to mandible under level of mandibular canal with ORN skin fistula or pathological fracture.

Table 1: Different type of classification stages of ORN.[9,10,11,12,13]

RISK FACTORS

The development of ORN is depends on many factors. These risk factors are associated with characteristics of primary cancer, the treatment, and patient hygiene and habits. Following are the risk factors.[14]

Risk Factors	Increased Risk of Osteoradionecrosis
Location of primary tumor	Tongue, floor of mouth, alveolar ridge, retromolar trigone, tonsil
Stage of cancer	Stage III/IV
Dose of radiation	Doses >60 Gy
Prior surgery for primary tumor	Mandibulectomies or osteotomies before radiation
Oral hygiene	Periodontal disease; oral hygiene also influences response to treatment
Dental extractions	Extraction after radiation exposure
Alcohol use	Continued use during and after radiation therapy
Tobacco use	Continued use during and after radiation therapy
Nutritional status	Poor nutrition affects wound healing

Illustration *2:* Risk factors associated with osteoradionecrosis.[14]

INVESTIGATION OF OSTEORADIONECROSIS

ORN can be investigated by many techniques, including radiographs, CT scans, MRI, doppler ultrasound, nuclear medicine, and near-infrared spectroscopy. According to Hutchinson, the perfect investigative tool should be ready to offer the following: (1) record quantitatively and qualitatively the severity and extent; (2) monitor the progress of treatment; (3) predict patients at risk; (4) predict risk factors more confidently; (5) permit comparison of treatment regimens; (6) predict the bone level damage above which surgery is essential.[15]

Radiographic images like orthopantomogram (OPG), with extraoral or intraoral radiographs, the foremost commonly used, and therefore the radiological appearance of ORN is that of a mixed radio-opaque radiolucent lesion, with the radiolucent areas representing bone destruction.

Computed tomography (CT) scans have similar limitations as traditional radiographs for the mandible or maxilla. Magnetic resonance imaging (MRI) suggests the amount of fibrosis of bone marrow in ORN. Positron emission tomography (PET) has been advocated as having the ability to differentiate between ORN and recurrent tumors.[15] Radionuclide bone scanning with technetium methylene diphosphonate (99mTc-MDP) can identify pathophysiologic changes in bone before conventional radiography because scan changes reflect osteoblastic activity and good blood flow. Near-infrared spectroscopy (NIRS) is a recognized non-invasive method, used largely to monitor cerebral tissue oxygenation and ischaemic changes.[15]

MANAGEMENT

Both medical and surgical management is used for ORN, depending on the severity of the condition. Medical management techniques include conservative management, including oral care, and native debridement, alone or combined with ultrasonography or hyperbaric oxygen. Surgical management involves resection of the necrotic bone and soft tissue with various reconstructions. An overview of the management of ORN, pre-post-radiation, is outlined.[1] [Illustration 3]

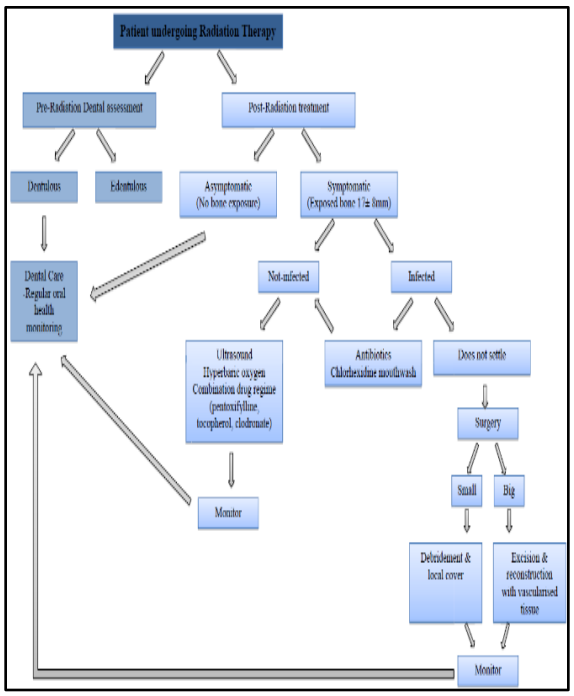

Illustration *3:* Overview of the management of ORN, pre-and post-radiation.[1]

Conservative Management

Conservative management consists of avoidance of irritants such as tobacco, alcohol, and ill-fitting dentures as well as

local wound irrigation with antiseptic solutions including chlorhexidine, sodium iodide, and peroxide, oral hygiene improvement, local application of antiseptics, curettage, debridement, sequestrectomy, bone filing and hyperbaric oxygen therapy (HBOT) and drugs that reduce post-RT fibrosis such as pentoxifylline and tocopherol.[14]

Antibiotic therapy based on Gram stain results and culture identification with antimicrobial sensitivity is indicated for secondary infection, whereas analgesics are used to control the pain. Ampicillin/sulbactam may be used for prophylaxis and suspicion of secondary infection may require amoxicillin/clavulanic acid plus fluoroquinolone.[16]

ORN cases with unresponsiveness to conservative treatments, persistent pain, trismus, ulcers, large necrotic tissue, a cutaneous fistula, or pathological fracture require more aggressive therapies. Nonetheless, the definite boundary between conservative and radical treatments remains unclear. Early diagnosis and prompt treatment are necessary to stop disease progression.

Hyperbaric oxygen therapy

Since first being introduced for use in ORN by Hart and Mainou in 1975, HBOT has become an increasingly popular treatment for ORN. Recently, however, there has been some controversy regarding its effectiveness.[14] It involves breathing 100% oxygen in a pressure chamber at 1.5 atmospheres or greater. Hyperbaric oxygen therapy benefits ORN by promoting angiogenesis, and hence, increasing tissue oxygenation, by controlling infection, predominantly through enhanced bacterial killing, and by stimulating fibroblast replication and development of a collagen matrix.[17]

HBOT is employed within the treatment of ORN during a sort of clinical situations. It is used as part of conservative management or combined with surgical treatment, or maybe applied prophylactically when a procedure, such as a tooth extraction, is performed. Marx was one of the initial proponents of HBOT for the treatment of ORN. In 1983 he introduced a treatment protocol combining HBOT with surgery known as the Marx's protocol.[6,16] [Illustration 4]

In a randomized trial Marx and colleagues showed that HBOT before and after dental extraction, in previously radiated patients, decreased the danger of ORN as compared with penicillin alone. The current protocol for HBOT includes 20 to 30 dives at 2.0 to 2.5 atmospheres for 90 to 120 minutes at each session, once a day for 5 days. If a dental extraction or surgery is performed, the patient takes a further 10 dives. Complications of HBOT include eustachian tube dysfunction, tympanic-cavity barotrauma, seizure, and aeroembolism. The main contraindications are optic neuritis and pulmonary disease.[14]

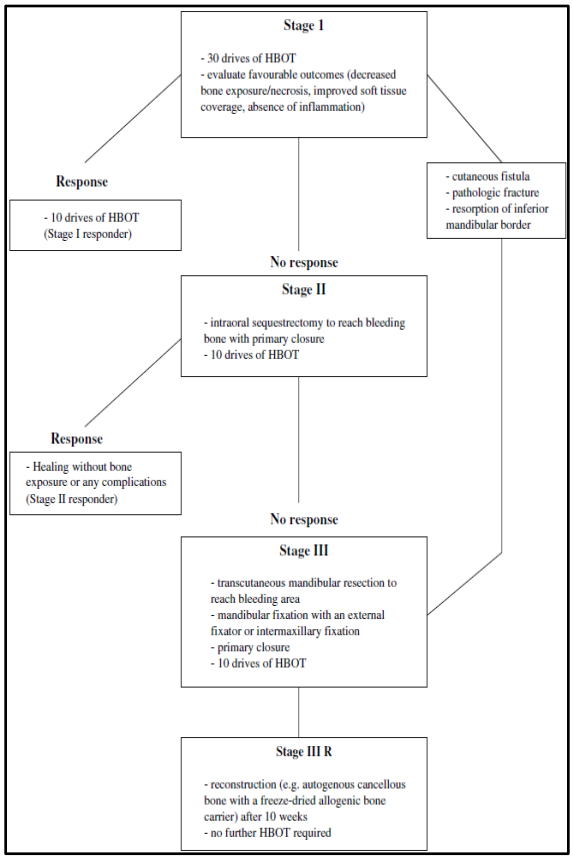

Illustration *4:* Marx's protocol. One drive of HBOT=100% O2, 2.4 atm, 90 min/day, 5 days/week.[6,16]

Ultrasound Therapy

The use of ultrasound has also been proposed as a conservative treatment for ORN and an alternate to HBOT. The use of ultrasound in ORN was started after it was successfully used in the healing of ischemic varicose ulcers and fracture non-union. It has been shown that ultrasound increases angiogenesis and stimulates collagen and bone production. Harris proposed a protocol of 40 to 50 10-minute sessions until healing is complete. Ultrasound can also be used as prophylaxis before post-radiation dental extractions.[17]

Pentoxifylline-Tocopherol-Clodronate Combination (PENTOCLO)

This new adjunctive treatment in ORN is the pentoxifylline (PTX)-tocopherol (TCP)-clodronate (CLO) combination (PENTOCLO) to radiation-induced fibrosis and bone destruction and to stimulate osteogenesis via the antioxidant pathway.[2] Based on the radiation-induced fibrosis theory of ORN pathogenesis, this mix therapy targets radiation-induced bone fibrosis and stimulates osteogenesis via the antioxidant pathway. Pentoxifylline is a methylxanthine derivative that exerts an anti–TNF-a effect vasodilates and inhibits inflammatory reactions. Tocopherol (vitamin E) scavenges the ROS generated during oxidative stress. These two drugs work synergistically as potent antifibrotic agents. Clodronate is a bisphosphonate that inhibits osteoclastic bone destruction and osteolysis.[14]

One phase II trial included refractory ORN patients and they were given a daily combination of twice-daily 400 mg PTX (800 mg/day) plus 500 IU vitamin E (1,000 IU/day) and once-daily 1,600 mg/day CLO for five days a week, the results showed improvement in reduction of exposed bone and all 54 participants experienced incomplete recovery in a median of nine months.[18] Another study has patients receive a daily dose of 800 mg of PTX, 1 g of TCP, 1,600 mg of CLO five days a week, and 20 mg of prednisone on the other two days a week. After 12 months of this PENTOCLO treatment, they found 71.4% of patients showed radiological regression, and all patients return to oral feeding and 57.1% no longer require analgesics.[2]

Surgical Therapy

Surgical intervention is indicated in severe cases that present with large intra-oral ulcerations and/or fistula formation, radiographically detected osteolysis of the inferior mandibular border, or a pathological fracture. Surgery involves resection of all involved necrotic bone and soft tissue and first reconstruction. The extent of planned bony resection is initially supported preoperative imaging studies. However, the last word extent of resection is predicted on intraoperative findings. Resection is continued until the presence of healthy bleeding bone at the margin is identified.[14] Reconstructive techniques comprise the use of reconstruction plates, autogenous bone grafts, regional flaps, and free tissue transfer. When conservative treatments fail, close surveillance and early aggressive resection with immediate free flaps create more reliable, functional, and aesthetically desirable outcomes. Vascularised grafts can be harvested from the fibula, iliac crest, scapula, and radius. Several factors, including the size and location of the defect, quality of the recipient bed, overall patient health and prognosis, and surgeon's favour or experience, affect the donor site selection.[16]

In a systematic review of microvascular free flap reconstruction for mandibular ORN, the fibula free flap was the foremost common and reliable "workhorse" flap used for reconstruction. The problems associated with reconstruction include vessel depletion for microvascular reconstruction and the presence of fibroused avascular tissue that had resulted in a higher risk of failure rate (10%) and post-operation complication rate (40%).[19]

PREVENTION OF ORN

ORN can be prevented by minimizing the risk factors, including dental care and the use of intensity-modulated radiation therapy. It is necessary to extract the teeth before radiation therapy in various conditions such as moderate to advanced periodontal disease, extensive periapical lesions, partially impacted teeth, or infected root stumps. Teeth that are completely covered by bone and mucosa are often left without increased risk of lately problems. It is recommended to provide a 2 to 3 weeks' healing interval between tooth extraction and the onset of radiation therapy.[14] Following the dental extractions, it is advisable to prescribe systemic antibiotics and oral rinse with 0.2% chlorhexidine on the day of extraction, for at least seven days.[2] Sialagogue should be prescribed for stimulation of the saliva which can help in lubrication of oral mucosa. It is very important to maintain good oral hygiene before, during, and after radiation therapy, and especially the use of high-fluoride toothpaste should be promoted.

CONCLUSION

ORN is a severe complication of radiotherapy related to a failure of healing for which no standard treatment is available. Conservative treatments are indicated for early and limited ORN lesions. In case of huge defects with an ulcer, large exposed bone, a fistula or pathological fracture, or resorption of the inferior mandibular border, jaw resection is suggested.

REFERENCES

1. Rice N, Polyzois I, Ekanayake K, Omer O, Stassen LF. The management of

osteoradionecrosis of the jaws—a review. Surgeon 2015;13:101–9.
2. Hwang LA, Chang CH, Tai WC, Su WC. Current Management of Osteoradionecrosis of Jaw in Head and Neck Cancer. Int J of Head and Neck Science. 2019;3:92-98.
3. Dumoulin S, van Maanen A, Magremanne M. Dental prevention of maxillo-mandibular osteoradionecrosis: A ten-year retrospective study. J Stomatol Oral Maxillofac Surg. 2021;122:127-34.
4. Robard L, Louis MY, Blanchard D, Babin E, Delanian S. Medical Treatment of Osteoradionecrosis of the Mandible by PENTOCLO: Preliminary Results. Eur Ann Otorhinolaryngol Head Neck Dis 2014;131:333-38.
5. Fan H, Kim SM, Cho YJ, Eo MY, Lee SK, Woo KM. A new approach for the treatment of osteoradionecrosis with pentoxifylline and tocopherol. Biomater Res 2014;18:13.
6. Marx RE. Osteoradionecrosis: A New Concept of Its Pathophysiology. J Oral Maxillofac Surg 1983;41:283-88.
7. Delanian S, Lefaix JL. The Radiation-induced Fibroatrophic Process: Therapeutic Perspective via the Antioxidant Pathway. Radiother Oncol 2004;73:119-31.
8. McCaul JA. Pharmacologic modalities in the treatment of osteoradionecrosis of the jaw. Oral Maxillofac Surg Clin North Am 2014;26:247–52.
9. Marx RE. A new concept in the treatment of osteoradionecrosis. J Oral Maxillofac Surg 1983;41:351–7.
10. Epstein JB, Wong FL, Stevenson-Moore P. Osteoradionecrosis: clinical experience and a proposal for classification. J Oral Maxillofac Surg1987;45:104–10.
11. Glanzmann C, Grätz KW. Radionecrosis of the Mandibula: A Retrospective Analysis of the Incidence and Risk Factors. Radiother Oncol 1995;36:94-100.
12. Schwartz HC, Kagan AR. Osteoradionecrosis of the Mandible: Scientific Basis for Clinical Staging. Am J Clin Oncol 2002;25:168-71.
13. Notani K, Yamazaki Y, Kitada H, et al. Management of Mandibular Osteoradionecrosis Corresponding to the Severity of Osteoradionecrosis and the Method of Radiotherapy. Head Neck 2003;25:181-86.
14. O'Dell K, Sinha U. Osteoradionecrosis. Oral Maxillofac Surg Clin North Am. 2011;23:455-64.
15. Chrcanovic BR, Reher P, Sousa AA, Harris M. Osteoradionecrosis of the jaws—a current overview—part 1. Oral Maxillofac Surg 2010;14:3–16.
16. Pitak-Arnnop P, Sader R, Dhanuthai K, Masaratana P, Bertolus C, Chaine A, Bertrand JC, Hemprich A, Management of osteoradionecrosis of the jaws: An analysis of evidence. Eur J Surg Oncol EJSO 2008;34:1123–34.
17. Deshpande SS, Thakur MH, Dholam K, Mahajan A, Arya S, Juvekar S. Osteoradionecrosis of the Mandible: Through a Radiologist’s Eyes. Clin Radiol 2015;70:197-5.
18. Delanian S, Chatel C, Porcher R, Depondt J, Lefaix JL. Complete Restoration of Refractory Mandibular Osteoradionecrosis by Prolonged Treatment with a Pentoxifylline- Tocopherol-Clodronate Combination (PENTOCLO): A Phase II Trial. Int J Radiat Oncol Biol Phys 2011;80:832-39.

19. Lee M, Chin RY, Eslick GD, Sritharan N, Paramaesvaran S. Outcomes of Microvascular Free Flap Reconstruction for Mandibular Osteoradionecrosis: A Systematic Review. J Craniomaxillofac Surg 2015;43:2026-203.

TREATMENT ALGORITHM FOR MANDIBULAR RECONSTRUCTION AND DENTAL REHABILITATION

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ABSTRACT

Mandibular reconstruction has been the subject of much debate and research in the fields of maxillofacial surgery and head and neck surgery. Reconstruction of the mandible is challenging because of the unique anatomy, the presence of vital structures and the diversity of defects. The primary objective of mandibular reconstruction is restoration of function with speech and swallow & desirable esthetics. Complexity of mandibular reconstruction ranges from simple rigid internal fixation to microvascular free tissue transfer, depending on factors related to both defect and patient. Three-dimensionally printed patient-specific surgical plates and implants have also been used for reconstructing the mandibular defects. While selecting a particular method of reconstruction, the surgeon must evaluate which components of the hard and soft tissue are missing that can be tailored to patients' specific needs.

Keywords*: Mandibular reconstruction, defect, dental rehab*

INTRODUCTION

Acquired defects of the mandible result from trauma, infection, osteoradionecrosis, and, most commonly, ablative surgery of the oral cavity and lower face. These defects are particularly debilitating not only because of the profoundly negative effect they have on facial appearance but also because they create disabilities of mastication and swallowing along with poor speech and oral competence.[1] Restoration of mandibular continuity and functionality, and attempting to return patients to their premorbid state, is the ultimate goal of reconstruction. Reestablishing jaw function, including chewing, swallowing, oral competence, and speech, is essential to providing successful execution of microvascular reconstruction. To achieve these goals, the reconstructive surgeon must address bony continuity, tongue mobility, and restoration of sensation to denervated areas. [2, 3]

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In 1986, Swartz et al. introduced the scapular osteocutaneous free flap (SOFF) for use in head and neck reconstruction. In 1989, Hidalgo became the first to report the transfer of fibular bone to reconstruct a segmental defect of the mandible. Bradley in 1978 and 1982 reported a two-stage procedure for reimplantation of 'autogenous freeze treated mandibular bone'. In 2010, Kuo et al. combined partial soleus muscle with fibula osteoseptocutaneous flap for dead space obliteration. Since then, modern surgery has developed more effective techniques including nonvascularized bone grafting, improved alloplastic materials, locoregional flaps, and vascularized soft-tissue and composite flaps with virtual planning.[1,15]

CLASSIFICATION OF MANDIBULAR DEFECTS

Most of the classifications are directed to defects including bony defects of the mandible after surgical excision of mandibular tumors or composite defects. The most accepted classification is given by Brown et al 2016. (Table 1) [5,6]

Brown classification 2016	
Class I (angle)	Lateral defect not including ipsilateral canine or condyle
Class Ic (angle and condyle)	Lateral defect including condyle
Class II (angle and canine)	Hemimandibulectomy including ipsilateral but not contralateral canine or condyle
Class IIc (angle, canine, and condyle)	Hemimandibulectomy including condyle
Class III (both canines)	Anterior mandibulectomy includes both canines but neither angle
Class IV (both canines and at least one angle)	Extensive anterior mandibulectomy including both canines and one or both angles
Class IVc (both canines and at least one condyle)	Extensive anterior mandibulectomy including both canines and one or both condyles

Table 1- Classification of mandibular defect.[5]

RECONSTRUCTIVE OPTIONS

RIGID FIXATION WITH INTERNAL PLATING

Fixation of mandibular segments with an intervening bony gap using titanium plates has been a well-described option in mandibular reconstruction since the 1980s. The most common metals used in the fabrication of these plates are stainless steel, vitallium, and titanium. Vitallium is an alloy of cobalt, chromium, and molybdenum. This type of plate initially seemed to be ideal; however, the low malleability can make application difficult. AO stainless steel and AO titanium reconstruction plates were developed in an attempt to find a mandibular reconstructive option that was fast, single-staged, and reliable while maintaining oral function and form.

The titanium hollow osseointegrated reconstruction plate (THORP) reconstruction plate system uses a perforated hollow titanium screw that allows bone ingrowth and

osseointegration This method provides a simple way to prevent collapse of the lowerface and provide a framework for soft tissues supported by the mandible. When applying this technique, locking plates and screws can be helpful in preventing bone resorption around the hardware and subsequent loosening and infection of the plate. It is considered an option for patients who may not tolerate other means of reconstruction because of medical comorbidities or as a temporary measure before definitive reconstruction. [1, 15, 17]

TECHNIQUES FOR BONE REPLACEMENT

1. Non-vascularized bone grafts
2. Vascularized free flaps [15]

For primary reconstruction of segmental defects, patient's with preoperative radiation therapy, defects >6 cm, and where composite hard/soft tissue is required, vascularized bone flap (VBF) is indicated. For shorter defects (<6 cm), non-continuity defects, defects with no soft tissue requirement, and ability for secondary reconstruction, many defects are amenable to reconstruction with non-vascularized bone grafts (NVBG). Osborn et al suggested the use of NVBG alone in continuity defects <9 cm, and with an osteoconductive crib in defects >9 cm.[4]

NONVASCULARIZED AUTOGENOUS BONE GRAFT

The most common option for mandibular reconstruction at present is the iliac crest graft from either an anterior or posterior approach, rib and tibia graft. The rationale is to transfer as many osteocompetent cells as possible to the recipient site. This action is best accomplished with cancellous bone chips, often with crib or scaffold that resorbs over time. Such a reconstruction can be a useful option for shorter segmental defects or marginal defects, especially those resulting from trauma or benign disease not requiring radiation.[4]

ILIAC CREST GRAFT

Non-vascularized iliac crest bone grafts are highly successful in mandibular continuity reconstruction for non-cancer patients and should be considered as first choice for defects less than 9 cm.It can be used to reconstruct the medium size defects as well as for reconstruction of entire ramus and posterior portion of the mandibular body. Because of the natural curvature the iliac crest can be sculpted to reconstruct the hemi mandible.[15]

RIB GRAFT

The rib can be used as whole rib or split rib graft. The whole rib graft is less successful because it gets revascularized very slowly owing to the absence of exposed cancellous bone. On the contrary split rib grafts provide large areas of exposed cancellous bone for its rapid revascularization. Two split rib grafts (joined to each other anteriorly and inserted into the rami posteriorly on each side—Frys technique) can be used to reconstruct the entire mandible.[4, 15, 17]

VASCULARIZED FREE TISSUE TRANSFER

The use of microvascular techniques for free tissue transfer has become the gold standard for oromandibular reconstruction. Since the 1980s this method has revolutionized maxillofacial reconstruction. These well-

vascularized reconstructions are able to resist infection in the face of oral contamination, permit simultaneous hard-tissue and soft-tissue reconstruction, heals by resorption of old bone and deposition of new bone, i.e., creeping substitution and allow rapid dental rehabilitation with endosseous implants. Their overall rate of success has been reported as greater than 95%. For reconstruction of the oromandibular complex, most common flaps are: fibula, iliac, scapula, anterolateral thigh and radius free forearm flap. Schultz et al. in 2015 gave algorithm for microvascular reconstruction for mandibular reconstruction. (Illustration 1) [2, 15]

FIBULA FLAP

The fibula flap was first described for mandibular reconstruction in 1989 by Hidalgo and it remains a commonly used flap because of its versatility. Up to 25 cm of bone can be harvested for long segmental defects, and the flap can be used as either an osseous or osteocutaneous flap by including septocutaneous or musculocutaneous perforators to the skin. The skin paddle can be used to close several mucosal or cutaneous defects. The cross-sectional shape of the bone allows for bicortical placement of dental implants, thus allowing for immediate dental reconstruction because of the excellent primary stability. The flap can also be made sensate by anastomosis to the lateral sural cutaneous nerve.

While the fibula osteocutaneous flap, is the most often choice of flap, allows for osteotomy and placement of dental implants, there are various modifications to improve the oral sphincter, reduce postoperative wound infection, and reduce donor site morbidity. The improvements include pedicled myoosseous flap with free skin flap, double free flaps with the tensor fascia lata for composite oromandibular defect reconstruction, and the fibula flap with a segmental soleus muscle for augmentation of submandibular dead space.

In addition, the fibula can easily be harvested with a 2-team approach, saving time under anesthesia and in the operating room. The dominant pedicle to the fibula flap is the peroneal artery, preoperative assessment of the lower extremity vasculature is required to ensure adequate perfusion to the flap as well as to the foot by remaining tibial vessels. (Illustration 5) [1, 6, 13, 16]

ILIAC CREST FLAP

Taylor and colleagues pioneered the use of the iliac crest flap as supplied by the deep circumflex iliac artery (DCIA), and its use in mandibular reconstruction. The increased bone height (2.5 vs. 1.5 cm for fibula) and thickness of the bone that can be obtained makes it a useful alternative for mandibular reconstruction. It is particularly useful in areas requiring closer height match to the native mandible, such as in anterior defects. This closer match facilitates dental rehabilitation. 14 cm of bone can be harvested from iliac crestal flap. (Illustration 2)

This flap can also be harvested as an osteocutaneous or osteomyocutaneous flap for reconstruction of soft tissues. An additional benefit to this technique is that it leaves the separate skin paddle for closure of any skin defect that may exist, making this flap useful for through and through defects as

well. Unlike the fibula, a DCIA flap is less likely to be compromised in patients with atherosclerosis, leaving this option available in the vasculopathic population.[3]

SCAPULAR FLAP

Another option for reconstruction of oromandibular defects is the scapular flap. Based on the subscapular system, specifically the circumflex scapular artery, a variety of composite flaps may be obtained. These flaps contain skin, muscle, and bone, including separate soft-tissue paddles based on the transverse and descending cutaneous branches of the circumflex scapular artery, all of which makes the scapular flap versatile for complex reconstructions. It can be harvested from lateral aspects (10-14 cm) and medial aspects (12-14cm) of scapula. Further versatility is provided by the fact that the thoracodorsal system can be accessed simultaneously, allowing for harvest of latissimus dorsi or tip of scapula on a separate pedicle.[1, 6]

RADIAL FOREARM

The radial forearm free flap is a fasciocutaneous flap that is useful in numerous ways for soft tissue defects including components of the oral cavity, oropharynx, and skin. It provides a pliable skin paddle with good color match based on the radial artery and vena comitantes or cephalic vein. Described initially by Yang and colleagues,it was Soutar and colleagues who introduced the osseous component by harvesting radius as part of the flap. Though it is worth mentioning as an option for mandibular reconstruction, the fact is that the bone stock is quite limited. 10cm of length can be achieved, but only 40% of radius can be harvested. Along with the significant risk of pathologic fracture, this has relegated the radial forearm flap to a secondary role in oromandibular reconstruction.[1, 6, 15]

ANTEROLATERAL THIGH

The ALT vascular axis also offers the option of harvesting the vastus lateralis flap, and can be harvested as a muscle flap or myocutaneous flap. This can provide additional soft-tissue coverage and can be used to resurface salvaged post-radiotherapy tissues, for example, skin of the cheek or neck. Up to 10*25 cm of skin can be harvested from this flap.[10, 15]

PECTORALIS MAJOR MYOCUTANEOUS FLAP

The pectoralis major myocutaneous (PM) flap was first described for head and neck reconstruction in 1979. It quickly became the cornerstone technique for reconstruction of large defects of the lower third of the face and neck. The ideal use of the PM flap is for the mandible, floor of mouth, upper neck, and lower one-third of the face. When defects are primarily mucosal or cutaneous, the bulk of the PM muscle and subcutaneous tissues can be problematic. A thinner or more delicate free flap should be considered in these instances. The bulk of muscle and subcutaneous tissue may be advantageous for large vessel coverage when a neck dissection or large resection is to be performed. If an osseous continuity defect is to be restored, a reconstruction bar is placed to maintain the native anatomy and prevent contracture. Definitive osseous reconstruction may be performed at a later date.[15, 17]

RECENT ADVANCES

Technological advances in medical imaging and rapid prototyping allows for the production of three-dimensional models. In cases where the mandible has been previously resected or destroyed by osteoradionecrosis, a digitally created ‘‘virtual’’ mandibular arch based on mirroringor a CT dataset with an appropriate occlusal relationship to the maxilla permits the reconstructive surgeon to contour a plate preoperatively or intra-operatively that will provide the patient with optimal post-operative occlusion. Three-dimensional modelling of the bone graft can also produce templates for contouring osteotomies, which saves the surgeon time and maximizes bone to bone contact to promote a strong bony union. CAD-CAM technologies also offer cutting guides for the mandible which can improve the accuracy of 3D contouring. (Illustration 3) [9,11,14,15]

3D-PRINTED TITANIUM IMPLANT

3D-printed titanium implant has successfully been used for the reconstruction of facial bone defect including the mandible. The advantage of 3D-printed titanium implant is that it can be designed according to the defect size and morphology. Customized titanium implants can be fitted accurately in the defective site without interference. It allows for reduced operating time and also recovers the original contour of the mandible and facial symmetry. Even so, 3D-printed titanium implant has its limitations regarding oral function in occlusal rehabilitation. (Illustration 4)

There are several ways to install fixed prosthesis on titanium implants, one of which is via the abutment designed as part of the titanium implant. Lee et al. reported the use of titanium mandibular implant with 2 abutment projections to rehabilitate occlusion. Another possible way to install fixed prosthesis is by installing the conventional dental implant to the titanium implant. The concept of submerged dental implant procedure was applied to allow initial healing period for osseointegration to the titanium mandible and promote barrier formation of soft tissue surrounding the titanium mandible including the periosteum. After this period, the dental implants were exposed to the oral cavity, and procedures for permanent prosthesis installation were carried out by the conventional method. The use of vascularized bone flap technique has been the golden standard for mandibular reconstruction treatment because it allows dental implant installation, promoting occlusal rehabilitation. [9, 12]

TRANSPORT DISC DISTRACTION OSTEOGENESIS (TDDO)

In 1995, Constantino et al. successfully applied transport distraction to restore the continuity of a mandibular defect formed as a result of cancer resection following radiation therapy in a patient. Transport distraction for reconstruction of continuity defects is most efficient for defects of the mandibular body. When used to reconstruct a defect of the body of the mandible, the transported segment not only achieves bone continuity but also, through histiogenesis, the associated attached tissue is reconstructed achieving a natural ridge with a vestibule to reconstruct a defect

of the symphysis, the best plan is to create transport discs from the right and left posterior stumps of the mandible and move them toward the symphysis. The residual defect in the symphysis requires a bone graft. An alternative plan is to transport right and left transport discs forward from the body with a vector that lets them consolidate in the midlineand then follow that procedure with a second midline osteotomy and application of a midline distracter to widen the symphysis.[15, 17]

MODULAR ENDOPROSTHESIS

Mandibular modular endoprosthesis is a novel method for alloplastic mandible reconstruction with replacement of the mandibular body and the ascending ramus/condyle unit. This technique emphasizes on removal of all diseased bone, followed by replacement with an artificial device fixed within the remaining bone using bone cement. Endoprosthesis is a metallic device fixed into the medullary space of the mandibular stump after resection. There is no need for screw fixation. The variable length of the bone gap can be bridged by using modules that allow for accurate 3d reconstructions. The modules are connected by a locking system. Occlusal rehabilitation may be achieved on implants that are screwed into existing holes of the endoprosthesis.

Animal studies by Lee et al. and Goh et al.for mandibular body and also ramus/condyle replacements revealed that it was unable to withstand the stresses that developed with mastication, leading to failure.[15, 17]

TISSUE-ENGINEERING

Tissue engineering is an interdisciplinary field that combines the principles of engineering, material and biological sciences toward the development of therapeutic strategies and biological substitutes that restore, maintain, replace or improve biological functions. Growth factors such as bone morphogenic proteins, and platelet rich plasma osteoprogenitor cells produced on a recipient bed can induce adequate regeneration. Tissue engineering can offer solutions.

(1) The shape can be controlled by customised scaffolds on the basis of CAD/CAM and radiographic imaging data.

(2) Bone can be grown in muscular environments and then be harvested with reduced morbidity.

An ideal site for such bone flap prefabrication is the latissimus dorsi muscle.[15, 17]

JAW IN A DAY

Recent advances in computer aided surgical simulation and rapid prototyping of custom surgical jigs, guides, and implants have overcome many of the challenges inherent in composite tissue transfer and facilitated improved accuracy in maxillo-mandibular reconstruction. Even with ideal free flap reconstruction of the mandible or maxilla, return to a full complement of teeth may require several staged procedures over a 6-month to 18-month period.[7]

In 2012, Patel and colleagues described a technique that used digital technology to plan, design, fabricate, and deliver a comprehensive reconstruction for an ablative mandibular defect using a fibular free flap that included immediate implant placement

and a provisionalized fixed dental prosthesis. This technique subsequently was refined and applied to both the maxilla and the mandible and has beentermed, Jaw in a Day. (Illustration 6) [7, 8]

CONCLUSION

Although there are many options for mandibular reconstruction, vascularized bone flaps are unique in that they permit reconstruction of the oromandibular complex even though the recipient bed is often compromised by salivary contamination and prior irradiation. In contrast to nonvascularized bone grafts, vascularized bone grafts remain capable of healing to the adjacent native mandible and eventually withstand the loading forces associated with mastication. The fibular, iliac, and scapular donor sites all provide bone stock sufficient for dental implants in the majority of patients, which has been demonstrated as an essential factor for full oral rehabilitation. Achieving functional and esthetic goals solely on the basis of experience is difficult for surgeons and with newer innovations in computer-assisted techniques such as virtual planning and navigation surgery provides better outcome.

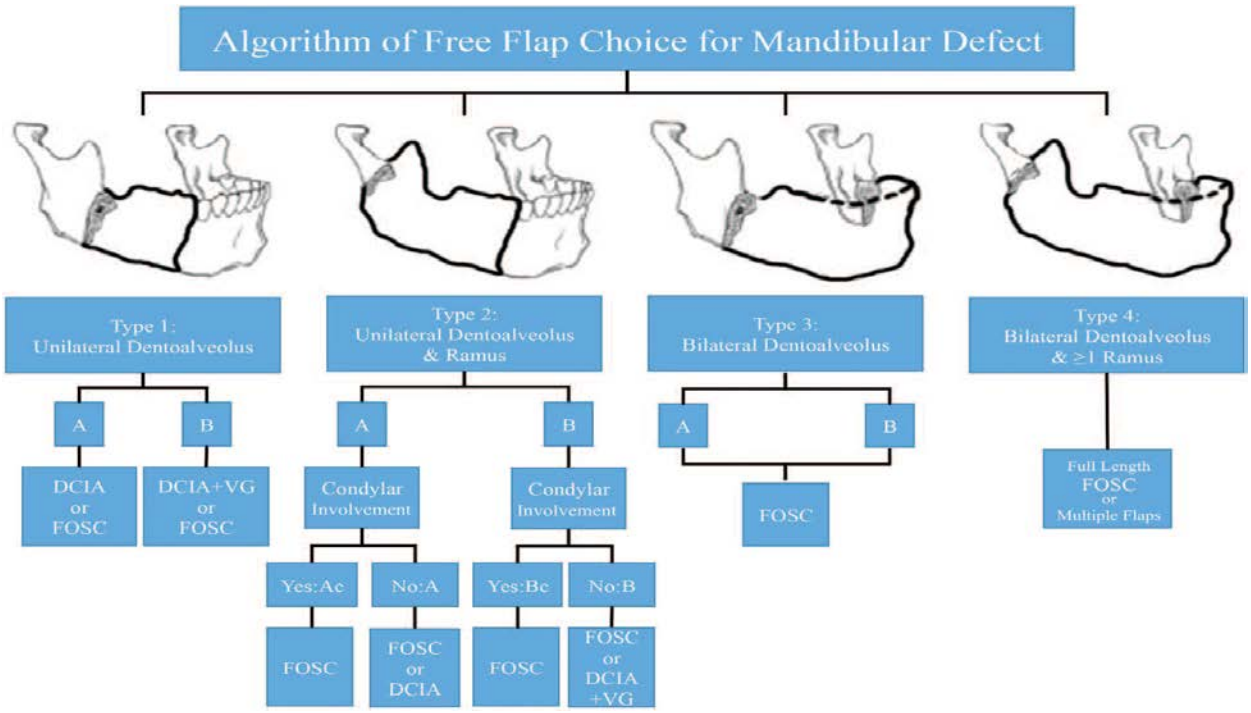

Illustration 1 Flow chart of algorithm for mandibular defect classification and microsurgical repair. *A*, viable ipsilateral vasculature; *B*, nonviable ipsilateral vasculature; *c*, condylar involvement; *DCIA*, deep circumflex iliac artery (iliac flap); *FOSC*, fibula osteoseptocutaneous flap; *VG*, vein graft.[2]

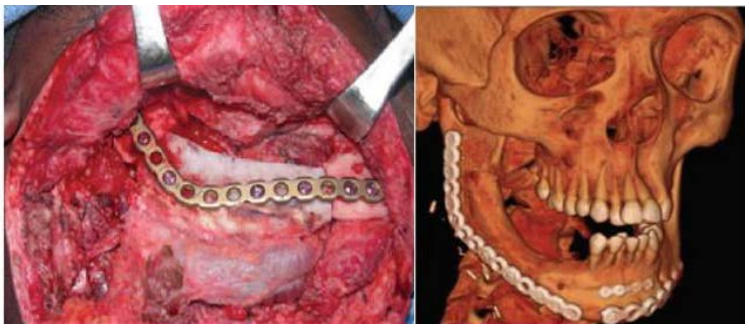

Illustration 2 Reconstruction of a type 2 defect with an iliac crest free flap[2]

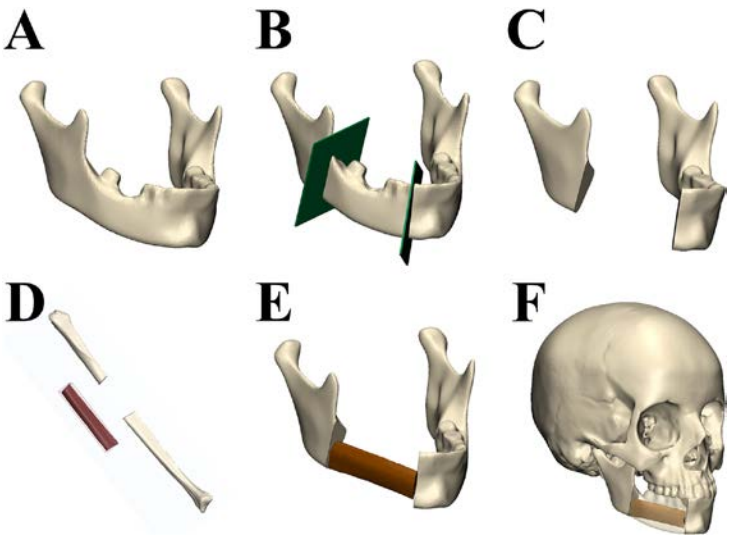

Illustration 3 Preoperative virtual resection of right mandibular lesions, followed by reconstruction with a vascularized fibula flap.[18]

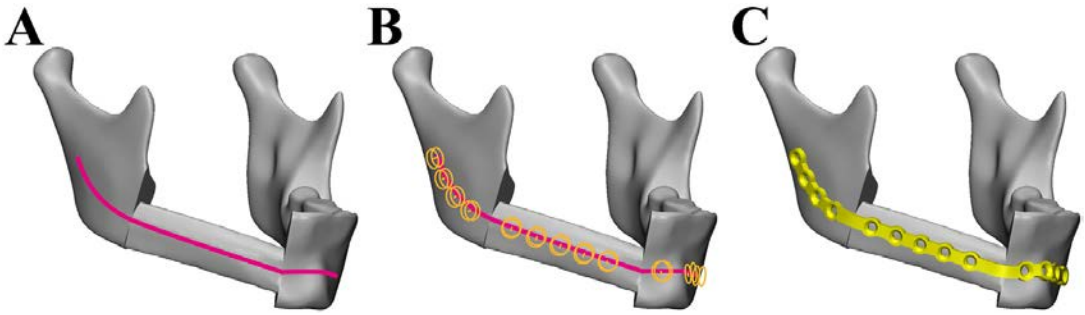

Illustration 4: An intuitive 'surgeon-dominated' method for the design of patient-specific surgical plates for mandibular reconstruction.[18]

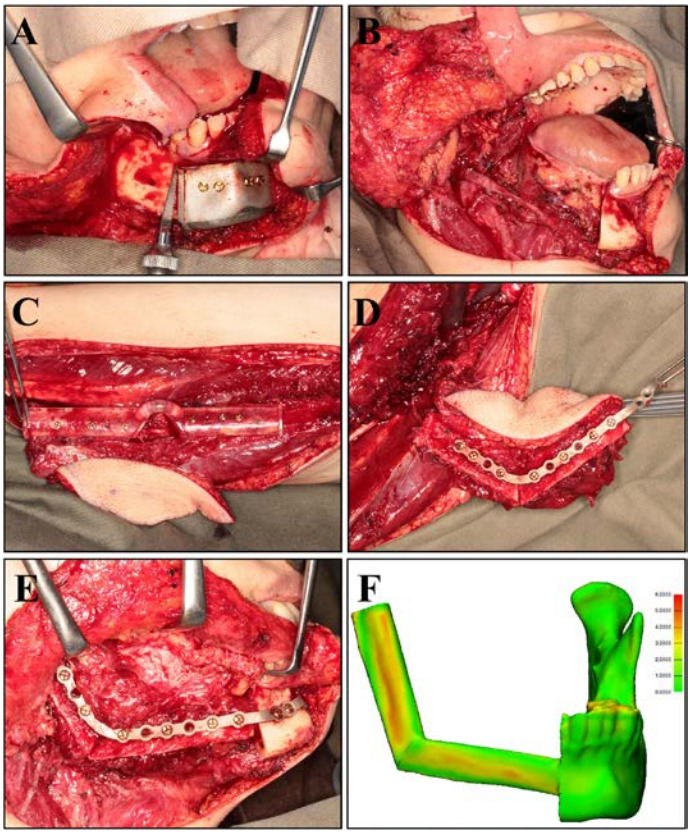

Illustration 5: A fibula-based mandibular reconstruction using the patient-specific surgical plate.[18]

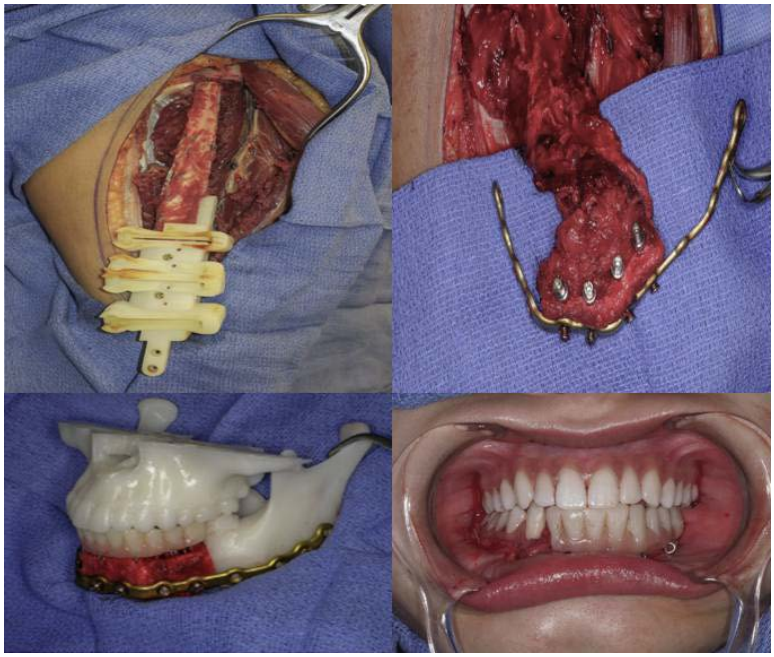

Illustration 6: Jaw in a day [7]

REFERENCES: -

1) Fernandes RP, Yetzer JG, Reconstruction of acquired oromandibular defects. Oral Maxillofacial Surg Clin Am. (2013) May; 25: 241–9 http://dx.doi.org/10.1016/j.coms.2013.02.003
2) Schultz BD,Sosin M,Nam A,Mohan R,Zhang P,Khalifian S,Vranis N,Manson PN,Bojovic B,Rodriguez ED. Classification of mandible defects and algorithm for microvascular reconstruction Plast. Reconstr. Surg. 2015 Apr;135: 743e-754.
3) Shnayder Y, Llin D, Desai S, Nussenbaum B, Sand JP, Wax MK, Reconstruction of the lateral mandibular defect a review and treatment algorithm Jama Facial Plast Surg. 2015;17:367-373. doi:10.1001/jamafacial.2015.0825
4) Osborn T, Helal D, Mehra P. Iliac crest bone grafting for mandibular reconstruction: 10-year experience outcomes journal of oral biology and craniofacial research .2018;8: 25–29 https://doi.org/10.1016/j.jobcr.2017.12.001
5) Brown JS, Barry C, Ho M, Shaw R. A new classification for mandibular defects after oncological resection Lancet Oncol 2016; 17: e23–30
6) Chim H, Salgado CJ, Mardini S, Chen HC, Reconstruction of mandibular defects seminars in plastic surgery 2010 May; 24:188-97 http://dx.doi.org/10.1055/s-0030-1255336.
7) Patel A, Harrison P, Cheng A, Bray B, Bell R Fibular reconstruction of the maxilla and mandible with immediate implant- supported prosthetic rehabilitation: jaw in a day Oral Maxillofacial Surg Clin N Am 2019;31: 369–386 https://doi.org/10.1016/j.coms.2019.03.002
8) Qaisi M ,Kolodney H , Swedenburg G , Chandran R ,Caloss R. Fibula jaw in a day: state of the art in mandibular reconstruction. A report of 3 cases, Journal of Oral and Maxillofacial Surgery 2016 Jun;74: 1284.e1-1284.e15. doi: 10.1016/j.joms.2016.01.047.
9) Rachmiela A ,Shiloa D,Blanca O,Emodia O Reconstruction of complex mandibular defects using integrated dental custom-made titanium implants Br J Oral Maxillofac Surg 2017 May;55:425-427
10) Bowe C,Butler D,Dhanda J ,Gulati A,Norris P,Bisase B. Lateral segmental mandibulectomy reconstruction with bridging reconstruction plate and anterolateral thigh free flap: a case series of 30 consecutive patients. Br jJOral Maxillofac Surg 2021 Jan ;59:91-96 https://doi.org/10.1016/j.bjoms.2020.08.054
11) Essig H,Rana M,Kokemueller H,von See C,Ruecker M,Tavassol

F,Gellrich NC. Pre-operative planning for mandibular reconstruction - a full digital planning workflow resulting in a patient specific reconstruction Head & neck oncology 2011,Oct 3:45

12) Park,JH,Odkhuu,M.,Cho,S.et al. 3d-printed titanium implant with premounted dental implants for mandible reconstruction: a case report Maxillofacial plastic and reconstructive surgery 2020; 42:28 https://doi.org/10.1186/s40902-020-00272-5
13) Shen Y,Guo XH,Sun J,Li J,Shi J,Huang W,Ow A. Double-barrel vascularised fibula graft in mandibular reconstruction: a 10-year experience with an algorithm journal of plastic, reconstructive & aesthetic surgery 2013,Mar; 66: 364-371
14) Tarsitano A, Mazzoni S , Cipriani R , Scotti R ,Marchetti C ,Ciocca L. The cad cam technique for mandibular reconstruction: an 18 patients oncological case-series Journal of cranio-maxillo-facial surgery 2014,42: 1460-1464
15) Kumar BP, Venkatesh V ,Kumar J, Yadav BY, Mohan SR. Mandibular Reconstruction: Overview J. Maxillofac. Oral Surg. (Oct–Dec 2016) 15 :425–441 DOI 10.1007/s12663-015-0766-5
16) Brown JS ,Lowe D,Kanatas A Schache A Mandibular reconstruction with vascularised bone flaps: a systematic review over 25 years. Br J Oral Maxillofac Surg(2017), 55:113-126 http://dx.doi.org/10.1016/j.bjoms.2016.12.010
17) Goh BT, Lee S, Tideman H, Stoelinga PJW: Mandibular reconstruction in adults: a review. Int. J. Oral Maxillofac. Surg. 2008; 37: 597–605.
18) Yang W, et al. A novel ‘surgeon-dominated’ approach to the design of 3D-printed patient-specific surgical plates in mandibular reconstruction: a proof-of-concept study, Int J Oral Maxillofac Surg 2018 Mar;78:31-36.

ASSESSING THE LEVELS OF FLUORIDE AND CHANGES IN FLUORIDE CONCENTRATION AFTER PROCESSING, IN FIVE DIFFERENT TYPES OF DRINKING WATER SAMPLES FROM THE TOWN OF NADIAD, GUJARAT

*Dr. Jyoti Mathur **Saloni Patel **Anshul Shah

ABSTRACT

The optimal fluoride concentration in drinking water depends on climate, which is derived using the Galagan and Vermillion equation. For the town of Nadiad, the lower limit of fluoride is calculated to be 0.6 mg/L in summers and 0.9 mg/L in winters. WHO suggests water fluoride levels to be in the range of 0.5-1.5 ppm.

Method: Five different water samples i.e. tap water, RO purified water, bottled water, cooler water and bore-well water chosen randomly from Nadiad, were analyzed for fluoride using the zirconium alizarin method, which is a colorimetric method described by the Bureau of Indian Standards for fluoride analysis of water and wastewater.

Results: Fluoride concentration was found to be 0.2 mg/dL in RO purified water and bottled water samples. It was found to be 0.4 mg/dL in tap water, cooler water and bore-well water samples.

Conclusion: The fluoride level in all samples was lower than optimal levels both, according to the climate and as specified by WHO. Moreover, excessively processed water such as bottled water and RO purified water had significantly lower fluoride levels. However simple filtration did not alter fluoride concentration. Children consuming only RO purified and bottled water are at a higher risk of developing caries and might require additional fluoride therapy.

***Keywords**: Water Fluoridation, Drinking Water Optimal Fluoride Concentration, Galagan Vermillion Equation, Water Processing, Fluorosis*

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INTRODUCTION

Fluoride is an inorganic anion of fluorine. It is found to be both, beneficial as well as harmful to oral health.

In 1901, Dr. Frederick McKay began his research on brown stains on teeth among the population of Colorado Springs, USA & in collaboration with Dr. G. V. Black later on till 1915 but with no success in finding its etiology. Such stains were also prevalent in the children of Bauxite, a company town owned by the Aluminum Company of America (ALCOA). ALCOA's chief chemist H. V. Churchill analyzed the town's water supply and found it to have high levels of fluoride. He revealed his findings to McKay in 1931 who concluded the cause of the brown stains (mottled enamel) to be the increased levels of fluoride in drinking water.

On the other hand, Dr. H. Trendley Dean began investigating McKay and Black's claims of mottled enamel being resistant to caries and concluded that fluoride levels of 1 ppm did increase caries resistance [1].

It is hence widely proven that the most effective preventive cariostatic measure is using fluoridated dental products[2]. Fluoride affects the demineralization and remineralization of enamel and dentin by forming fluorapatite and calcium fluoride like precipitates and making the enamel more resistant to decay [3].

The standard units for fluoride measurement are parts per million (ppm), milligrams per litre (mg/l) and milligrams per kilogram (mg/kg); 1 ppm = 1 mg/kg [4]. For the purpose of this research these will be used interchangeably.

The optimal daily fluoride intake for caries prevention is at or below 0.05 mg F/kg for a 9-year child having no caries and fluorosis and the intake decreases thereafter[5]. Natural sources of fluoride include tea, shellfish, wine, beer, pork, chips, rice, salami [6].

Water fluoridation was introduced to combat the growing caries burden as a systemic means of fluoride administration firstly in 1945 in Grand Springs, Michigan, USA [1].

Optimum levels of fluoride in drinking water differs on the basis of climate. It is calculated by the Galagan and Vermillion equation [7]. Fluoride levels of 0.5 ppm are advised in warm climates where water consumption is more whereas in colder climates where the water intake is lesser, the recommended level is 1.5 ppm [8]. The US Health and Human Services Department suggested the fluoride levels in potable water to be 0.7 mg in 2015 [9].

WHO recommends fluoride concentration of 0.5-1.5 ppm in drinking water [10].

Ingestion of fluoride over recommended levels produces acute and chronic toxicity. The lethal dose of fluoride orally, is 35-70 mgF/kg which causes acute toxicity. Chronic toxicity causes dental fluorosis when the amount in water is twice that of the recommended levels or 2 ppm approximately; and skeletal fluorosis when levels as high as 8 ppm are ingested over a course of several years [11].

In India, fluoride endemic areas where fluoride levels exceed 1.5 ppm are - Haryana, Delhi, Rajasthan, Karnataka, Uttar Pradesh, Maharashtra, Gujarat, Madhya Pradesh, Andhra Pradesh, Tamil Nadu, Kerala, Jammu and Kashmir, Punjab, Orissa, Himachal Pradesh and Bihar [12].

Water fluoride levels depend on the type of water consumed. Bottled water contains fluoride levels in a range of 0.06-1.05 mg F/L. Water from bore-well contains fluoride in the range of 3.50 ± 0.02 ppm [13]. Fluoride levels are reduced when water is processed by RO purifiers which remove

fluoride in the range from 0.27 to 0.45 ppm [14].

A study conducted on 1065 school children in Nadiad town by The Department of Public Health Dentistry, Faculty of Dental Science and Research, Dharmsinh Desai University, Nadiad concluded the prevalence of dental fluorosis to be 9.95%[15].

This study aims at assessing the fluoride levels in 5 different water samples i.e. tap water, RO purified water, bottled water, cooler water with in-built filtration and bore-well water, taken randomly, from the town of Nadiad.

MATERIALS AND METHODS

Fluoride analysis was done based on the zirconium alizarin method as described by the Bureau of Indian Standards for fluoride analysis of water and wastewater [16]. It is a colorimetric method wherein the reagent is red and on being added to water without fluoride, the solution turns pink. As the fluoride concentration increases, the pink of the reagent starts acquiring a yellow tint leaving a spectrum of pinkish yellow hues in between.

Sample Collection

Five different types of drinking water samples for the purpose of the study were retrieved on the same day as follows:

i. Bottled water, of a random company, purchased from a local shop in Nadiad.
ii. RO-purified water, from the Department of Pedodontics and Preventive Dentistry, Dharmsinh Desai University, Nadiad.
iii. Cooler filtered water, from the campus of Faculty of Dental Science, Dharmsinh Desai University, Nadiad.
iv. Tap water, from the Department of Pedodontics and Preventive Dentistry, Dharmsinh Desai University, Nadiad.
v. Bore-well water, from a randomly selected school in Nadiad.

These samples were taken in one-liter polyethylene bottles. The bottles were rinsed with distilled water two to three times and were then filled with samples. The bottled water was kept in its original sealed plastic bottle. The samples were sealed with tape, labeled and sent to the laboratory on the same day.

Preparation of standard solution of fluoride

Measure 0.22 g of sodium fluoride powder and dissolve it in 1000 ml of distilled water in a volumetric flask. Add another 1000 ml of distilled water to it making the total volume of the solution to be 2000 ml. The concentration of fluoride is 0.01 mg/ml in the prepared solution.

Preparation of Zirconium-Alizarin Reagent

Prepare a 50 ml solution of zirconium oxychloride by dissolving 0.3 g of it in distilled water. Prepare another solution by adding 0.07 g of alizarin sodium monosulphonate to 50 ml of distilled water. Mix these two solutions together with continuous stirring. Dilute it to 1000 ml. Dilute 112 ml of concentrated hydrochloric acid to 500 ml with distilled water. Then dilute 37 ml of concentrated sulphuric acid to 500 ml. Mix these two acidic solutions together.

Mix the final two solutions i.e. the acidic solution and zirconium alizarin solution together. This gives us our red colored zirconium alizarin reagent.

Preparation of dilutions of standard fluoride solution

Prepare a series of 6 dilutions of the standard fluoride solution
corresponding to 0.1 mg/L, 0.2 mg/L, 0.4 mg/L, 0.6 mg/L, 0.8 mg/L and 1.0 mg/L concentration of fluoride.
To prepare a 0.1 mg/L of fluoride solution, dilute 1 ml of the standard solution in 100 ml of distilled water in Nessler's tubes. Similarly, to prepare the other solutions, add 2 ml, 4 ml, 6 ml, 8 ml and 10 ml of standard solution diluted to 100ml with distilled water to give corresponding solutions with concentration of 0.2 mg/L, 0.4 mg/L, 0.6 mg/L, 0.8 mg/L, 1.0 mg/L of fluoride. Label these solutions according to their fluoride concentrations.

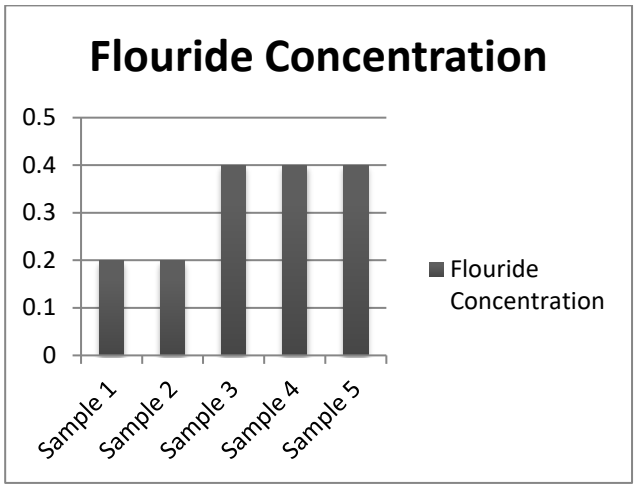
Mixing the reagent with the standard solutions and samples

Take 100 ml of each of the 6 dilutions of the standard solution in a Nessler's tube. Add 5 ml of the zirconium-alizarin reagent to all the solutions. The colour will then start developing from pink to yellow as the fluoride concentration increases. Wait for 20 minutes. Place these tubes in a stand in an increasing order of fluoride concentration.
Similarly take 100 ml of a sample, add 5 ml of the reagent, wait for 20 minutes and compare the color of the solution with that of the 6 dilutions of the standard solution. The standard solution with a matching color with that of the sample has the same fluoride concentration as that of the sample. Repeat this for all the samples one by one and take the reading in mg/L.

RESULTS

Sample No.	Sample type	Concentration of fluoride
1	Bottled water	0.2 mg/L
2	RO-purified water	0.2 mg/L
3	Cooler filtered water	0.4 mg/L
4	Tap water	0.4 mg/L
5	Bore-well water	0.4 mg/L

Table-1: Fluoride Concentration in the five different types of drinking water samples



Graph-1: Fluoride Concentration in the five different types of drinking water samples

The fluoride concentration in bottled water and RO purified water was found to be 0.2 mg/L, which is the lowest among all the samples. The fluoride concentration of the other 3 samples i.e. tap water, cooler water and bore-well water was the same at 0.4 mg/L, which is only slightly lower than the desired amount.

DISCUSSION

Drinking water is the most important source of fluoride. Water fluoridation has been greatly studied and is a proven and effective method of fluoride ingestion. Optimal fluoride levels range from 0.5-1.5

ppm based on the climate. The climate of Nadiad is considered tropical, with mild winters and very hot summers much like the rest of the Gujarat state[17]. The Galagan and Vermillion formula for optimal fluoride is:

$$F = \frac{0.34}{E}$$

$(Optimum\ F^{-}\ concentration = \frac{Optimum\ water\ consumption}{Estimated\ water\ consumption})$

Where,

$E =$ daily water intake in oz/lb of body weight which is $(-0.038 + 0.0062\ t)$

t = maximum daily temperature in degrees F[5].

The maximum temperature in Nadiad is around 93.9 F and minimum is around 69.8 F derived from the climate of Ahmedabad city [18]. Applying this to calculate with the Galagan and Vermillion equation gives us the lower limit of fluoride to be 0.6 mg/L in summers and 0.9 mg/L in winters.

The result of the study shows the fluoride concentration to be lower than the optimal, according to both WHO and Galagan and Vermillion, in all five of the samples. Even the bore-well water had only 0.4 mg/L of fluoride. This is consistent with previous studies that stated the level of fluoride to be less than 0.5 ppm in Nadiad's groundwater [19].

The fluoride concentration was only 0.2 mg/L in bottled water and RO purified water, which is remarkably low. This supports the claim that RO purification can significantly lower the fluoride content in water. Thus, children who consume only RO purified water and bottled water are at a higher risk of developing dental caries due to fluoride inadequacy. Hence in these children, preventive fluoride therapy may be necessary.

Notably, the fluoride content of cooler water, which underwent filtration instead of RO purification, was not altered from that of tap water. This suggests that simple filtration, unlike RO purification, does not alter the fluoride concentration of drinking water.

Despite such low concentrations of fluoride in all forms of drinking water in Nadiad, 1 in 10 or 9.92% of children suffer from dental fluorosis according to the previously mentioned study done in The Department of Public Health Dentistry, Faculty of Dental Science and Research, Dharmsinh Desai University, Nadiad [15]. This calls for a larger scale study with extensive number and types of drinking water samples from multiple locations in the town of Nadiad. The zirconium-alizarin method is recommended by the Bureau of Indian Standards for the analysis of fluoride in water. It is an inexpensive, simple and reliable method for fluoride analysis. However, there are certain limitations of the same, like the maximum amount of fluoride that can be detected is 1 mg/L. For concentrations higher than 1 mg/L, other sophisticated methods like ion selective electrode and ion chromatography can be used.

CONCLUSION

The fluoride concentration of the samples was 0.2 mg/L in RO purified water and bottled water samples, 0.4 mg/L in tap water, cooler water with in-built filtration and bore-well water samples. This is lower than the optimal level suggested by WHO and corresponds to the lower limit when calculated by the Galagan Vermillion equation. RO purification reduces the fluoride levels of water but filtration does

not. Children consuming only bottled water and RO purified water are at a higher risk of developing dental caries. This study can be considered a pilot study and more studies are required with larger number of samples and more sophisticated techniques.

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REFERENCES

1. National Institute of Dental and Craniofacial Research. [Internet]. The story of fluoridation. July 2018 - [cited 6 May 2021];1 Available from: https://www.nidcr.nih.gov/health-info/fluoride/the-story-of-fluoridation#:~:text=Trendley%20Dean%2C%20head%20of%20the,drinking%20water%20before%20fluorosis%20occurred.
2. Peterson PE, LennonMA. Effective use of fluorides for the prevention of dental caries in the 21st century: the WHO approach. Community Dent Oral Epidemiol 2004;32:319-21.
3. Rosin-GrgeK, Peroš K, Sutej I, Bašić K. The cariostatic mechanisms of fluoride. Acta Medica Academica 2013;42: 179-81.
4. Center for Hazardous Substance Research, Kansas State University. [Internet]. Environmental Science and Technological briefs for citizens, Understanding Units of Measurement 2006 - [cited on 6 May 2020] Available from: https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.files/fileid/14285
5. Warren JJ, Levy SM, Broffitt B, Cavanaugh JE, KanellisMJ, Weber-Gasparoni K. Considerations on Optimal Fluoride intake using dental fluorosis and dental caries outcomes- A longitudinal study. J Public Health Dent 2009;69:111-15.
6. United States Agriculture Department USDA. [Internet]. National Fluoride Database of Selected Beverages and Foods. Release 2. Dec 2005 - [cited on 5 May 5, 2021]. Available from: https://www.ars.usda.gov/ARSUserFiles/80400525/Data/Fluoride/F02.pdf
7. Khan AA, Whelton H, O'Mullane D. Determining the optimal concentration of fluoride in drinking water in Pakistan. Community Dent Oral Epidemiol 2004;32:166-72.
8. Unde MP, Patil RU, Dastoor PP. The untold story of fluoridation: Revisiting the changing perspectives. Indian J of Occup and Environ Med 2018;22:121-27.
9. U.S. Department of Health and Human Services Federal Panel on Community Water Fluoridation Public Health Rep. [Internet]. U.S. Public Health Service Recommendation for Fluoride Concentration in Drinking Water for the Prevention of Dental Caries 2015; 130:318-31 - [cited on 5 May 2021]. Available from: https://pubmed.ncbi.nlm.nih.gov/26346489/

10. World Health Organisation. [Internet] Guidelines for drinking water quality, 2011;4thed:371 - [cited on 5 May 2021] Available from: https://apps.who.int/iris/bitstream/handle/10665/44584/9789241548151_eng.pdf;jsessionid=FD0CDF4821337DB919CC0F111E5F3C1F?sequence=1
11. Dhar V, Bhatnagar M. Physiology and toxicity of fluoride. Indian J Dent Res. 2009;20:350-55.
12. Susheela A.K. Fluorosis in developing countries: Remedial Measures and Approaches. Fluorosis Research and Rural Development Foundation. Proc Indian natn Sci Acad(PINSA). 2002; B68:389-400.
13. Thippeswamy H M, Kumar Nanditha, Anand S R, Prashant G M, Chandu G N. Fluoride content in bottled drinking waters, carbonated soft drinks and fruit juices in Devnagree city, India. Indian J of Dent Res2010;21:528-30.
14. Khiarnar M R, Jain VM,Wadgave U, Dhole RI, Patil SJ, Chopade SR. Effect of different reverse osmosis water filters on fluoride content of drinking water. J. Indian Assoc Public Health Dent. 2018;16:165-68.
15. Pandya H, Patel P, Patel T. Prevalence and severity of dental fluorosis in Nadiad Taluka, Gujarat. [Department of PHD, Faculty of Dental Science and Research, Dharmsinh Desai University, Nadiad]. 2019.
16. Bureau of Indian Standards. [Internet]. Methods of sampling and test(physical and chemical) for water and wastewater, Part 60 Fluoride, first revision, IS 3025 part 60 April 2008 - [cited on 5 May 2021],pg1.
17. Ray,Karmalijit&Mohanty,Manorama& Chicholikar,JR. [Internet]. Climate variability over Gujarat,Ind 2009. - [cited on 5 May 2021]Available from: https://www.researchgate.net/publication/278348238_Climate_Variability_over_Gujarat_India
18. Climatology of Ahmedabad city. [Internet]. Climate Research Services Pune, Indian Meteorological Department. - [cited on 6 May 2021] Available from: https://imdpune.gov.in/caui/smartcities.html
19. Dave RS, Machhar MT, Patel AM,Chuha NB,Acharaya DG, Physiochemical analysis of drinking water of Nadiad region(North Gujarat), Der PharmaChemica 2010;2:157-62

MANAGEMENT OF ENDO-PERIO LESION USING CHORIONIC MEMBRANE AND CANCELLOUS BONE ALLOGRAFT: A CASE REPORT

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ABSTRACT

Endo-perio lesions primarily occur by way of the intimate anatomic and vascular connections between the pulp and the periodontium. It is caused due to cross infection between the root canal and periodontal ligament. The goal of endodontic and periodontal therapy is to maintain the natural dentition and also to restore the lost periodontium. This present case report determines the efficacy of cancellous bone allograft material with chorionic membrane in the treatment of an endo-perio lesion in relation to left maxillary central incisor. A 62-year-old male patient with an endo-perio lesion in relation to left maxillary central incisor was initially treated with endodontic therapy. Following the endodontic treatment, the bony defect was treated with cancellous bone allograft material with guided tissue regeneration (GTR) membrane. There was a significant reduction in the probing depth at the end of 6 months. Radiographic evidence showed that there was a significant bone fill.

Keywords: *Bone graft, Endo-perio lesion, GTR membrane*

INTRODUCTION

The relationship between periodontal and pulpal disease was first described by Simring and Goldberg in 1964.[1] Since then, the term “endo-perio” lesion has been used to describe lesions due to inflammatory products found in different degrees in both the pulpal and the periodontal tissues. The endodontium and periodontium are inter-related and diseases of one tissue may lead to the involvement of the other. Tissue of pulp and periodontium are interlinked from the embryonic stage. The dental papilla and dental sac have common mesodermal origin. The cross infection between periodontal ligament and the root canal can occur via anatomic pathway, lateral or accessory canals, apical foramen, palatogingival grooves, dentinal tubules etc.[2] The bacteria rapidly invade and colonize in a necrotic pulp.

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The inflammatory by products of the pulp may leach out through these pathways and an inflammatory vascular response in the periodontium is initiated. This causes destruction of the periodontal fibers and resorption of the alveolar bone and cementum.[3] The differential diagnosis of endodontic and periodontal diseases can be difficult but it is important to make a correct diagnosis so that proper treatment can be given. The development and progression of such lesions are affected by etiologic factors such as bacteria, fungi, and viruses as well as other contributing factors such as root resorptions, perforations, trauma and dental malformations.

Different treatment modalities proposed for the management of bony defects are open flap debridement, bio-modification of root surface and different regenerative procedures including GTR and bone grafts.[4] Bone grafts have been used in the past with the property of osteogenesis, osteoinduction and osteoconduction.

The treatment of endo-perio lesion requires both endodontic therapy and periodontal treatment along with restorative treatment.

The most commonly used classification for endo-perio lesions was given by Simon et al.[5]

1. Primary endodontic lesion
2. Primary periodontal lesion
3. Primary endodontic lesion with secondary periodontal involvement
4. Primary periodontal lesion with secondary endodontic involvement
5. True combined lesion

CASE REPORT

A 62-year-old male patient reported to the Department of Periodontology Dharmsinh Desai University, Nadiad, with a chief complaint of pain and swelling in upper left anterior region of tooth for 1 week. Medical history and dental history were non-contributory.

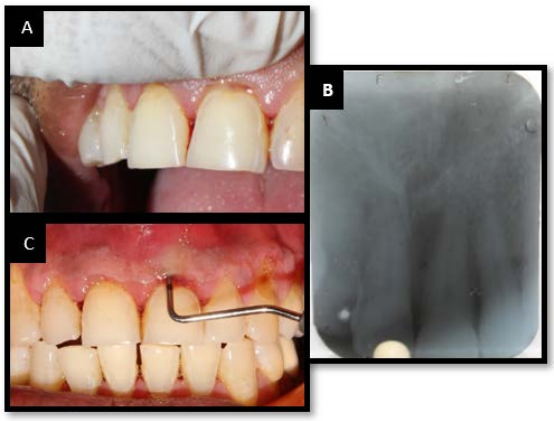

Illustration-1: A) Pus discharge in relation to 21 B) Pre-operative IOPA C) Probing depth 13 mm in relation to 21 labially

On intraoral examination there was pus discharge in association with 21 as shown in *Illustration-1A*. On radiographic examination there was widening of periodontal ligament space seen in relation to 11 and 21 along with a homogenous radiolucency in relation to 21 mesially (*Illustration-1B*). Tooth was nonvital on pulp testing. On periodontal examination there was a deep 13 mm periodontal pocket labially in relation to 21 as measured with UNC-15 probe (*Illustration-1C*). On clinical and radiographic examination, the patient was diagnosed with primary periodontal lesion with secondary endodontic involvement.

MANAGEMENT

A multidisciplinary approach was formulated to salvage the tooth. Scaling and root planning was done. Root canal treatment in relation to 21 was done in the Department of Conservative Dentistry and Endodontics Dharmsinh Desai University, Nadiad. Periodontal regenerative surgery was planned for treatment of bony defect.

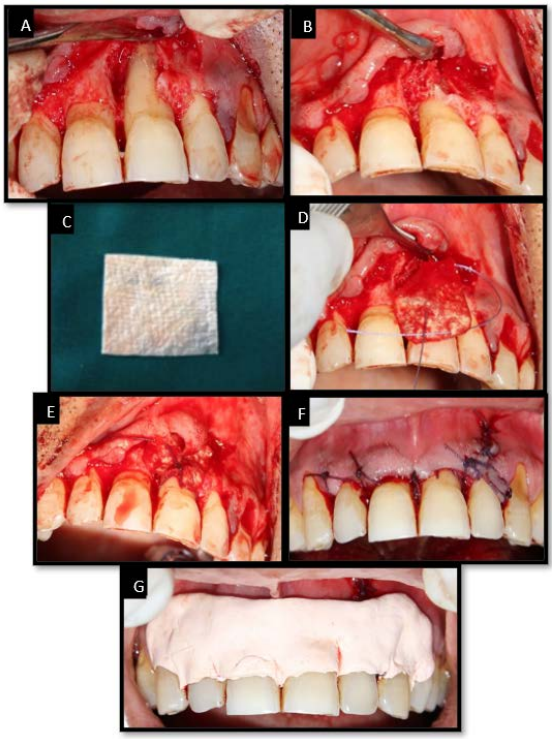

Illustration-2: A) Flap reflection and degranulation B) Placement of allograft material C) Chorionic membrane D) Placing chorionic membrane E) Chorionic membrane placed F) Sutures taken G) Periodontal dressing applied

A sulcular incision was placed and vertical releasing incision was given on the mesial line angle of 22. A full thickness flap was elevated labially. After reflection of flap meticulous degranulation and debridement was done of the defect area in tooth number 21 (*Illustration-2A*). A shallow developmental groove was seen on labial aspect of 21. It was treated by odontoplasty. Infrabony defect was seen after complete degranulation. Isolation of area was done with bleeding control. The bony defect was filled by using cancellous bone allograft (Rocky Mountain) material (*Illustration-2B*). A chorionic membrane 3 x 3 cm obtained from, Tata Memorial Hospital Tissue Bank, Mumbai, India, was trimmed with sharp scissors to an approximate size (*Illustration-2C*) so that the apical border of the membrane would extend 3 to 4 mm apical to the margin of the defect, laterally 2 to 3 mm beyond the defect and the coronal border of the membrane was placed 2 mm apical to the cementoenamel junction (*Illustration-2D & 2E*). The flap was secured with 3-0 silk suture (*Illustration-2F*) and periodontal dressing was given (*Illustration-2G*). Patient received post-operative instructions and was prescribed antibiotic (Doxycycline 100mg) and analgesics (Brufen 600mg) for 5 days. Patient was instructed to rinse twice daily with 0.2 % chlorhexidine gluconate for 4 weeks. The periodontal dressing and sutures were removed 10 days post-surgery. The patient was recalled for regular follow up at 1, 3 and 6 months.

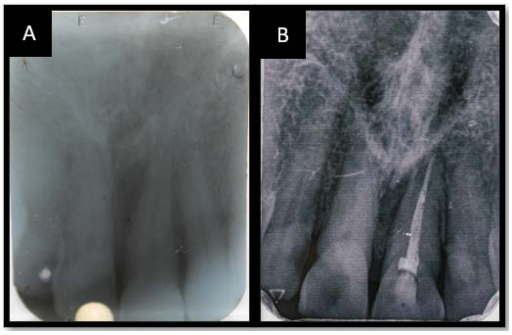

Illustration-3: A) Pre-operative IOPA B) 6 months post-operative IOPA

Radiographic examination at 6 months showed significant bone fill in relation to 21 (*Illustration-3B*).

Illustration-4: A) Pre-operative 13mm probing depth i.r.t 21 labially B) 6 months post-operative 3mm probing depth labially i.r.t. 21

There was a significant reduction in probing depth at 6 months postoperative which was 3 mm as measured with UNC-15 probe (*Illustration-4B*).

DISCUSSION

Endo-perio lesions are challenging to the clinician as far as assessment of diagnosis and prognosis of the teeth are concerned.[6] Treatment of endo–perio lesion requires both endodontic treatment and periodontal regenerative treatment.[7] Endodontic treatment precedes periodontal treatment. The treatment strategy is to first focus on debridement and disinfection of the root canal system. The goal of periodontal surgery is to remove all necrotic tissues from the surgical site and facilitate the regeneration of hard and soft tissue along with the formation of new attachment apparatus.[7] In this case periodontal regeneration has been attempted with cancellous bone allograft along with chorionic membrane. Bone grafts are used as fillers in periodontal defects and aid in healing. They have osteogenic, osteoinductive and osteoconductive properties.[8] Cancellous allografts present interconnecting porous system and trabecular architecture which provide a framework for vascular ingrowth and proliferation and differentiation of the cells for bone remodelling at the surgical site.[9,10] The chorionic membrane (CM) has gained importance because of its ability to reduce scarring and inflammation; enhance wound healing; and serve as a scaffold for cell proliferation and differentiation as a result of its antimicrobial properties. In addition, it is a biomaterial that can be easily obtained, processed and transported. As epithelial cells quickly migrate across the CM barrier, they form a seal over the underlying bone graft and do not apically migrate into the defect. Histologic studies by Wallace and Cobb (2011), demonstrated this concept by the fact that when amnion chorionic membrane was used as a barrier in site preservation, trephined bone core samples from healed surgical sites demonstrated new bone, residual bone graft, and connective tissue percentages comparable to those found in prior studies utilizing traditional GTR barriers. The CM acted as a barrier membrane between the gingival epithelium and hard tissue. Schallhorn and McClain (1988)[11] showed improved clinical outcome in intrabony defects and grade II furcation involvement, following a combination therapy using barrier membranes along with DFDBA and citric acid root conditioning. Sculean et al, observed an average CAL gain of 4.07 ± 1.3 mm, 1 year after the GTR procedure using bovine bone xenograft in combination with a collagen membrane in infrabony defects.[12]

CONCLUSION

Endodontic lesion shows predictable healing, while the repair or regeneration of periodontal tissues show questionable healing if associated with it.

Endodontic therapy resolves only the endodontic component of involvement and has a little effect on the periodontal lesion. Hence, a thorough diagnostic examination usually will determine the primary etiology and direct a proper treatment planning as presented in this case.

The present case report showed significant amount of bone fill and reduction in pocket probing depth with combination regenerative therapy using cancellous bone allograft and chorionic membrane.

REFERENCES

1. Simring M, Goldberg M. The pulpal pocket approach: retrograde periodontitis. J Periodontol 1964;35:22-48.
2. Dr. Asha Prabhu, Dr. Munaf Maknojia, Dr. Nupur Sah, Dr. Jyotsna Anjankar, Treatment of Endodontic- Periodontic lesion with combination therapy: PRF and DFDBA, IOSR Journal of Dental and Medical Science 2015;14:46-51.
3. Abhishek Parolia, Toh Choo Gait, Isabel C C.M. Porto, Kundabala Mala, Endo-perio lesion: A dilemma from 19th until 21st century, Journal of Interdisciplinary Dentistry 2013:3;2-11.
4. Müller HP, Eger T. Furcation diagnosis. J Clin Periodontol 1999;26:485-98.
5. Simon JH, Glick DH, Frank AL. The relationship of endodontic-periodontic lesions. J Periodontol 1972;43:202-8.
6. Khalid S. Al-Fouzan, A New Classification of Endodontic Periodontal Lesions, International Journal of Dentistry, Volume 2014:1-5.
7. Puspendra Kumar Verma, Ruchi Srivatava, K.K. Gupta, Amitabh Srivastava, Combined endodontic-Periodontal Lesion: A clinical Dilemma, Journal of Interdisciplinary Dentistry 2011;1:119-24.
8. Bassam Michael Kinaia, Sami M. A. Chogle, Atheel M. Kinaia, Harold E. Goodis, Regenerative Therapy A periodontal- Endodontic Perspective, Dent Clin N Am 2012;56:537-47.
9. Leonetti JA, Koup R. Localized maxillary ridge augmentation with a block allograft for dental implant placement: case reports. Implant Dent. 2003;12:217-26.
10. Lyford RH, Mills MP, Knapp CI, Scheyer ET, Mellonig JT. Clinical evaluation of freeze-dried block allografts for alveolar ridge augmentation: a case series. The International J of Periodontics & Restorative. 2003;23:417-25.
11. Schallhorn RG, McClain PK. Combined osseous composite grafting, root conditioning, and guided tissue regeneration. Int J Periodontics Restorative Dent 1988;8:8-31.
12. Sculean A, Berakdar M, Chiantella GC, Donos N, Arweiler NB, Brecx M. Healing of intrabony defects following treatment with a bovine-derived xenograft and collagen membrane. A controlled clinical study. J Clin Periodontol 2003;30:73-80.

POST COVID-19 COMPLICATION - MUCORMYCOSIS: A CASE REPORT

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ABSTRACT

Mucormycosis - a rare opportunistic fungal infection is of concern as one of the post COVID-19 complications in current scenario. Mucormycosis is caused by saprophytic fungi found in soil, bread, decaying fruits and vegetables and it can enter into the body through the nose, breached skin, and tooth extraction sockets. There have already been more than three million deaths worldwide due to COVID-19 and mucormycosis has been ruled as an epidemic in India. Early diagnosis and immediate intervention are essential for such patients. Clinical diagnosis and early treatment with surgical debridement are vital in preventing the morbidity of this often-fatal condition.

Keywords: *COVID-19, Mucormycosis, fungal infection, COVID-19 associated mucormycosis, rhino-orbital-cerebral mucormycosis.*

INTRODUCTION

The pandemic coronavirus disease 2019 (COVID-19) continues to be a significant problem worldwide that was first identified in December 2019. The severity of the disease ranges from asymptomatic infection to respiratory failure and death.[1] The use of corticosteroids for modulating immune-related lung injury, may predispose the patients with Covid-19 to secondary infections especially in those with immunocompromised condition. And thus, increasing the risk of mortality among them.[1] While several treatment options have been evaluated, systemic glucocorticoids have been shown to improve survival in COVID-19. Glucocorticoids are inexpensive, widely available, and have been shown to reduce mortality in hypoxemic patients with COVID-19.[3] Unfortunately, the widespread use of glucocorticoids can lead to secondary bacterial or fungal infections. Candidiasis and pulmonary aspergillosis have been common fungal infections that were reported as superinfections in COVID-19 patients.[4] Moreover, the immune dysregulation caused by the virus and the use of concurrent immunomodulatory

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drugs such as tocilizumab could further increase the risk of infections in COVID-19 patients.[5]

Due to the rich vascularity of anatomy in the maxillofacial region, there are few incidences of opportunistic infections.[6] Mucormycosis can evade this defense mechanism because of their potential virulence.[7] Attributable risk factors are uncontrolled diabetes mellitus, Acquired Immune Deficiency Syndrome (AIDS), long-term steroid therapy, hematological conditions like leukemia, lymphomas, renal failure and lack of oral hygiene.[8] Mucormycosis can gain entry into the body through the nose, breached skin, and tooth extraction sockets. Primary infection sites include the skin, ears, gastrointestinal tract, and there could be disseminated forms involving multiple locations like pulmonary and rhino-orbito-cerebral.9 Depending on the site of infection and underlying predisposing factors, mortality rates may vary from 10% to 100%.6 Early diagnosis and immediate intervention are essential for such patients. Treatment includes control of the underlying risk factors, antifungal therapy, surgical debridement, supportive therapy, and surgical or prosthetic rehabilitation. In the present case report, patient had no immunocompromised condition/disease.

CLINICAL PRESENTATION

A-33 year-male patient reported to the Department of Periodontology, with a compliant of pain in upper right and left back tooth region for 3 days. Patient had no history of any systemic illness including diabetes mellitus. Patient had a history of testing positive for Covid-19 before 25 days. He was on a ventilator for 4 days and was treated with systemic steroids.

Patient presented with an extraoral swelling on the left side of his face (Illustration 1A). On intraoral examination, periodontal pockets were present in relation to 11, 12, 21, 22, 25, 26, 27. Periodontal abscesses were detected in relation to 12, 22, 25, 26 with active pus discharge (Illustration 1 B, C). Necrotic ulcerative areas were present on labial attached gingiva of 22 measuring about 4 x 6mm, and on the buccal aspect involving marginal gingiva of 25 measuring about 5x7 mm in diameter. Both the ulcerative lesions were covered with yellowish slough and had everted edges.

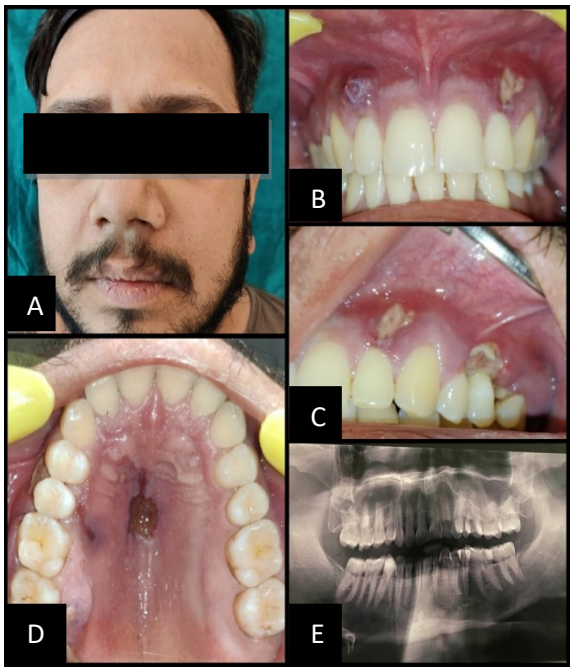

Illustration 1: Clinical and radiographic presentation of the patient with mucormycosis

An oval greyish black ulcerated patch with ragged borders was observed in the mid palatal region measuring about 6 x 8 mm and a linear greyish black patch on the right side of the palate in relation to 25, 26 with erythematous margins measuring about 2 x 6 mm (Illustration 1D).

The orthopantamogram (OPG) showed apical radiolucencies in relation to 12, 22, 25, 26 (Illustration 1E).

DISCUSSION

Mucormycosis is an acute and potentially fatal fungal infection caused by fungi related to the mucoraceae family.[10] These fungi are opportunistic microorganisms and can be found in fruit, soil, feces, and may be cultured from the nasal and oral mucosa of healthy humans.[11] The pathogen as an asexual spore-forming fungus can infect the oral and nasal cavities through inhalation. The clinical hallmark of mucormycosis is vascular invasion resulting in thrombosis and tissue infarction/necrosis. The most common clinical presentation of mucormycosis is a rhino- orbital- cerebral infection. It is believed to be secondary to inhalation of spores into the paranasal sinuses of a susceptible host. In the presence of a normal immune system, the spores are removed by phagocytic leukocytes. The pathogen can transform into hyphae form in individuals with predisposing factors such as uncontrolled DM (particularly in the presence of ketoacidosis), malignancy (such as lymphoma and leukemia), renal failure, organ transplantation, advanced rheumatologic disorders using immunosuppressive agents (such as prolonged use of corticosteroids), AIDS, extensive burn, and chronic sinusitis. [12] In these conditions, leukocytes have less efficacy on the hyphae forms of fungi and the pathogen may proliferate more easily.[13] The organism proliferates and invades the vessel walls of the infected region and results in thrombosis, ischemia, and necrosis. The infection can directly spread into the paranasal sinuses and then invade into orbital and intracranial spaces by direct spread or via the bloodstream.

The symptoms presenting in rhino-orbitocerebral mucormycosis are facial pain and paresthesia, headache, periorbital and nasal swelling, inflammation, eyelid drooping, proptosis, external and internal ophthalmoplegia, visual loss, and blackish necrosis of palate and nasal mucosa.[10] The disease usually initiates on the nasal and oral mucosa and spreads to paranasal sinuses.[13] It propagates into the orbital space through the lamina papyracea. Vision loss is due to the involvement of optic nerve or retinal supplying vessels. Intracranial space can be involved directly through the orbital orifices and sinus walls, or through the bloodstream. Cavernous sinus thrombosis as another complication results in damage to the cranial nerves III, IV, V1, V2, and VI.[14] Some studies disclosed that T lymphocytes (CD4 and CD8) are lower in severe COVID-19, and levels of IL-2 R, IL-6, IL-10, and TNF-α are markedly higher in these cases.

Zinc influences diverse mechanisms of fungal pathogenesis by directly associating with virulence determinants or by regulating the expression of many proteins required for infection. The regulation of zinc acquisition by the Zap1 transcription factors is fundamental for fungal pathogenesis in mammalian hosts. As active zinc deprivation by hosts represents an important antifungal mechanism, development of chelating strategies to control invivo fungal development may be a plausible chemotherapeutic alternative.

Zinc has been frequently prescribed as supplemental medication in Covid-19 patients. Zinc is fundamental for all domains of life, as it composes the catalytic

and structural center of a large array of proteins. The zinc quota i.e. zinc content required for optimal growth is maintained by the activity of specific membrane transporters or by zinc-binding proteins that mediate zinc uptake or storage. Zinc-depleting conditions are known to reduce fungal growth and evidence suggests that host cells employ sequestration of zinc to hamper fungal development. [15] Zinc chelation is able to reduce fungal growth in both rich and defined media. Zinc restriction by host cells is achieved by lowering metal availability via the activity of the host zinc transporters or the expression of zinc-binding proteins.[16] Cells that are exposed to zinc deprivation experienced increased levels of ROS.

Although all the sequelae and complications of COVID-19 are yet to be documented and described, spike in secondary infections are being increasingly recognized worldwide. Patients with COVID-19 are more vulnerable to fungal infection because of the compromised immune system with decreased CD4+ and CD8+ lymphocytes, associated comorbidities such as diabetes mellitus which potentiates both the conditions, decompensated pulmonary functions, and the use of immunosuppressive therapy for the management in moderate to severe cases. The infections are also more likely in patients with severe COVID-19 disease and in those requiring intensive care unit admission or mechanical ventilation.

REFERENCES

1. Zhou F, Yu T, Du R, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. Lancet 2020; 395(10229): 1054–1062.
2. RECOVERY Collaborative Group, Horby P, Lim WS, Emberson JR, et al. Dexamethasone in hospitalized patients with Covid-19-preliminary report. N Engl J Med 2021; 384: 693–704.
3. Group WHOREAfC-TW, Sterne JAC, Murthy S, Diaz JV, Slutsky AS, Villar J, et al. Association between administration of systemic corticosteroids and mortality among critically Ill patients with COVID-19 a meta-analysis. JAMA. 2020; 324:1330–13341.
4. Arastehfar A, Carvalho A, van de Veerdonk FL, Jenks JD, Koehler P, Krause R, et al. COVID-19 associated pulmonary aspergillosis (CAPA)-from immunology to treatment. J Fungi (Basel). 2020; 6:91.
5. Kimmig LM, Wu D, Gold M, Pettit NN, Pitrak D, Mueller J, et al. IL-6 inhibition in critically Ill COVID-19 patients is associated with increased secondary infections. Front Med (Lausanne). 2020; 7:583897.
6. Verma A, Singh V, Jindal N, Yadav S. Necrosis of maxilla, nasal, and frontal bone secondary to extensive rhino-cerebral mucormycosis. National Journal of Maxillofacial Surgery. 2013 Jul;4:249.
7. Spellberg B, Edwards J, Ibrahim A. Novel perspectives on mucormycosis: pathophysiology, presentation, and management. Clinical microbiology reviews. 2005 Jul 1;18:556-69
8. Leitner C, Hoffmann J, Zerfowski M, Reinert S. Mucormycosis:

necrotizing soft tissue lesion of the face1. Journal of oral and maxillofacial surgery. 2003 Nov 1;61:1354-8.
9. Roden MM, Zaoutis TE, Buchanan WL, Knudsen TA, Sarkisova TA, Schaufele RL, Sein M, Sein T, Chiou CC, Chu JH, Kontoyiannis DP. Epidemiology and outcome of zygomycosis: a review of 929 reported cases. Clinical Infectious Diseases. 2005 Sep 1;4:634-53.
10. Mohindra S, Mohindra S, Gupta R, et al. Rhinocerebral mucormycosis: the disease spectrum in 27 patients. Mycoses 2007;50:290–296.
11. Goel S, Palaskar S, Shetty VP, et al. Rhinomaxillary mucor- mycosis with cerebral extension. J Oral Maxillofac Pathol 2009; 13:14–17.
12. Viterbo S, Fasolis M, Garzino-Demo P, et al. Management and outcomes of three cases of rhinocerebral mucormycosis. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011; 112: e69–e74.
13. Afroze SN, Korlepara R, Rao GV, et al. Mucormycosis in a diabetic patient: a case report with an insight into its patho- physiology. Contemp Clin Dent 2017;8:662–666.
14. McCarthy M, Rosengart A, Schuetz AN, et al. Mold infections of the central nervous system. N Engl J Med 2014;371:150–160.
15. Lulloff, S. J.,Hahn, B. L., and Sohnle, P. G. (2004). Fungal susceptibility to zinc deprivation. J. Lab. Clin. Med. 144, 208–214.
16. Goyette, J., and Geczy, C. L. (2011). Inflammation-associated S100 pro- teins: new mechanisms that regulate function. Amino Acids 41,821–842.

KNOWLEDGE, ATTITUDE AND BEHAVIOUR FOR CHOOSING ORAL HYGIENE AIDS AMONG STUDENTS OF DHARMSINH DESAI INSTITUTE, NADIAD, GUJARAT

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ABSTRACT

Objectives: The purpose of the study was to determine the knowledge, attitude and behaviour about oral hygiene aids among students of Dharmsinh Desai University.

Methods: A questionnaire survey which consists of self-administered validated, structured, 14 close-end multiple choice questions about oral hygiene aids was circulated among students of Dharmsinh Desai University. The data extracted was statistically analysed and results obtained.

Results: The study showed that toothbrush and toothpaste were the main products used for the maintenance of oral hygiene by the students which is 99.20%. According to this study the 62.60% of students select dentifrice on the basis of influence of dentist compared to parents which is 15.20% and 9.90% select dentifrice by the influence of advertisement. The criteria for choosing additional oral hygiene aids is influenced mostly on the basis of dentist's advice which is 83.70% compared to 11.10% due to family advice and 5.30% due to advertisements. So in this study, selection of oral hygiene products was based more on dentist influence compared to parental and friends influence.

Conclusion: Selection of oral hygiene products was based more on dentist influence. There seems to be a proper knowledge and awareness about how to choose a toothbrush, dentifrice, interdental aids and mouthwash, so there will be good oral hygiene maintenance by students of Dharmsinh Desai University.

Keywords: *Attitude, behaviour, knowledge, management, oral hygiene aids, students*

INTRODUCTION

Dentists play an important role in the improvement of the public oral health education. Prevention of oral disease is considered to be the most effective, acceptable and efficient method to attain oral health.[1] Dental health education has been largely aimed at children and adolescents as priority. The attitude of

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people towards maintenance of health of their own teeth and the attitude of dentists who provide dental care, play an important role in determining the oral health condition of the population.[2]

Maintenance of oral hygiene is important for dental well-being in which we keep our teeth clean by brushing and flossing in order to remove deposits of dental calculus, plaque and thereby prevent gum diseases. The best way to maintain good oral hygiene for good health of oral tissues is by "plaque control" since plaque is the main factor responsible for dental and gingival diseases. Toothbrush and toothpaste are the most widely used oral hygiene aids.[3]

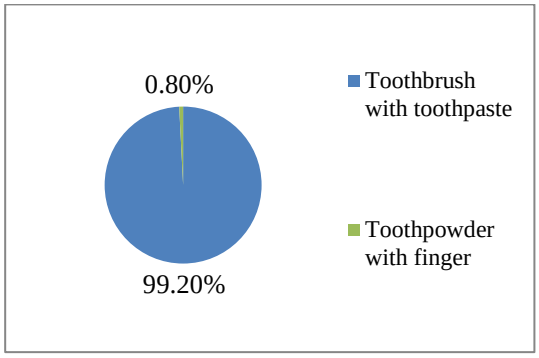
One of the factors that is responsible for someone's attitude and behaviour is knowledge. Knowledge can be described as level of understanding of an individual towards facts, information, skills and many more. Factors like education, income, information from media (advertisements) and personal choices like taste/flavour, colour and appearance have an effect on choosing an oral hygiene product.[4] The present study was conducted among students of Dharmsinh Desai university to assess the knowledge, attitude and behaviour for choosing oral hygiene aids.

METHOD

A cross sectional study was conducted during the academic year 2020 -2021 among the students of Dharmsinh Desai University, Nadiad. Total 250 students of Dharmsinh Desai University participated voluntarily in this study. All students in the study completed a validated self-administered questionnaire consisting of 14 closed ended questions. The questions in the questionnaire were designed to assess their knowledge, attitude and behaviour regarding oral hygiene maintenance. Data was collected, statistical analysis was done and results were obtained using percentage.

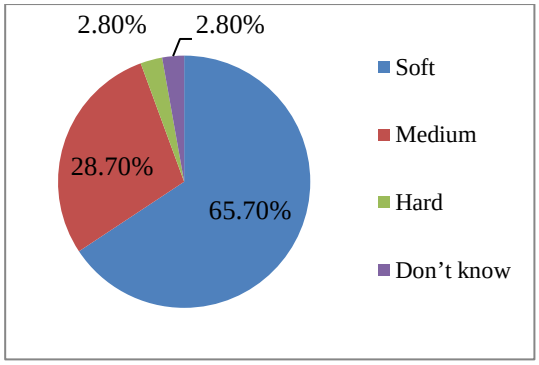
RESULTS

Total 250 students participated voluntarily in this study. Each individual gave the answer according to their knowledge, attitude and behaviour. According to the present survey, 99.20% of the students use toothbrush with tooth paste and 0.80% of students use toothpowder with finger (Illustration -1).



*(*Illustration *-1 Oral hygiene products used by the subjects)*

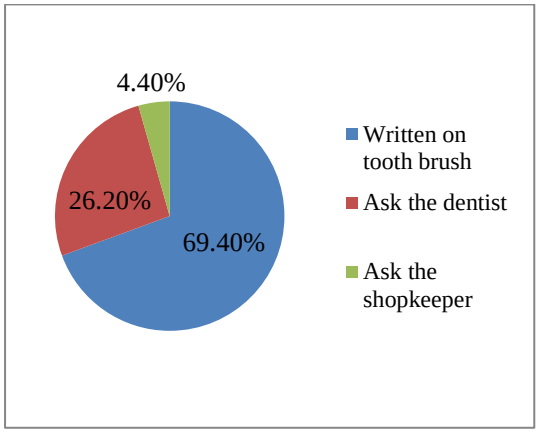
According to the current survey, 65.70% of the students use soft bristles tooth brush, 28.70% of the students use medium bristles tooth brush and 2.80% of students use hard bristles tooth brush and rest 2.80% of students don't know the type tooth brush (Illustration -2).



*(*Illustration *-2 Consistency of the bristles in toothbrush used)*

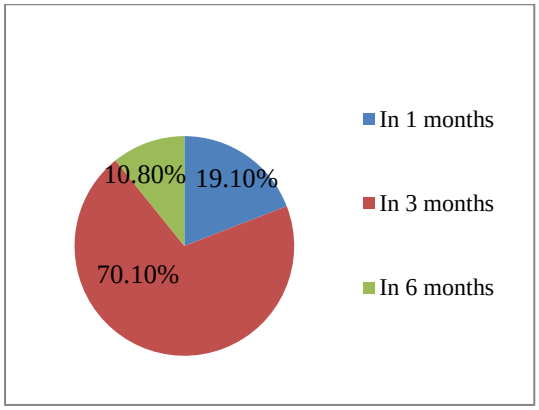
According to the survey done, 69.40% of the students get to know about the type bristle because its written on the box,

26.20% of the students know it by asking the dentist and 4.40% of the students get to know about the type of bristles by asking the shopkeeper (Illustration -3).



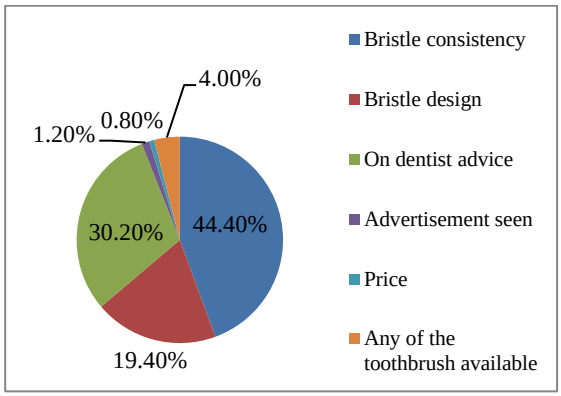
*(*Illustration -3 *How subjects get to know about type of bristles present in the toothbrush while buying)*

According to the current survey, 70.10% of the students change the toothbrush in 3 months, 19.10% students change the toothbrush in 1 month and 10.8% student change the toothbrush in 6 months (Illustration -4).



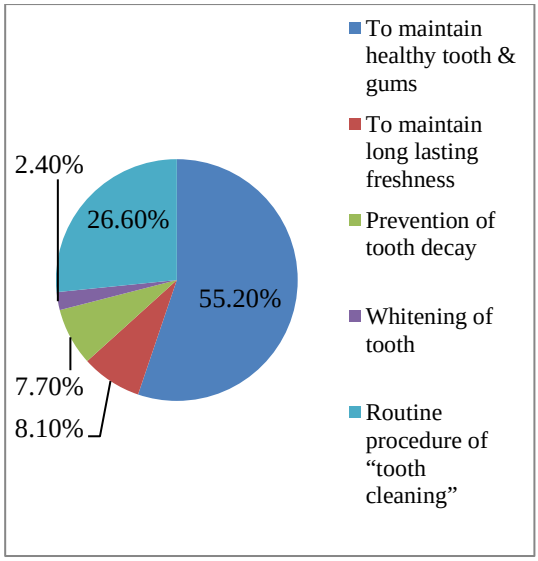
*(*Illustration -4 *Frequency of changing toothbrush)*

According to the present survey, 44.40% of the students select the toothbrush on the basis of bristle consistency, 30.20% of the students select the toothbrush by taking dentist's advice, 19.40% select it on the basis of design, 4.00% select it depending upon the availability of toothbrush, 1.20% select it by seeing advertisements and 0.80% select it according to price (Illustration -5).



*(*Illustration - 5 *Influential factors in selection of a toothbrush)*

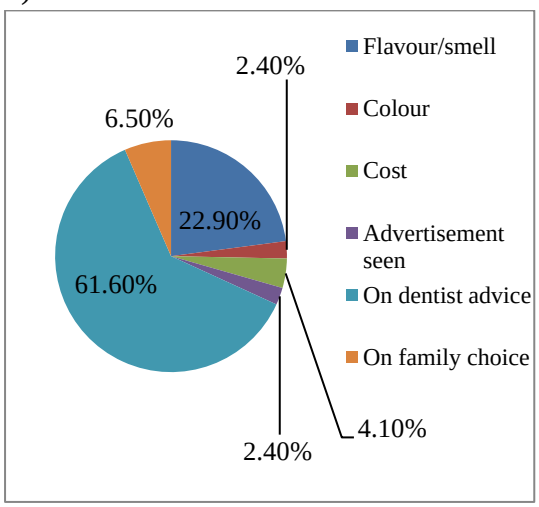
According to the survey done, 55.20% of students use toothpaste to maintain healthy tooth and gums, 8.10% of students buy toothpaste to maintain long lasting freshness, 7.70% of students buy toothpaste for prevention of tooth decay, 2.40% of students buy toothpaste for whiteness of teeth and 26.6% of students buy toothpaste for routine procedure of tooth cleaning (Illustration -6).



(Illustration -6 *Reason for using toothpaste / tooth powder)*

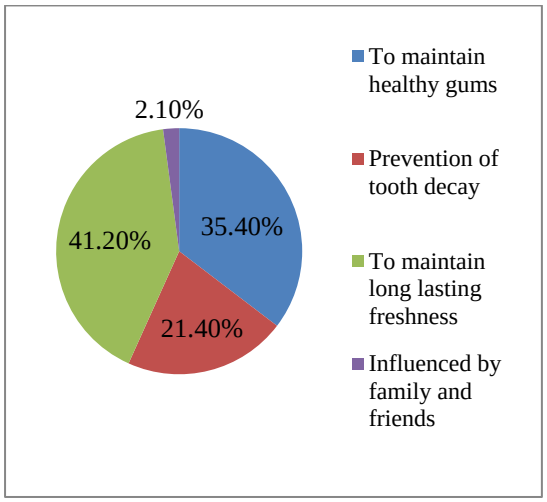
According to the present survey, 61.60% students choose dentifrice on the basis of criteria informed by dentist, 22.90%

students choose it on the basis of flavour, 6.50% students choose it on the basis of family choice, 2.40% students choose it on basis of colour, 4.10% students choose it on basis of cost and 2.40% students choose it on the basis of advertisement (Illustration -7).



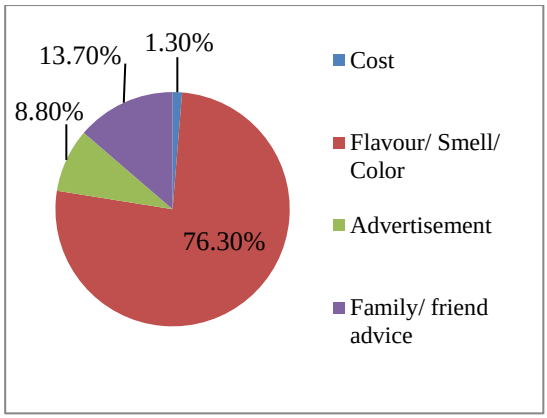
*(*Illustration *-7 Criteria for choosing the dentifrice)*

According to the current survey, 41.20% of students use mouthwash to maintain long lasting freshness, 35.40% of students select it to maintain healthy gums and 21.40% of students select it for prevention of tooth decay and 2.10% of student selects it on the basis of influence of family and friends (Illustration -8).



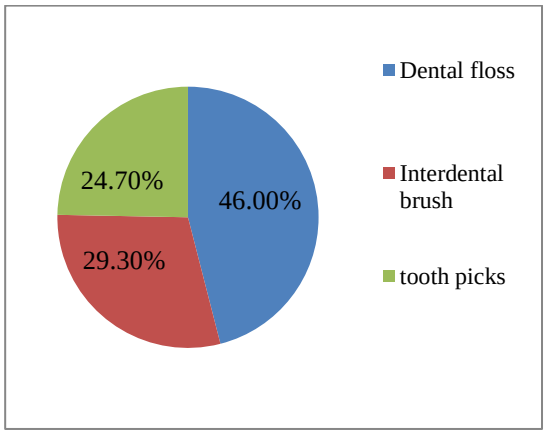
*(*Illustration- *8 Reason for using mouthwash)*

According to this survey, 76.30% of students select mouthwash on the basis of flavour or smell, 13.70% of students select mouthwash on the basis of criteria of family or friend's advice and 8.80% of students select mouthwash on the basis of criteria of advertisement and 1.30% of students select mouthwash on basis of cost (Illustration -9).



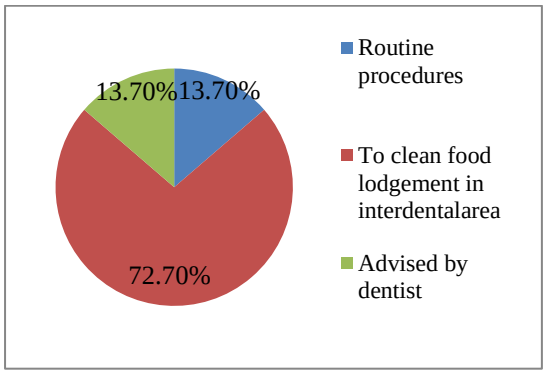
*(*Illustration *-9 Criteria for selection of mouthwash)*

According to current survey, 55.90% of the students use additional oral hygiene aids and 44.10% of students use no other oral hygiene aids. 46.00% of the students use dental floss as additional oral hygiene aids and 29.30% of students use additional oral hygiene aids as interdental brush and 24.70% of students use additional oral hygiene aids as tooth picks (Illustration -10).



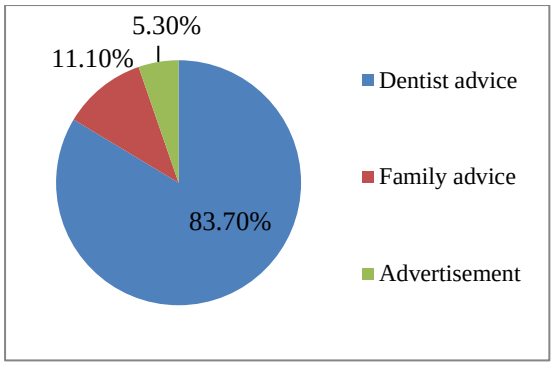
*(*Illustration *-10 Additional oral hygiene aids used among the students)*

According to present survey, 72.70% of students use additional oral hygiene aids to clean food lodged in interdental area, 13.70% of students use additional oral hygiene aids as routine procedures and remaining 13.70% of students use additional oral hygiene aids because it is advised by dentist (Illustration -11).



*(*Illustration *-11 Reason for using additional oral hygiene aids)*

According to survey done, 83.70% of students select additional oral hygiene aids on the basis of dentist's advice, 11.10% of students select additional oral hygiene aids based on family advice and 5.30% of students select additional oral hygiene aids on the basis on advertisement (Illustration -12).



*(*Illustration *-12 Criteria for selection of additional oral hygiene aids)*

DISCUSSION

Oral hygiene practices in India are heavily based on tradition and culture with use of indigenous substances being widely prevalent. The present study was conducted among students of the Dharmsinh Desai University who are part of the urban population, where most of the people are educated and hence, toothbrush and toothpaste use were expected to be more.

Toothbrush and dentifrice were the main products used for the maintenance of oral hygiene among the population of this study. The percentage of toothbrush with toothpaste use was 99.20% compared to 97.6% for secondary school students in a study done by *Lian et al*[5] and 100% for secondary school students in Nepal.[6] The percentage of toothbrush use was found to be more in the current study compared to the urban population of Udaipur 94.4% [7], of teachers 76.7%[8], of caregivers 93.0% in day care centres[9], of consumer's 80%[10] and of nursing students 77.7% in Bangalore.[11]

In the present study, toothpaste use was found to be 99.20%, supported by other studies such as 93.0% for caregivers in day-care centres[9], 90.6% of an urban population[7] and 100% of secondary school students in Nepal.[6] Toothbrush and toothpaste use is the most effective way of cleaning teeth and maintaining oral hygiene.

In the present study, the percentage of people using soft bristle toothbrush was high compared to medium and hard bristle brush users (65.70%, 28.70%, 2.80% respectively), similar to studies done by Sharda (59.6% soft, 17.0% medium)[7]. In the present study 2.80% of students don't know about the type of toothbrush bristles, which is lower than the 4.6% compared to the study by Sharda[7] and much less than the 25.3% in the study done by Neamatollahi and Ebrahimi.[12] Though the effect of the

bristle consistency on the efficiency of cleaning has not been proven, soft bristle brushes are likely to cause less damage to the tooth structure and the gums. For optimal oral health, the American Dental Association (ADA) and US Surgeon General recommend that individuals brush twice and floss at least once a day and have regular prophylactic dental visits.[13]

In the present study, 70.10% of people changed their toothbrush in three months followed by 19.10% in one month and 10.80% in six months, which is similar to study done by Neamatollahi and Ebrahimi.[12] A toothbrush with frayed bristles might be less effective in plaque bio-film removal and harmful to the tooth structure.Toothbrush selection was based more on bristle consistency which is 44.40%, fewer people 30.20% did so on the advice of dental professionals, bristle design which is 19.40%, 4.00% selected it on the availability, 1.20% selected it on the basis of advertisement and 0.8% on the basis of price.

Previous studies have shown that mass media, dental professionals and dental literature are the main sources of oral health information.[7] In the present study, 61.60% of students select their toothpaste by dentist's advice, 6.50% of the students select their toothpaste by parental influence, 22.90% of students select by flavour, 4.10% of students select their tooth paste by cost, 2.40% of students select their tooth paste by colour and only 2.40% of the students select their toothpaste by media influence, in contrast to another study in which 39.6% of subjects choose their toothpaste by media influence, 16.0% by brand, 16.0% by flavour, 4.8% on dentist's advice and 6.0% by parental influence.[7] Parental influence in this study (6.50%) was contradictory with the study done by Al-Omiri *et al*[14] and Vani *et al*[10] [59.0% and 40.0%, respectively].

In the present study 55.90% of students use oral hygiene aids and among the 46.00% use dental floss, 29.30% use interdental brush and 24.70% use tooth picks. The selection of these aids was mainly based on the dental professional's advice. Dental professionals should spend more time making people aware of the different oral hygiene aids available, how to use these aids and the importance of their uses.

According to this study selection of oral hygiene products was based more on dentist influence compared to parental influence, advertisement, cost, friends or other criteria. There seems to be a proper knowledge and awareness about how to choose a dentifrice, toothbrush and mouthwash so there will be good oral hygiene maintenance in students.

Knowledge about oral health has an important role in maintaining oral hygiene and reducing the level of plaque and decayed teeth among students of Dharmsinh Desai University. As knowledge and awareness levels increase, their oral health improves. The attitude and behaviour towards oral health maintenance of the students of Dharmsinh Desai University reflect their understanding of the preventive oral health measures, and this is very important for the improvement of their oral health.

CONCLUSION

To summarize, selection of oral hygiene products by students of Dharmsinh Desai University was based more on dentist's influence. There seems to be proper

knowledge and awareness about how to choose a dentifrice, toothbrush and mouthwash so there will be good oral hygiene maintenance by students. Moreover, proper selection and method of use of oral hygiene products is also good among students.

REFERENCES

1. Dagli RJ, Tadakamadla S, Dhanni C, Duraiswamy P, Kulkarni S. Self reported dental health attitude and behaviour of dental students in India.J Oral Sci 2008; 50: 267−72.
2. Paik DI, Monn HS, Horowitz AM, Gitt HC, JeongKL, Suh SS. Knowledge of oral practices related to caries prevention among Koreans. J Public Health Dent 1994; 54**:** 205−10.
3. Wright FA. Children's perception of vulnerability to illness and dental disease. Community dentistry and oral epidemiology. 1982; 10: 29-32.
4. Morrison V, Bennet P, An Introduction to Health Psychology, Essex: Pearson Education Limited; 2012.
5. Lian CW, Phing TS, Chat CS, Shin BC, Baharuddin LH, Jalil ZB et al. Oral health knowledge, attitude and practice among secondary school students in Kucing, Sarawak. Arch Orofac Sci 2010; 5: 9−16.
6. Humagain M. Evaluation of knowledge, attitude and practice (KAP) about oral health among secondary level students of rural Nepal – aquestionnaire study. WebmedCentral Dentistry 2011; 2: 1−11.
7. ShardaA, Sharda J. Factors influencing choice of oral hygiene products used among the population of Udaipur, India. Int J Dent Clin 2010; 2: 7−12.
8. Shanthi M, Hiremath SS. Knowledge and attitude about dental diseases and their prevention among primary and middle school teachers in urban and rural areas of Bangalore District. J Ind Assoc Pub Health Dent 2011; 2011 (Suppl 1): 692−5.
9. Vinay S, Naveen N, Naganandini N, Devi MA. Oral health knowledge, attitude and practices of caretakers in baby day care centres of Bangalore city. J Ind Assoc Pub Health Dent 2011; 17 (Suppl 1): 233−6
10. Vani G, Babu MG, Panchanatham N. Toothpaste brands – a study of consumer behaviour in Bangalore city. J Econ Behav Stud 2010; 1: 27−39.
11. Senthil M, Bhat PK. Oral health knowledge and attitude among final year nursing undergraduate students in Bangalore city, India. J Ind Assoc Pub Health Dent 2011; 17 (Suppl 1): 389−96.
12. Neamatollahi H, EbrahimiM. Oral health behaviour and its determinants in a group of Iranian students. Indian J Dent Res 2010; 21: 84−8.
13. American Dental Association: ADA Seal of Acceptance Program: Toothpaste.www.ada.org/ada/seal/toothpaste. asp.june25, 2009.
14. Al-Omiri MK, Al-Wahadni AM, Saeed KN. Oral health attitudes, knowledge, and behaviour among school children in North Jordan. J Dent Educ 2006; 70: 179−87.

A Questionnaire study on SARS-CoV-2: An analysis regarding professional and personal well-being of Dental Surgeons during the pandemic.

*Gunjan Barot **Dr. Shalini Gupta

ABSTRACT

Objectives*:* The purpose of the present study was to understand the feasibility of the sudden alterations regarding General Dental Practice in the times of COVID-19 pandemic.

Methods*:* The Questionnaire of cross-sectional survey regarding sudden alterations in General Dental Practice during COVID-19 pandemic was constructed using Google Forms and was sent to various dental surgeons of Gujarat through Emails and generated google form links.

Results*:* Around 150 Dental Surgeons were invited to take part in the survey; out of which 121 Dental Surgeons enthusiastically completed the survey, with a response rate of 80.6%. Almost equal number of subjects (39.7% and 38.8%) found lockdown to be a 'happy experience' and 'irritating at end' respectively. A large chunk of subjects (68.6%) agreed that their lifestyle changed during lockdown; while 41.3% admitted to have consulted people over calls. Though being healthcare professionals; majority of the subjects chose home-remedies as the preferential choice for increasing the immunity. Overall, the findings of the present study showcased some notable alterations in the lives of the Dental Professionals during the pandemic.

Keywords: *COVID-19, Dentists, Dentistry*

INTRODUCTION

Almost a year and half ago, nobody was aware about a new Virus, which was originating then in the People's Republic of China. The Virus was no less than *Thanatos*, the Greek personification of Death itself. Coronavirus Disease (COVID-19) outbreak was first reported in Wuhan, China, in December 2019.[1] Soon, it created a havoc in the People's Republic of China, due to its strong transmission abilities. It, though, couldn't escape from the eyes of WHO, and they named it the SARS COV-2 (aka CoVID-19), another addition to the Corona Family of Viruses. On January 30, 2020, the World Health Organization (WHO) declared that Coronavirus outbreaks have constituted a global health emergency of international concern.[2]

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COVID-19, soon started infecting people all over the world, and before the world could understand the scenario, it had already led to a Global Pandemic. Nations (no matter whether they were developing or developed, better at healthcare facilities or not) started falling prey to it, and soon, stringent measures; the highlight being complete lockdown was imposed in most of the countries. In a sense, the COVID-19 removed the social barriers. It infected the rich and the poor equally, and at the health centres, both were treated with the same care and diligence. Physicians, Nurses, Dentists all worked day and night; drenched in sweat in the Personal Protection Equipments (PPEs); fighting with dehydration, just to defeat that microscopic monster. Things were actually pretty hazardous for everyone; the virus weakened people financially to varying degrees, while it emotionally separated the society. But the people at the highest risk are the Doctors; especially the Dentists. Since the virus is a respiratory virus, and the mode of transmission is through aerosols (through sneezes and wheezes); the nature of dental procedures as well as the close contact with patients increases the risk of COVID-19 transmission. Treatment procedures which involve the use of rotary dental and surgical instruments such as handpieces or ultrasonic scalers and air–water syringes and others are a direct route for virus spread.[3] The onset of COVID-19 pandemic has had devastating effects on the lives of dentists. Not only professional but the personal lives have also been affected. A capricious change has been noted in various aspects emotionally and psychologically. The aim of the present survey was to determine the feasibility of sudden changes regarding General Dental Practice during and after the COVID-19 pandemic amongst the Dental Surgeons of Gujarat; and to assess their professional and personal experience of this pandemic.

MATERIALS AND METHOD:

The present study was designed as a questionnaire based cross-sectional study performed among the DCI registered dentists of Gujarat. The study had a sample size of 150 dentists. Inclusion criteria were any dental practitioner of Gujarat holding the Bachelor of Dental Surgery (BDS) and Master of Dental Surgery (MDS). The exclusion criteria included dentists practicing outside Gujarat and dental students. A digital version of pretested and prevalidated questionnaire consisting of both open-ended and close-ended questions of the cross-sectional survey regarding sudden alterations in General Dental Practice due to COVID-19; was constructed using an internet online survey tool (Google Forms). A link was generated that was e-mailed to dentists of Gujarat. Study was conducted over a period of 4 months. Data was collected and descriptive analysis was done.

Results

A detailed analysis of the collected data was done and the following results were obtained:

QUESTIONS	OPTION 1	OPTION 2	OPTION 3	OPTION 4
ACADEMIC QUALIFICATION	BDS	MDS	BDS Fellowship	PhD
	43%	39%	12%	6%
CLINICAL WORKING EXPERIENCE	0-5 YEARS	6-10 YEARS	11-15 YEARS	>15 YEARS
	47%	25%	14%	14%
AGE RANGE	20-35 YEARS	36-40 YEARS	41-55 YEARS	>55 YEARS
	59%	20%	16%	5%
GENDER	MALE	FEMALE		
	45%	55%		
RESPONSE REGION	NORTH GUJARAT	CENTRAL GUJARAT	SOUTH GUJARAT	SAURASHTRA+KUTCH
	8.26%	49.50%	15.70%	14.04%

TABLE 1: DEMOGRAPHIC DATA

On receiving the responses, it was found that the younger age group showed a remarkable zest of 59% (Age range: 20-35 Years); in which too the females predominated the survey by 55%. And the academically qualified with BDS degree subjects were the highest (43%) in filling up the survey. The subjects having clinical working experience of 0-5 years showed great participation. (Chart 1)

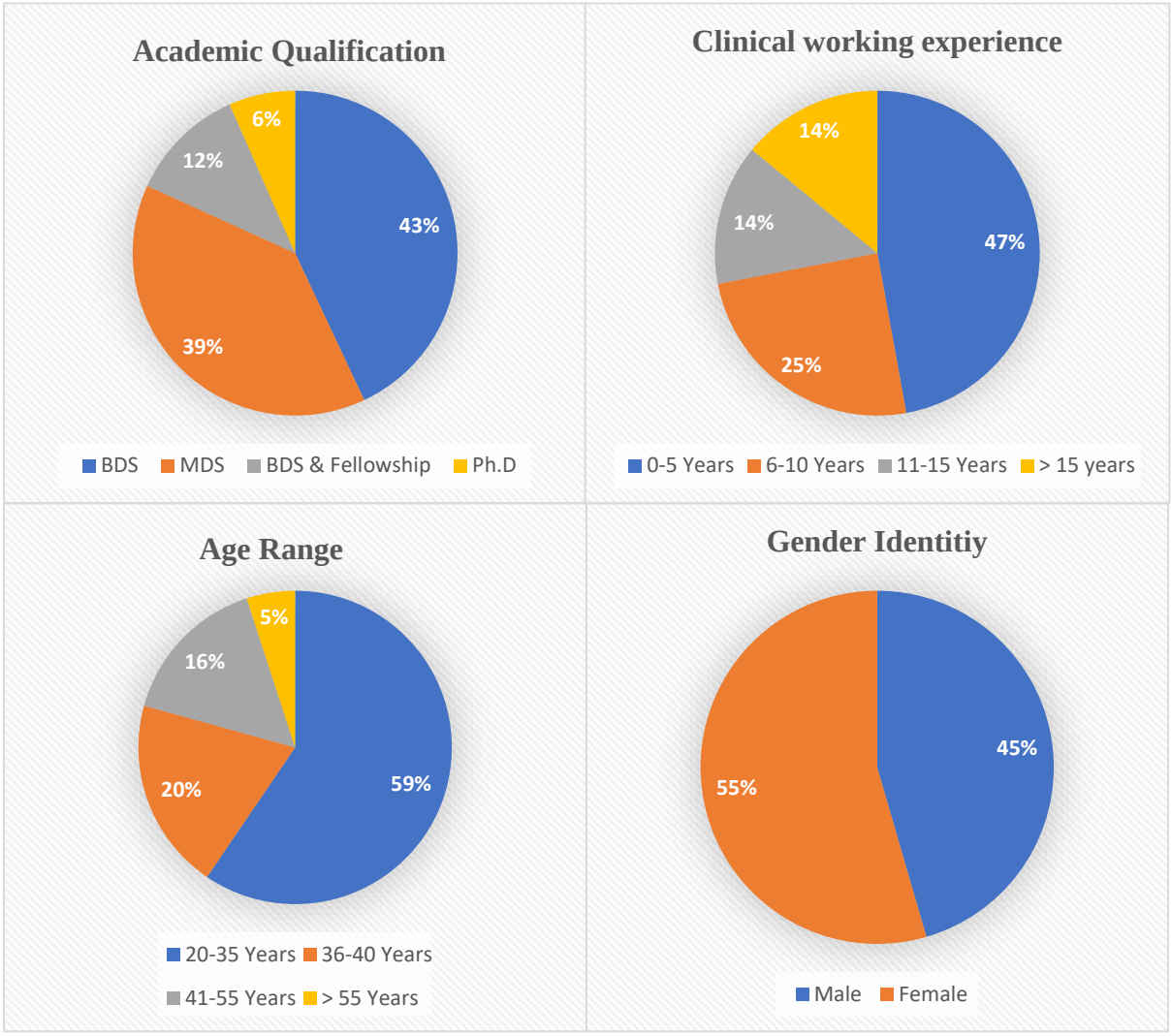

Chart 1: Demographic data in pictorial form

Awareness regarding the covid pandemic was highly appreciable as majority of the subjects, (77%) had its cognizance since it initiated while 21% of the subjects were aware when the cases were low in the country. (Chart 2)

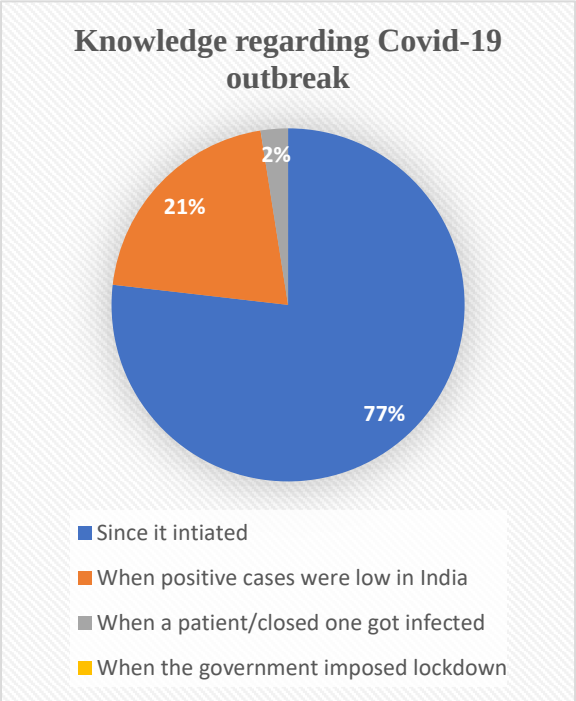

Chart 2: Knowledge regarding the Covid-19 outbreak

Almost equal number of subjects (40% & 39%) found Lockdown to be a 'happy experience' and 'irritating at end', while the other answers were also interesting as some subjects found it to be relaxing and fun while some could focus more on the academic aspect during it. (Chart 3) A large chunk of subjects (69%) agreed that their lifestyle changed during Lockdown, while the second majority of the subjects concurred that the lifestyle eventually became as it was. (Chart 4)

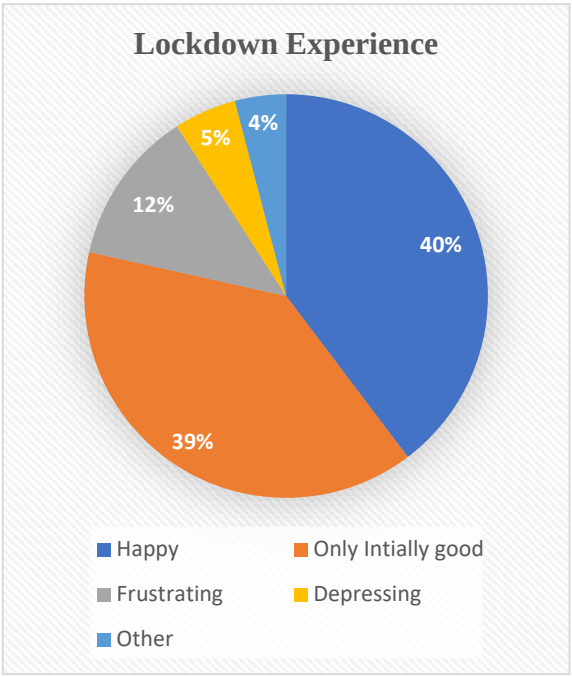

Chart 3: Lockdown as an experience

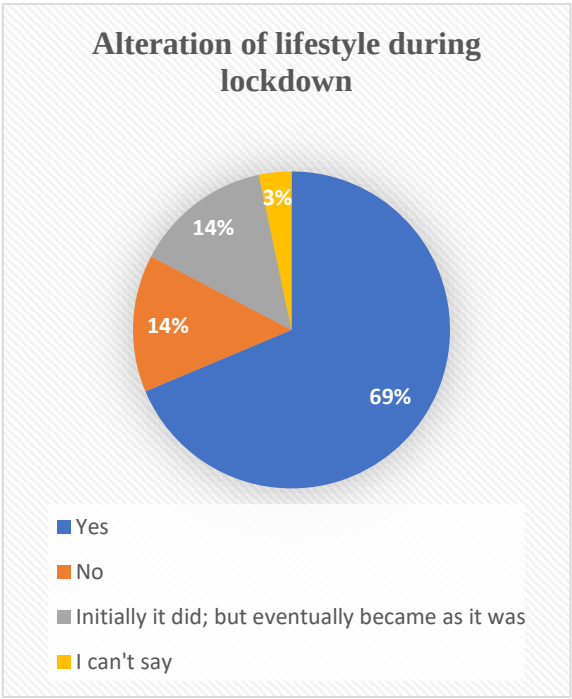

Chart 4: Alteration of lifestyle during lockdown

The tele dentistry concept was highly valued by the subjects during the tough times of lockdown as 42% of the professionals consulted but didn't charge the fees. (Chart 5)

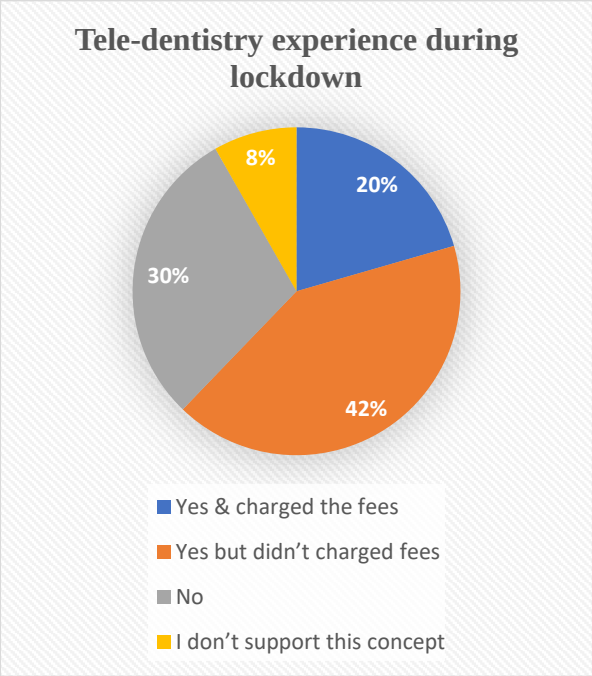

Chart 5: Tele-Dentistry during lockdown

Most of the Dental Surgeons (85%) attended some kind of Webinars. (Chart 6) And 57% expressed that both Webinars & Seminars are good at their own place. (Chart 7)

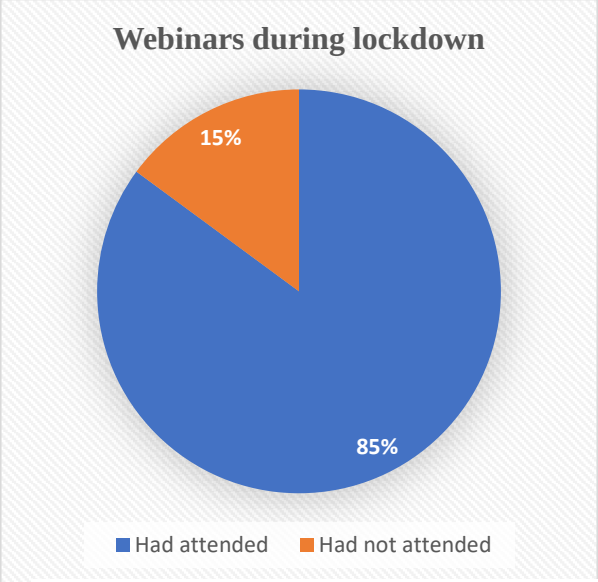

Chart 6: Webinars during lockdown

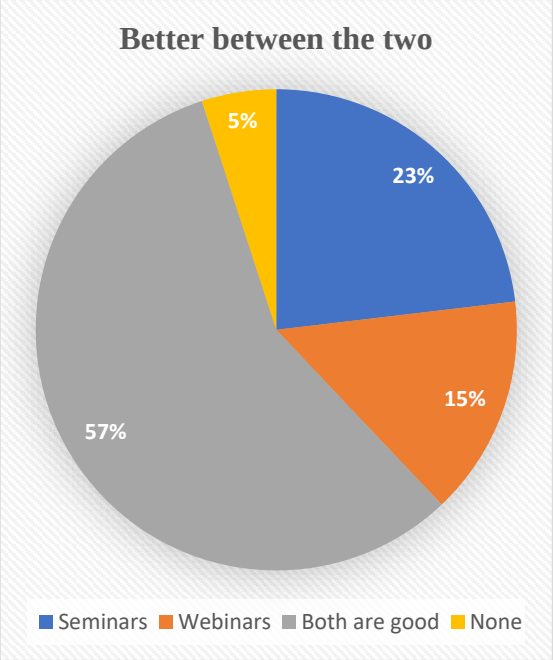

Chart 7: Choice between seminars and webinars

A large proportion of the subjects (42%) found the patient flow at their clinics to be decreased due to the pandemic; while 32% noticed it to normalize gradually. (Chart 8) In rational to that it was also found that 30% felt their working hours as that of pre-covid times. (Chart 9)

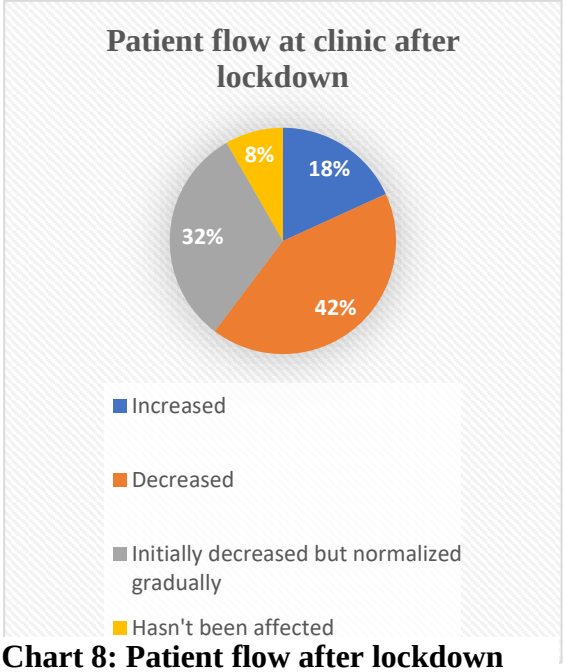

Chart 8: Patient flow after lockdown

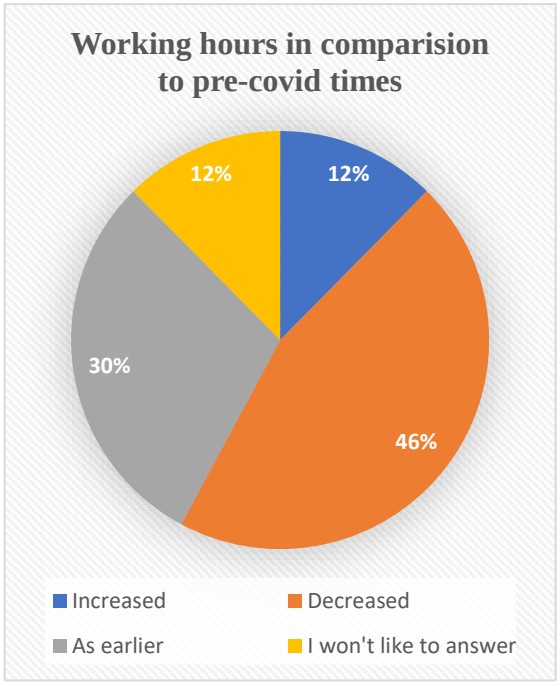

Chart 9: Working hours of dental professionals in the pandemic

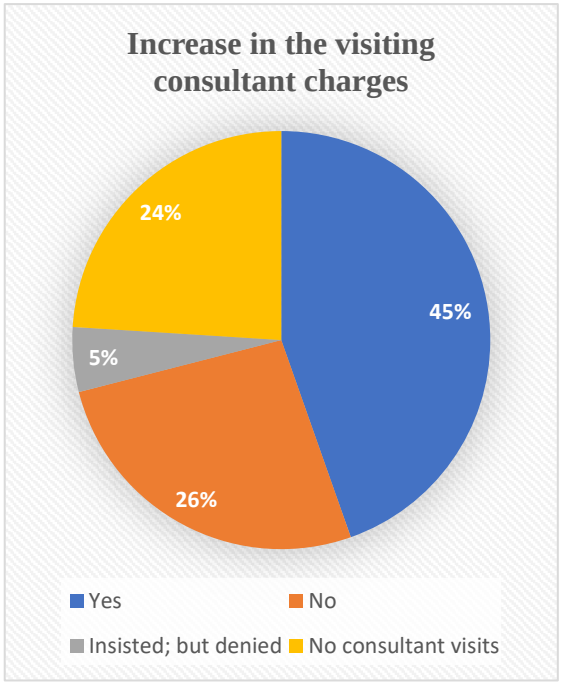

Chart 11: Increased charges by the visiting consultant

The subjects (35%) admitted to have increased both, the consultation and treatment charges in the aftermath of the pandemic. (Chart 10) In addition to this the visiting consultants also raised their charges. (45%) (Chart 11)

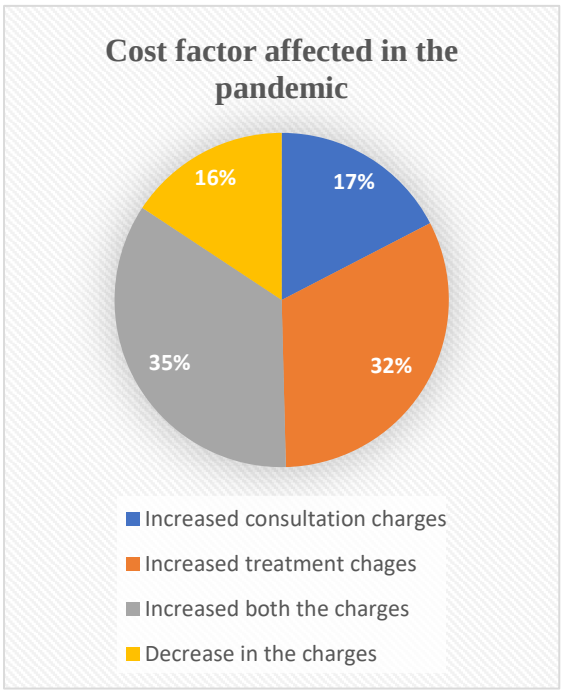

Chart 10: Cost factor due to pandemic

Many Dental Surgeons (60%) couldn't recruit an assistant owing to the pandemic (Chart 12); while most Dental Surgeons (85%) preferred to confirm with their lab technicians about extra hygiene measures. (Chart 13)

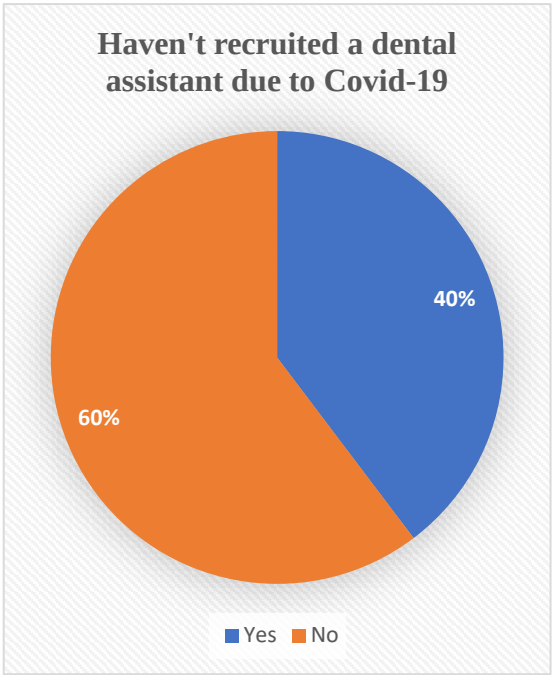

Chart 12: Recruitment of a dental assistant

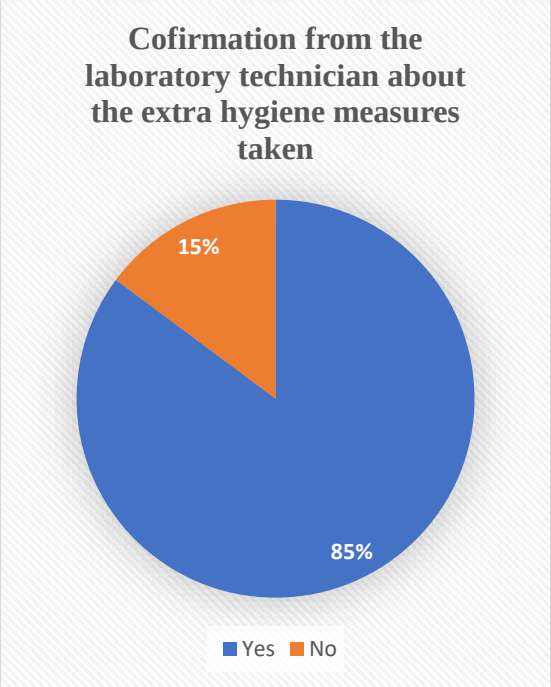

Chart 13: Asking laboratory technician about extra hygiene measures

Covid 19 pandemic has rather a major mental effect and impact in people's life and hence the subjects too found it in patients as 84% of them noticed patients with reduced enthusiasm for the resumed treatments in the unlock phase. (Chart 14)

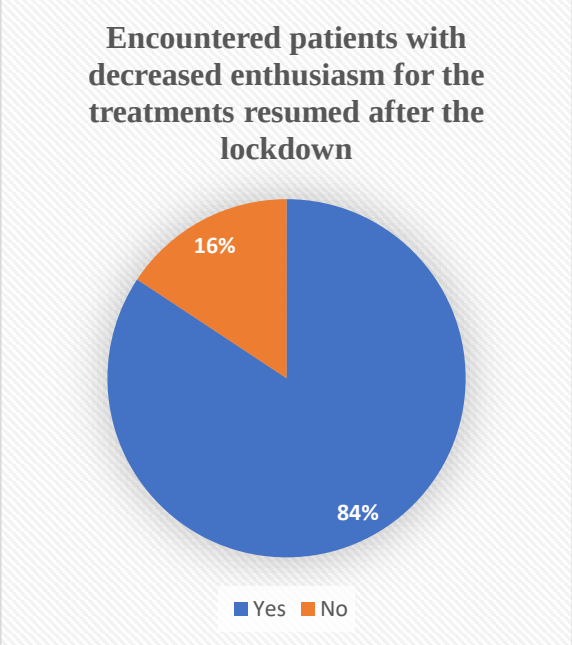

Chart 14 Enthusiasm of patients post lockdown

In the lockdown; the human spirit was really high; even majority of survey subjects (86%) reconciled with their friends and colleagues;(Chart 15) while 78% of the subjects developed a hobby which wasn't in any relation to their profession. (Chart 16)

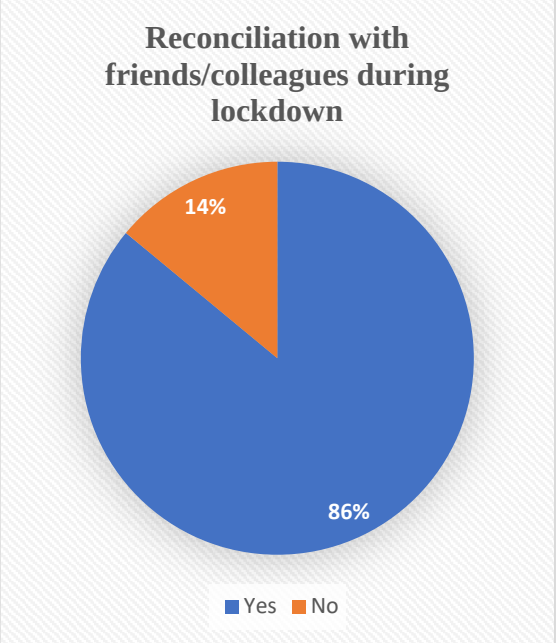

Chart 15 Reconciliation during lockdown

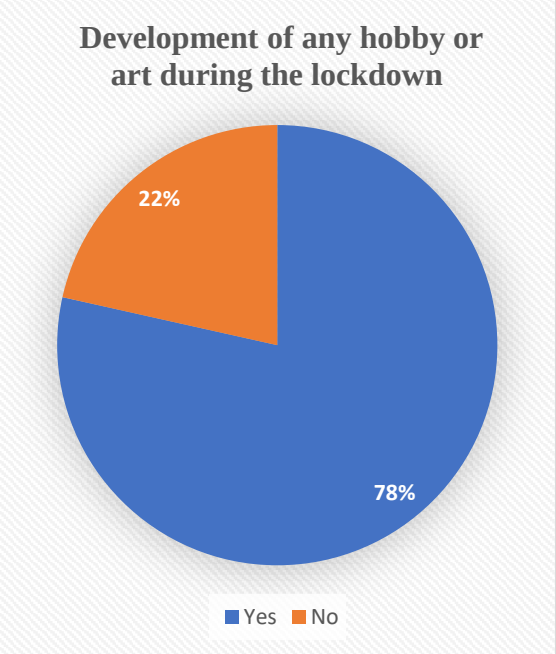

Chart 16: Development of hobby during lockdown

Hygiene and the precautionary protocols have been very well understood by the subjects as it was found that a large number of them (62%) haven't been tested positive up till the survey. (Chart 17)

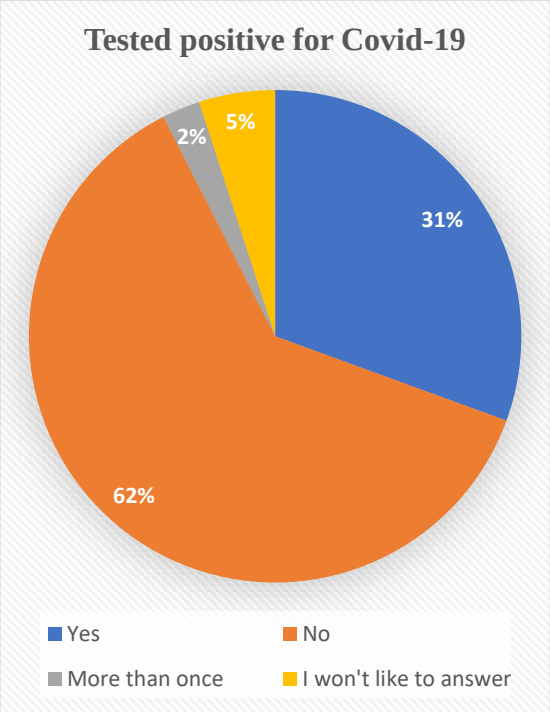

Chart 17: Tested positive or negative to Covid 19

It was interesting to find that though being health care professionals' large chunk of subjects (50%) preferred home remedies for increasing immunity power followed by allopathic medicine. (28%) (Chart 18) While importance of vaccination has been very well understood by the dental professionals as a major mass of the subjects (59%) have been vaccinated up till the survey. (Chart 19)

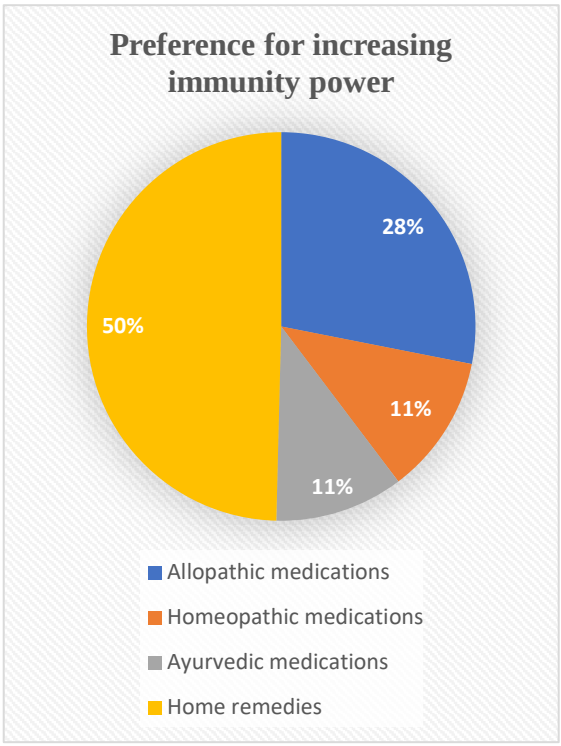

Chart 18: Preference of type of medication

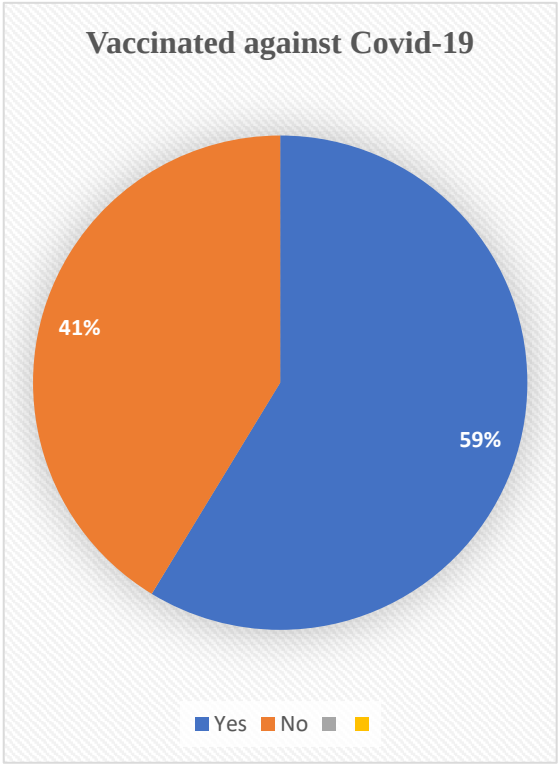

Chart 19: Vaccination against Covid-19

Overall for the subjects this pandemic scenario has been a fairly good segment in realtion to mental state.(Chart 20)

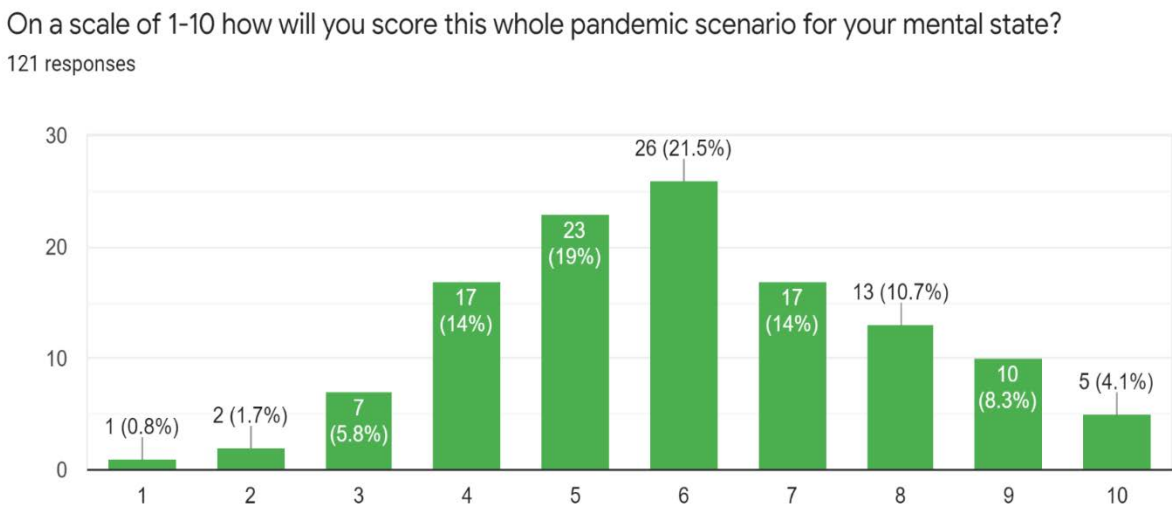

Chart 20: Mental state of the subjects during this pandemic (0=Worst; 10=Excellent)

DISCUSSION

Covid-19 pandemic has affected lives tremendously. No profession is left untouched by it. The dental profession too has been affected; probably a bit more. Dentist are working with the oral cavities; the prime source of transmission of the virus. This pandemic has brought changes not only emotionally, physically and mentally but to a certain extent financially too, in the lives of dental professionals. The present study was not just only focused and concerned with the professional protocols followed by the dental surgeons but even with the personal impediments in their lives due to this. Every age group of both the gender entities with various academic qualifications of the dental stream were involved in this study. Majority of them were quite aware about the pandemic scenario since it started. The imposed lockdown was taken quite affirmatively as many of them enjoyed the stay at home which normally becomes a difficult task due to the work load. Though a bit of gloomy outlook should also be considered as it inhibited the work and made the professionals bit anxious. In a survey of their members, the Dental Defence Union found 68% of respondents felt that their stress and anxiety levels had increased since the pandemic.[4] However, the dental professionals did have a lifestyle change due to the imposed lockdown which included developing new hobbies not related to their profession, reconciling with college friends, attending the webinars and getting in touch with the newer perspective of dentistry in this pandemic. Overall, one can state that the dental professionals handled the imposed lockdown with quite affirmative attitude. The unlock phase can be considered challenging as whole new set of protocols had to be followed. The patient flow had also been comparatively decreased and the enthusiasm of patients to continue the treatment post lockdown was lowered. A recent study from China also

found that the number of nonurgent dental consultations fell by 70%.[5] The night curfew restrictions also affected the clinical working hours of the professionals. The financial aspect of the dental clinics was also affected as the treatment and the consultation charges were raised due to the safety protocols which were to be followed as a precautionary measure not only for the dentist but for the patient as well. Importance of vaccination has been very well understood by the dental professionals and steps to take the same have been followed. Home remedies have been given a preference followed by allopathic, homeopathic and ayurvedic medications. Overall, this pandemic period has proved to be a fairly good segment of a dental surgeon life. Although, we need to consider the results and analysis of this study, taking into account some study limitations.

- Because the survey was sent via emails, and was self-managed by Dental Surgeons; we cannot rule out the probability of a possible response bias to certain questions.
- Since the sample size and the number of responses received were small; it is difficult to establish a conclusion, which shall be applicable to Dental Surgeons of Gujarat.

Nevertheless, the survey has churned out many positives; and hence this survey shall pave way to various other endeavours in future, which shall study in great depth; the effects of COVID-19 on Dental Conditions/Procedures.

CONCLUSION

Most of the Dental Surgeons surely had their lifestyle altered during the pandemic. They consulted patients over calls, attended webinars and discovered new passion towards various activities, to keep themselves engaged.

Certainly, the pandemic changed the conventional ways of dental practices. Reduced enthusiasm in patients for treatment, led to decreased working hours of the Dental Surgeons. Due to lack of resources, many couldn't recruit an assistant, even if they wanted to. And while many Dental surgeons increased only their treatment charges; many visiting consultants did increase their consultation charges as well. Almost all the Dental Surgeons adhered to strict hygiene measures during the treatment; and expected the same from their respective lab technicians. Howsoever the situation is or will be, dental professionals will always stand with the thought that; *"You always have more reasons to believe that you can; than to believe that you cannot."*

References

1. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A novel coronavirus from patients with pneumonia in China, 2019. N Engl J Med. 2020; 382:727–33.
2. World Health Organization (WHO). Novel Coronavirus (2019-nCoV): situation report, 11. Geneva: World Health Organization.2020:1-31.
3. Cleveland JL, Gray SK, Harte JA, Robison VA, Moorman AC, Gooch BF. Transmission of blood-borne pathogens in US dental health care settings. J Am Dent Assoc. 2016; 147:729–38
4. Dental Defence Union. Data on file; 2020. https://dentistry.co.uk/2020/06/30/three-five-dentists-covid-pandemic/
5. Fini MB What dentists need to know about COVID-19. Oral Oncol 2020;105:104741. doi:10.1016/j.oraloncology.2020.104741.

FIXED IMPLANT PROSTHESIS DESIGN CONFIGURATIONS FOR RESTORATION OF EDENTULOUS MANDIBLE

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****Dr.Trishala Patel ****Dr. Thanmai Taduri.

ABSTRACT: The major issues making it difficult to masticate with complete dentures are the lack of retention and stability of the mandibular denture. The mandibular denture moves considerably during function. Treatment choices depend on a number of interrelated factors, including the degree of resorption and whether the inferior alveolar nerve is exposed on the crest of the ridge, the amount of keratinized attached mucosa remaining on the alveolar ridge at the implant sites, the potential for effective oral compliance, the aesthetic needs of the patient with regard to the need to support the lower lip and the corners of the mouth, cost, and the psychological demands of the patient. By considering the patient's functional behavior, limiting the extension of the prosthesis and controlling the occlusal pattern and contacts, possible overload situations can be minimized

***Key words**: Fixed prosthesis, Implant fixed prosthesis, Hybrid denture, metal ceramic fixed implant prosthesis, implant fixed prosthesis design*

INTRODUCTION

Rehabilitation with implant prosthesis is a prosthetically oriented discipline. The goal of prosthodontics is the maintenance and preservation of the remaining dentition and surrounding structures. Implant treatment can add greatly to patient's perceptions of themselves and their surroundings. However fulfilling a patient's desire for fixed restorations, rather than removable appliances, may not always be possible. An implant failure may occur after a less than optimum diagnosis and treatment plan by the implantologist in order to avoid problems in implant dentistry, the clinicians should understand site and selection of implant, optimum use of hard tissue,

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maintenance of soft tissues and papilla for aesthetics, replacement of one implant body for each missing tooth, and fit of the prosthesis. Ideally the practitioner evaluates the diagnosis and plans for the sequential treatment prior to any surgical consultation. The diagnostic and treatment planning phase is critical in implant prosthodontics to avoid early and late failures. The proper sequencing of treatment should promote the maximum function during rehabilitation.

Implant-Retained/Supported Versus Fixed Prostheses for restoration of edentulous mandibles:

Advantages of a Full-Arch Fixed Partial Denture versus Overdenture[1]:

1. Psychological: "feels like teeth"
2. Less prosthetic maintenance (e.g., attachments, relines, new overdenture)
3. Less food entrapment
4. Posterior mandibular bone gain

Mandibular Dynamics

A. Medial Movement

Relgi advocated that out of five different movements, medial convergence is the one most commonly addressed.[2,3] The mandible between the mental foramina is stable relative to flexure and torsion. However, distal to the foramina, the mandible exhibits considerable movement toward the midline on opening.[2,4] This movement is caused primarily by the attachment of internal pterygoid muscles on the medial ramus of the Mandible.

B. Torsion

Torsion of the mandibular body distal to the foramina has also been documented in both animal and human studies.[5,6] Parasagittal bending of the human jaw during unilateral biting was confirmed by Marx, who measured localized mandibular distortion in vivo in humans by using strain gauges on screws attached to cortical bone in the symphyseal and gonial regions. Parafunctional bruxism and clenching may cause torsion-related problems in the implant support system and prosthesis when the mandibular teeth are splinted from the molar-to-molar regions.

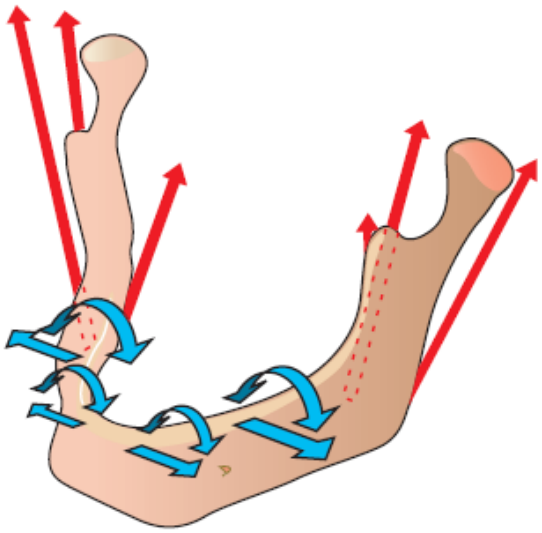

Illustration-1. The mandible flexes toward the midline on opening or during protrusive movements as a result of the internal pterygoid muscle attachments on the ramus. The mandible also torques, with the inferior border rotating out and up and the crestal region rotating lingually. The movement is caused by the masseter muscles during forceful biting or parafunction.

Implants placed in front of the foramina and splinted together or implants in one posterior quadrant joined to anterior implants have not shown these complications related to the flexure or torsion of the mandible.[6] Complete

implant-supported fixed restorations can halt the posterior bone loss associated with edentulism, improve psychological health, and produce fewer prosthetic complications than removable restorations. Therefore, all edentulous mandibular patients should be given the option of having a fixed prosthesis. However, the increase in forces of mastication, increase in force with patients of greater force factors (e.g., parafunction, crown height space, opposing arch type), or reduced bone density in the implant sites warrants an increase in implant number or implant position in anterior and posterior implant sites.

Five treatment options are used to restore a complete edentulous mandible with a fixed prosthesis. These implant position options also may be considered for implant-supported overdentures. When a mandibular overdenture is completely implant supported and retained and stabilized by a cantilevered bar, it acts similarly to a fixed prosthesis in function and bone maintenance. Therefore, the five treatment options included in this chapter may be used for either a RP-4 overdenture or a fixed prosthesis.

Implant Treatment Options for Fixed Restorations

Treatment Option 1: The Brånemark Approach[7]

Treatment option 1 places four to six implants between the mental foramina, and bilateral distal cantilevers replace the mandibular teeth. The mandible does not flex or exhibit significant torsion between the mental foramina. Therefore, anterior implants may be splinted together without risk or compromise.

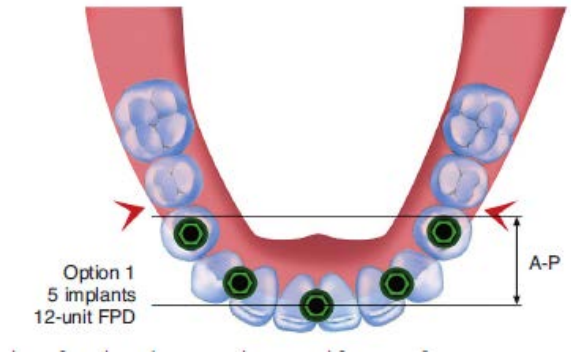

Illustration-2. The most common number of implants between the mental foramina for option 1 is five. These implants provide as great an anteroposterior (A-P) distance as possible between the foramina with sufficient interimplant spacing for treatment of complications. FPD, Fixed partial denture.

Treatment Option 2

Bidez and Misch have evaluated dentate and edentulous mandibles and developed a three-dimensional bone strain model of flexure and torsion.[8] A slight variation of the ad modum Brånemark protocol is to place additional implants above the mental foramina because the mandible flexes distal to the foramen. An implant above one or both foramina presents several advantages. First, the number of implants may be increased to as many as seven (which increases the implant surface area). Second, the A-P spread for implant placement is greatly increased (usually by 7 mm) even when the total implant number is five. The more distal implant position reduces the class 1 lever forces generated from the distal cantilever. Third, the length of the cantilever is reduced dramatically

because the distal most implant is placed one tooth more distal.

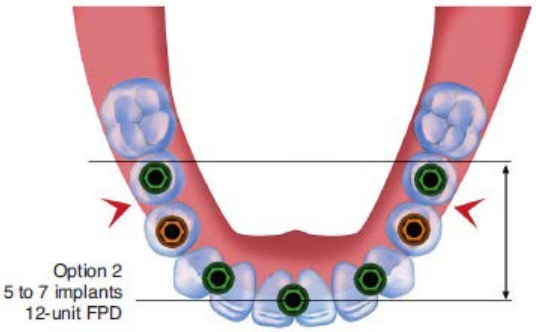

Illustration-3. Treatment option 2 has five key implant positions: two implants placed over the mental foramina, two implants in the canine positions, and one implant in the midline. Secondary implants may be positioned in the first premolar sites. This has a much improved anteroposterior distance and reduces the cantilever length to the first molar. FPD, Fixed partial denture.

Treatment Option 3

The Bidez and Misch strain model of an edentulous mandible indicated that implants in one posterior section may be splinted to anterior implants without compromise. The author has evaluated full-arch fixed prostheses on implants with one posterior segment connected to the anterior region over the past decade and has found no additional complications experienced during this time frame compared with those with independent segments. Therefore, an improved treatment plan option to support a fixed mandibular prosthesis consists of additional implants in the first molar or second premolar position (or both) connected to four or five implants between the mental foramina. Hence, five to seven implants usually are placed in this treatment option.

The key implant positions for treatment option 3 are the first molar (on one side only), the bilateral first premolar positions, and the bilateral canine sites. The secondary implant positions include the second premolar position on the same side as the molar implant and the central incisor (midline) position.

Treatment option 3 is a better option than anterior implants with bilateral cantilevers (option 1 or 2) for several reasons. When one or two implants are placed distal to the foramina on one side and are joined to anterior implants between the foramina, a considerable biomechanical advantage is gained. Although the number of implants may be the same as option 1 or 2, the A-P spread is 1.5 to 2 times greater because on one side, the distal aspect of the last implant now corresponds to the distal aspect of the first molar. In addition, only one cantilever is present rather than bilateral cantilevers. When force factors are greater, six to seven implants may be used for this option. Five implants between the foramina and one or two implants distal on one side comprise the usual placement.

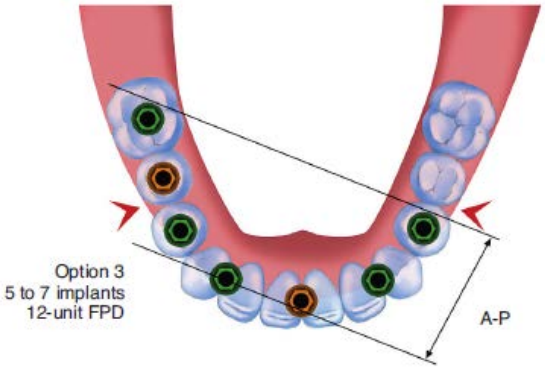

Illustration-4. Five of the seven mandibular implants are positioned between the mental foramina, and two are placed on the patient's right or left side. The anteroposterior (A-P)

distance is measured from the two distalmost implants to the anteriormost implant from the cantilever. The placement increases the A-P distance and eliminates the prosthetic cantilever on the patient's left side.

Treatment Option 4

Treatment plan options for fixed full-arch prostheses also may include bilateral posterior implants as long as they are not splinted together in one prosthesis. This option is selected when force factors are great or the bone density is poor. Poor bone quality most often is observed in the posterior maxilla, but on occasion, it is also found in the mandible. This option is also used when the body of the mandible is division C–h and subperiosteal or disk-design implants are used for posterior implant support. Several options for fixed restorations are available when bilateral posterior implants are included.

In treatment option 4, implants are placed in all three segments of the mandible. Key implant positions for this treatment option include the two first molars, two first premolars, and two canine sites. Secondary implants may be added in the second premolars or the incisor (midline) position (or both). All implants in the anterior and one posterior side are splinted together for a nine-unit, fixed prosthesis. The other posterior segment is restored independently with an independent three-unit, fixed prosthesis supported by implants in the first premolar and first molar region as the key positions.

The primary advantage of this treatment option is:

1) Elimination of cantilevers

2) As a result, risks of uncemented restorations and occlusal overload are reduced

3) Prosthesis has two segments rather than one. The larger segment (molar to contralateral canine) has an improved advantage because it has implants in three to four different horizontal planes

4) Because no cantilever is present, weaker cements can be used to install the prosthesis

5) The restoration should exhibit posterior disclusion in excursions to limit lateral loads, especially to the prosthesis supported by fewer implants.

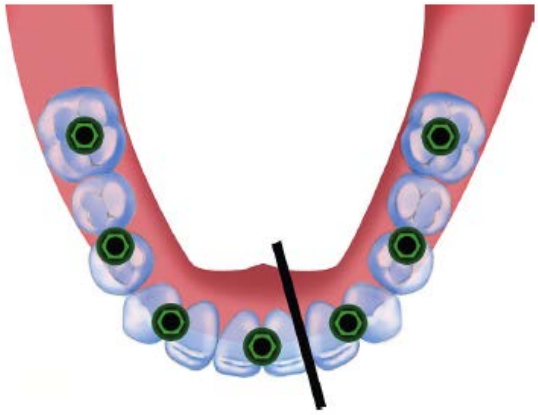

Illustration-5. Most often treatment option 4 uses at least seven implants, so the smaller segment has three implants.

Disadvantages for treatment option 4 include the need for abundant bone in both mandibular posterior regions and the additional costs incurred for one to four additional implants.

Treatment Option 5

Another modification for the completely edentulous mandible is to fabricate three

independent prostheses rather than one or two. The anterior region of the mandible may have four to five implants. The key implants are in the two first molar sites, the two first premolar, and two canine regions. Secondary positions are the two second premolar and central incisor (midline) sites. The posterior restorations are two independent implant prostheses, usually with two units.

The advantages of this option are smaller segments for individual restorations in case one should fracture or become uncemented. In addition, if greater mandibular body movement is expected because of parafunction or a decrease in size of the body of the mandible, the independent restorations allow the most flexibility and torsion of the mandible.

The primary disadvantage of option 5 is the greater number of implants required. In addition, the available bone needs are greatest with this treatment option. Nine implants are rarely required to replace the lower teeth, regardless of the bone density or force factors present. Option 5 is the treatment of choice when force factors are severe.

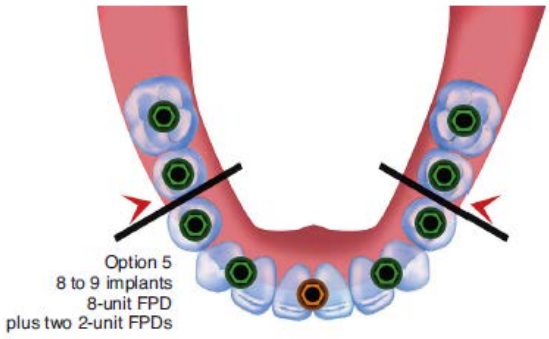

Illustration-6. Option 5 often has a fixed prosthesis from first premolar to first premolar supported by four or five implants. The posterior segments each have two units.

THE HYBRID RESTORATION[9,10]

When the anatomical presentation of the patient will allow an overdenture restoration and more than two implants are possible, the choice of restoration to be placed should be the implant supported fixed restoration or hybrid type restoration.The implant retained and supported overdenture has little indication in the mandibular arch when four or more implants are placed. The hybrid restoration requires that four to six implants are placed between the mental foramina. These implants are sufficient to support a fixed restoration with cantilevers posterior to the terminal implants.

Illustration-7. Undersurface of a hybrid restoration illustrating the cantilever length that can be placed.

Illustration-8. Intra oral view of hybrid restoration illustrating full support of the restoration by implants alone without tissue contact.

Treatment planning for this type of restoration begins with a patient interview, followed by a clinical examination and a review of radiographs. A minimum of 10-12 mm of inter occlusal space from the platform of the implant to the opposing occlusion is required for the implant components, framework and teeth. If insufficient space presents then consideration to increasing the vertical dimension, ostectomy or fixed metal ceramic restorations requiring less inter occlusal space must be considered.

METAL CERAMIC FIXED UNITS

When patients present while dentate with many of the teeth unrestorable, for periodontal or structural reasons there are times when removing these teeth in order to provide implant supported restorations becomes the most common option. As the alveolar housing is still present as teeth are retained, the minimal resorption would contraindicate the use of a hybrid prostheses. In these situations, all the principles of restoring teeth in the anterior and posterior quadrants which have been described in earlier must apply. For this type of restoration more implants are required to support the restoration for both biomechanical, technical and ease of maintenance issues. The bulk of the frameworks are smaller therefore cantilevers should be avoided, metal ceramic units distort during fabrication so short segments are easier to manage and repairs and maintenance are easier with short spans.

Usually three segments are fabricated, one replacing each posterior sextant and one anteriorly. Force estimations for each segment should be assessed based on the factors outlined above and the number of implants determined accordingly. With this type of restoration, the implant position is more critical than the other two choices of restoration, therefore the surgical guide and stabilisation of the surgical guide is critical. At times teeth can be maintained to help and if this is not possible, temporary implants can be used to aid in stabilising surgical guides.[11]

Illustration-9. Anterior view of restoration, note minimal space available for restorations resulting in choice of metal ceramic restorations to replace teeth in the mandibular arch.

CONCLUSION

There are three main choices for restoring the mandibular arch with implants: a minimalist approach with two implants to retain a removable prosthesis or a fixed restoration which may be a hybrid type restoration or metal ceramic implant supported restoration. The overdenture type restoration is the least expensive initially, however, it requires more maintenance and the prosthesis continues to load tissues posterior to the implants.

The fixed types of prostheses will provide almost normal function and require minimal post-operative adjustments; the overdenture is more economical and very satisfactory for those patients who lack the muscular coordination to wear complete dentures but

have no complaint of pain due to loading of the mucosa.

REFERENCES:

1. Misch C.E. Contemporary Implant Dentistry 2nd edition, St-Louis: Mosby Elsevier 2015.
2. Regli CP, Kelly. The phenomenon of decreased mandibular arch width in opening movement. J Prosthet Dent 1967;17:49-53.
3. Hylander WL. Stress and strain in the mandibular symphysis of primates: a test of competing hypotheses. Am J Phys Anthropol 1984;64:1–46.
4. Grant AA. Some aspects of mandibular movement: acceleration and horizontal distortion. Ann Acad tiled Singapore 1986;15:305—310.
5. Abdel-Latif HH, Hobkirk JA, Kelleway JP. Functional mandibular deformation in edentulous subjects treated with dental implants. Int J Prosthodont 2000;13:513–519.
6. Omar R, Wise MD. Mandibular flexure associated with muscle force applied in the retruded axis position, J Oral Rehabil 1981;8:209–221.
7. Adell R, Lekholm U, Rockler B, et al. A 15-year study of osseointegrated implants in the treatment of the edentulous jaw, Int J Oral Surg 1981;10:387–416.
8. Misch CE. Treatment options for mandibular full arch implantsupported fixed prostheses. Dent Today 2001;20:68–73.
9. Randow K, Ericsson I, Nilner K et al. Immediate functional loading of Branemark dental implants. An 18-month clinical follow-up study. Clin Oral Implants Res 1999;10:8-15.
10. McAlarney M E, Stavropoulos D N. Theoretical cantilever lengths versus clinical variables in fifty-five clinical cases. J Prosthet Dent 2000;83:332-343.
11. Aalam A A, Reshad M, Chee W W, Nowzari H. Surgical template stabilization with transitional implants in the treatment of the edentulous mandible: a technical note. Int J Oral Maxillofac Implants 2005;20:462-465.

DIAGNOSIS AND TREATMENT PLANNING OF OCCLUSAL PLANE DISCREPANCIES

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****Dr. Takshil Shah

ABSTRACT:

An understanding of the factors controlling the pattern or contours of occluding tooth surfaces is desirable in planning for the maintenance of oral health and function. As broadly defined, occlusion is not limited to occlusal contact relationship to teeth. It also encompasses neuromuscular and psycho physiological areas that may reflect disturbance that occurs as a result of or are the cause of occlusal dysfunction. An occlusion is the provision of an effective chewing mechanism. The long-range objective, of even greater importance, is the preservation of the residual structures in a state of optimum health. The concepts of occlusion vary with almost every specialty of dentistry.

Keywords: *Occlusion, Occlusion in natural dentition, Natural dentition.*

INTRODUCTION

The need to understand and define the role of occlusion within the charge of restoring and maintaining form, function, and esthetics is clear.

Knowledge, concepts and emphasis in relation to the subject of occlusion have changed considerably and will probably continue to change over the years to come.

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The term plane of occlusion refers to an imaginary surface that theoretically touches the incisal edges of the incisors and the tips of the occluding surfaces of the posterior teeth. Because the term plane refers geometrically to a flat surface, it is not entirely correct to describe the occlusal surface as following a true plane. Instead of a flat surface, the plane of occlusion represents the average curvature of the occlusal surface. Despite the problem of semantics, it is probably the most practical way of relating the occlusal surfaces of the teeth to one another and to other structures of the head. Each curvature of the plane is related to specific effects it should produce. Its acceptability should be analysed on a functional basis rather than on its conformity to a set ideal. The concepts of occlusion vary with almost every specialty of dentistry. Until recently, only a few concepts of occlusion have included functional criteria, and because the dentofacial complex is highly dynamic, ideas of occlusal stability often misunderstood and seldom mentioned as a part of a concept of occlusion.

The objective of this literature is to attempt to portray the status of occlusion plane as it stands today with a clear emphasis on clinical implication with respect to natural dentition.

OCCLUSAL PLANE:

The configuration of the occlusal plane is one of the most beautiful examples of design that can be found in nature.

The curvatures of the anterior teeth are determined by the establishment of an esthetically correct smile line in the upper arch and the relationship of the lower incisal edges to the anterior guidance and the requirements for phonetics.

The curvatures of the posterior plane of occlusion are divided into;

(1) An anteroposterior curve called the curve of Spee and

(2) A mediolateral curve, referred to as the curve of Wilson.[1]

THE CURVE OF SPEE

In 1890 the curve of Spee was described by the German anatomist, Ferdinand Graff Spee. The curve of Spee refers to the anteroposterior curvature of the occlusal surfaces, beginning at the tip of the lower canine and following the buccal cusp tips of the bicuspids and molars and continuing to the anterior border of the ramus. If the curved line continued further back, it would ideally follow an arc through the condyle. The curvature of the arc would relate, on average, to part of a circle with a 4-inch radius.[2]

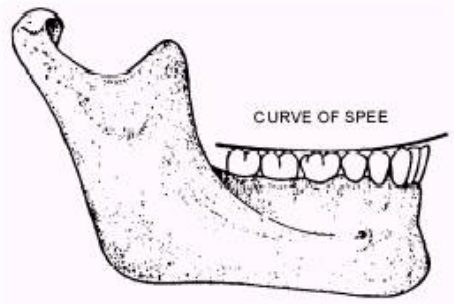

Illustration *1: Curve of Spee*

THE CURVE OF WILSON

In 1911, George H. Wilson described the curve of Wilson. The curve of Wilson is the mediolateral curve that contacts the buccal and lingual cusp tips on each side of the arch. It results from inward inclination of the lower posterior teeth, making the lingual cusps lower than the buccal cusps on the mandibular arch; the buccal cusps are higher

than the lingual cusps on the maxillary arch because of the outward inclination of the upper posterior teeth.[3]

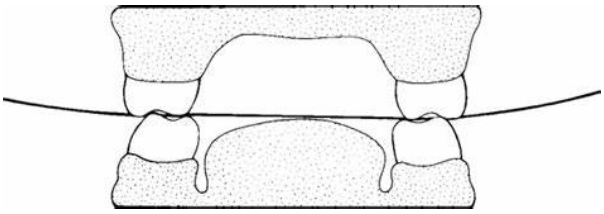

Illustration *2: Curve of Wilson*

CURVE OF MONSON

In 1932 G. S. Monson proposed the spherical theory, which was based, on the concept that the mandibular teeth move over the occlusal surface of the maxillary teeth, as over the external surface of a segment of an 8-inch sphere, and the radius (or the common center) of the sphere is located in the region of the glabella.[4]

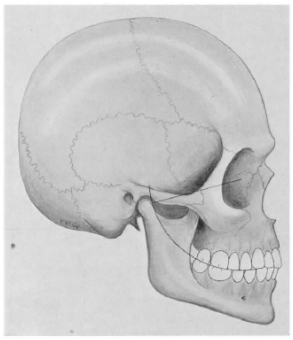

Illustration *3: Monson's sagittal curve with estimated 4-in. radius*

EXAMINATION OF OCCLUSAL PLANE PROBLEMS

An occlusal examination is not complete unless it includes an analysis of the occlusal plane. On protrusion of mandible, if the anterior teeth are separated by the posterior teeth, there is a problem with the occlusal plane. The problem may be the result of a single misaligned tooth, or it may be caused by improper curvature or alignment of the entire occlusal plane.[1]

CORRECTING OCCLUSAL PLANE PROBLEMS

There are two basic approaches to solving occlusal plane problems.

1. Levelling or flattening the occlusal plane
2. Steepening the anterior guidance

Levelling or flattening the occlusal plane can be discluded by the existing anterior guidance, which remains unchanged. Steepening the anterior guidance can disclude the existing occlusal plane, which remains unchanged.[5]

ESTABLISHING THE PLANE OF OCCLUSION

There are 4 practical methods for establishing an acceptable plane of occlusion.[1]

1. Analysis on natural teeth through selective grinding
2. Analysis of facebow-mounted casts with properly set condylar paths
3. Use of Broadrick Occlusal Plane Analyzer
4. Meyer's functionally generated pathway

Analysis of natural teeth through selective grinding

This includes analyzing precisely articulated diagnostic casts and carefully observing the patient's occlusion intraorally. Careful observation of occlusal/incisal wear facets followed by use of articulating paper and occlusal indicating wax enables identification of occlusal patterns. Areas of adjustment are strategically planned so that

the vertical dimension of occlusion is not modified and interferences to normal mandibular movement are removed from offending cusp inclines.[1]

Analysis of facebow-mounted casts with properly set condylar paths

Any articulator that can duplicate condylar border paths can be used to analyze or establish a correct occlusal plane, as long as an acceptable anterior guidance can also be programmed into the instrument. Selective grinding or preliminary wax up, or both, can be done on the cats to show the outer limits of occlusal plane contour and position. The preliminary correction and wax up can also be used for the fabrication of provisional restorations.[1]

The need for fully adjustable instrumentation for analyzing occlusal plane is that condylar path settings can be accomplished with protrusive and lateral interocclusal records made at the edge-to-edge position of the incisors.[1]

Use of Pankey-Mann-Schuyler method (PMS) of occlusal plane analysis

When it is determined that restoration of all or most of the posterior teeth is necessary, the PMS technique provides an excellent and practical method for determining an occlusal plane that will fulfil all the requirements of correct occlusion. The simplest method of implementing this technique is through the use of Broadrick Occlusal Plane Analyzer.[1]

Broadrick Occlusal Plane Analyzer:

The Broadrick Flag allows the construction of the Curve of Spee in perfect harmony with the anterior condylar guidance allowing total posterior tooth disclusion on mandibular protrusion. This results in the esthetic positioning and proper functioning of the mandibular incisors.[6]

The Broadrick Occlusal Plane Analyzer consist of (Illustration 4):[6]

1- Card Index.

2- Bow Compass with graphite leads with an extra center point and needle point.

3- Scribing knife.

4- Plastic Record cards.

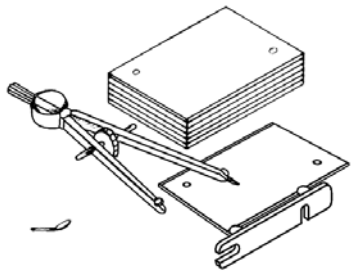

Illustration *4*

The maxillary cast is mounted by a Facebow transfer and the mandibular cast is mounted in centric relation. An accessory Split-Cast Mounting plate is mounted on the Upper member of the articulator. This split cast allows rapid cast removal and accurate replacement during the survey. It also provides a visual guide for adjustment of the articulator to protrusive and lateral inter-occlusion records.[7]

Preparation of the Analyzer:

1. The card index is placed on the upper member with the open end around the incisal pin and the slot on the side

around the mounting plate thumbscrew.[8]

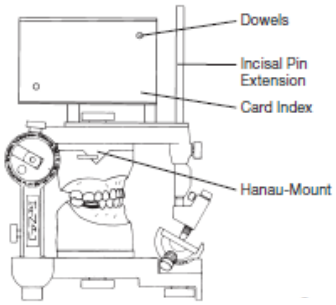

Illustration*: 5*

2. The thumbscrew is tightened to hold the card index in position.[8]
3. If there is an Orbitale indicator mounted on to the articulator, care should take to remove it in order to mount the card index.[8]
4. Press a plastic record card over the dowels on the right side of the card index. The cards are matte finished on both sides, thus accepts ink or pencil markings readily.[8]
5. A relatively small divergence between arcs of 3-3/4 “4” and “5” radius over the functional occlusal surfaces on the lower posterior teeth. The radius of sphere in the Curve of Spee is suggested to be at 3.75 inches in skeletal Class II relationship, whereby a 5-inch radius is more appropriate in a skeletal Class III relationship. A 4-inch radius is considered normal and most often used in majority of cases especially in class I relationships.[8]

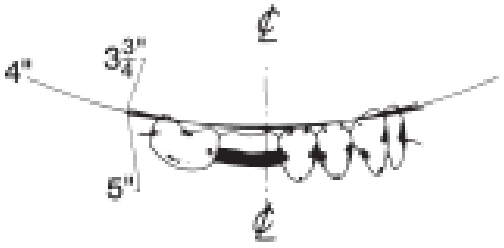

Illustration*: 6*

6. Then tapered pin is withdrawn from the split mount cast plate and the upper cast is removed. A lead piece is inserted on to the compass and it is adjusted to a selected radius.[8]
7. The center point of the compass is adjusted to the anterior survey point (A.S.P), which is usually the disto-incisal of the canines. If it is noticed that the cusp of the canine is attrited or worn our flat, the anterior survey point may be at the incisal edge. If a point is selected as the most desirable point that beams the line and plane of occlusion posteriorly, it is marked on to the canine and not changed.[8]
8. As the center of the compass is positioned on the A.S.P, a long arc of 3 inches is applied on to the plastic record card. The occlusal plane survey centre (O.P.S.C) will eventually be located on some point on the arc.[8]

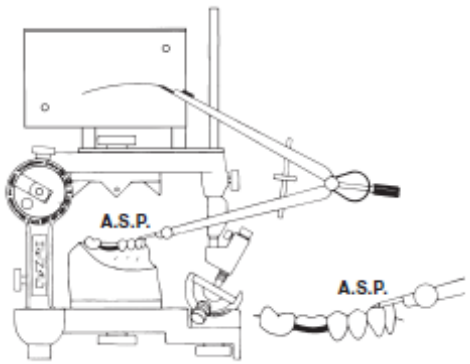

Illustration: *7*

9. A posterior most point (P.S.P) is selected at the distobuccal cusp of the lower last molar.[8]

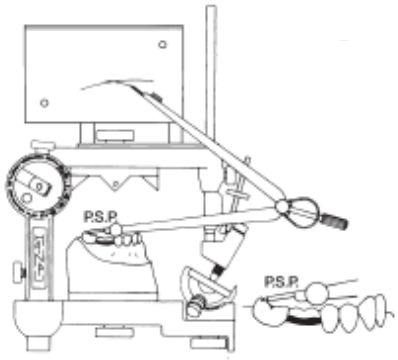

Illustration*: 8*

10. In such cases where there is an absence of the lower molar, the upper cast is replaced and a soft modelling compound is placed over the ridge, closing the articulator until the incisal pin contacts the incisal guide in a centric relation. The compound is chilled and the excess is carved away, leaving only compound contacting into the upper fossae, simulating the lower buccal cusp.[8]
11. The upper cast is removed and a posterior survey point (P.S.P) is selected on the modelling compound.
12. The center point of the compass is positioned on the P.S.P and an arc is applied to intersect the arc from the A.S.P.[8]
13. Alternate to the molar P.S.P, is a position on the condylar element of the articulator, at its anterior intersection with the condylar shaft.[8]
14. The center point of the compass is positioned on the condylar posterior survey point (C.P.S.P) and an arc to intersect the arc formed from A.S.P.[8]
15. The needle point is then swept over the occlusal surfaces of the lower posterior teeth to see how the arc conforms to the existing occlusal plane. This occlusal plane survey center (O.P.S.C) is shifted on the long arc on the plastic record card, the A.S.P line, until the most acceptable plane of occlusion and line is found.[8]
16. If there is a need to raise the line and plane of occlusion at the distal end, the center point is moved anterior to the arc intersection. To lower the line and plane of occlusion, the point is moved posterior of the intersection.[8]
17. After repeated trial and retrial, the ideal survey center forming the most
18. acceptable line and plane of occlusion will be located.
19. The scribing knife is for the placement into the compass for scribing and cutting the plaster, compound or wax during the occlusal plane correction.

The usage of this instrument offers great help in terms of esthetics and masticatory functions through the proper orientation of the occlusal plane.

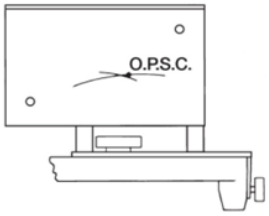

Illustration*: 9*

As the radius of sphere in Curve of Spee varies between patients, Broderick occlusal plane analyzer is often the instrument used. The radius of sphere in the Curve of Spee is suggested to be at 3.75 inches in a Class II skeletal relationship, whereby a 5-inch radius is more appropriate in a skeletal Class III relationship, as anything less would create a steep posterior curve causing further posterior interference.[6]

MEYER'S FUNCTIONALLY GENERATED PATHWAY:

The functionally generated pathways (FGP) of occlusion refer to the registration of the paths of movement of the occlusal surfaces of the teeth of one dental arch, to the teeth or occlusion rims of the opposing arch, recorded three-dimensionally in the functional wax with the help of a plastic medium with acceptable condylar and anterior guidance and normal occlusal anatomy.[9] it is recorded in following way:[10]

1. A stone crib (a platform designed to provide stability of the slurry stone bulk when constructing the stone core intraorally) was fabricated using custom tray material on a mandibular diagnostic cast (Illustration 10A).

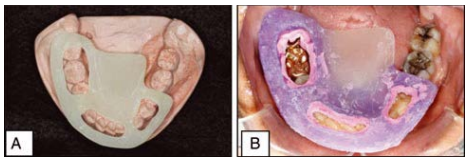

Illustration: *10*

2. The stone crib allowed indexing of the stone core to the unprepared teeth in the mandibular arch while capturing the FGP recording without removing the recording table/FGP recording intraorally.
3. The recording table (a platform designed to support the FGP wax during recording) was fabricated directly on prepared teeth using a bis-acryl interim material with a putty matrix normally used to fabricate an interim crown stabilized with custom tray material (Illustration 11).

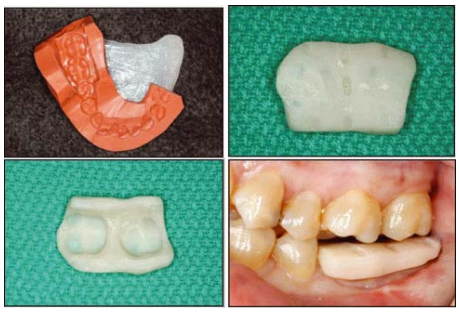

Illustration: *11*

4. The recording table was trimmed and adjusted to fit prepared teeth with good stability and approximately 1 to 2 mm interocclusal space (Illustration 11). Multiple 1 to 2 mm grooves were prepared on the occlusal aspect of the recording table, and a thin layer of Sticky Wax was applied to the occlusal aspect of the recording table for additional retention of the FGP wax. The stone crib was placed intraorally to verify no interference with the recording table (Illustration 12).

Illustration *12*

5. FGP wax was placed onto the occlusal aspect of the recording table. The FGP recording was made (Illustration 13) by guiding and instructing the patient into MIP and eccentric movements as follows:
    - First, the patient closed into MIP.
    - The patient then moved from MIP to a lateral working position and back to MIP.
    - The patient then moved from MIP to a lateral nonworking position and back to MIP.
    - The patient then moved from MIP to a protrusive position.

    These movements were repeated.

    The patient was then instructed to move through all the potential eccentric position combinations and back to MIP.

    During the MIP and eccentric positions/movements, the patient moistened the opposing maxillary dentition with saliva to act as a lubricant.

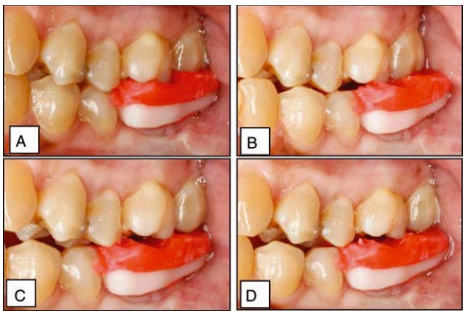

Illustration *13*

6. Following the FGP recording, the wax was evaluated for continuity and a smooth surface replicating the movements of the opposing maxillary cusps. The recording table with the FGP wax recording was retained on the prepared teeth, while the stone crib was then placed on the mandibular arch (Illustration 14A).
7. A slurry of type IV dental stone mixed and gently applied via hand vibration using a mixing spatula onto the FGP wax recorded surface and the exposed incisal/occlusal surfaces of the unprepared mandibular teeth (Illustration 14B).

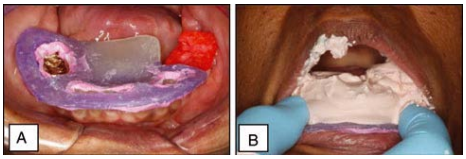

Illustration *14*

8. Additional slurry stone was then applied for bulk and strength to create the stone core. The slurry stone was allowed to set intraorally prior to removal. The stone core and stone crib were removed from the oral cavity as one piece (Illustration 15).

Illustration *15*

The stone core was evaluated to ensure accurate capture and representation of the FGP wax recorded surface and proper indexing to the ipsilateral and contralateral teeth. The stone core was then related to the mounted mandibular master cast using the index to the unprepared incisal/occlusal surfaces and mounted to the upper member of the articulator. (Illustration 16)

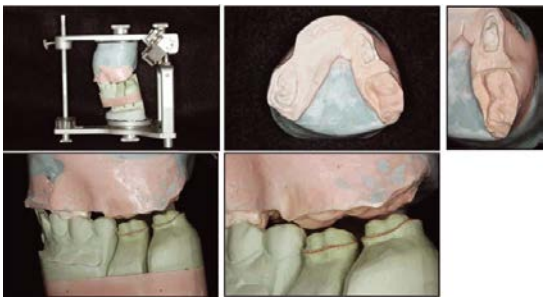

Illustration *16*

CONCLUSION

Occlusion is a fundamental concept in dentistry, yet it is commonly overlooked as it is perceived to be not important, or too difficult to teach and understand. Clinicians should have a sound understanding of principles regarding occlusal harmony in order to be able to recognize and treat common problems associated with occlusal disharmony. Occlusal disharmony can be treated well when orderly sequence is followed in examination and treatment planning. A complete mouth survey must include through radiographic analysis, periodontal examination, occlusal analysis on correctly mounted casts, and a systematic tooth-by-tooth search for every factor that could cause accelerated deterioration.

REFERENCES:

1. Dawson P: Evaluation, diagnosis and treatment of occlusal problems, Mosby, 1974.
2. Spee FG: Prosthetic dentistry, (4th ed.).: Medico-dental Publishing, 1928.
3. Wilson GH: Dental prosthetics, Philadelphia, Lea & Febiger, 1917.
4. Monson GS: Applied mechanics to the theory of mandibular movements. Dent Cosmos 1920;74:1039-1932.
5. Dawson P: Functional Occlusion: From TMJ to Smile Design, Mosby, 2007.
6. S. Manvi et al. Occlusal Plane Determination using Custom Made Broadrick Occlusal Plane Analyser: A case control study. International Scholarly Research Network Dentistry 2012,3:73-87.
7. W.M Corporation, Restorative oral health (U.S.A, Whip-Mix Corporation - West, 2008.
8. Lynch CD, McConnell RJ. Prosthodontic management of the curve of Spee: Use of the Broadrick flag. J Prosthet Dent 2002;87:593-7.
9. Meyer FS: The generated path technique in reconstruction dentistry. Part II: fixed partial dentures. J Prosthet Dent 1959;9:432-440.
10. DuVall NB, Rogers PM. Application of the Functionally Generated Path Technique to Restore Mandibular Molars in Bilateral Group Function Occlusion. J Prosthodont 2012;22,226–232.

ABRASION AND POLISHING IN PROSTHODONTICS: A REVIEW ARTICLE

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****Dr. Akanksha Dwivedi ****Dr. Manan Shah

ABSTRACT

Surface finish and appearance are important aspects of restorative dentistry. The surfaces of normal, healthy-looking teeth have a high gloss and an unstained white/ivory color. Abrasion is a process of surface roughening that can either wear away tooth structure destructively or be used to correct tooth shape or attain an optimal smooth finish on the surface of a restoration. Polishing and bleaching are two different approaches to whitens teeth by attacking surface stains. Polishing is an abrasive process of smoothing a rough surface and removing stains with very fine particles. Bleaching lightens or eliminates surface stains chemically by application of strong peroxide solutions. A dental abrasive is an important part of dental services. This specialty deals with the finishing and polishing of dental appliances like complete dentures, removable partial dentures, crown and bridges and the direct dental restorative materials. Effective finishing and polishing of direct or indirect dental restorations may not only responsible for good aesthetics but also provide healthy oral environment and the longevity of the restorative material. This review is based on latest technology and the material used in dentistry which provides an overview of basic principles based on dental abrasives. The overall aim is to provide the awareness and broader knowledge of the principles and tools available to produce an optimal surface finishing and polishing in dental restoratives techniques.

Keywords: *Abrasion, Abrasive agents, Finishing and polishing process, Finishing and polishing agents.*

INTRODUCTION

Finishing and polishing techniques are meant to remove excess material and smooth roughened surfaces. A rough surface on a restoration may be uncomfortable and make oral hygiene difficult. When a restoration is located in proximity to the gingiva, surface roughness can cause painful irritation and eventual recession of the soft tissue. It is also responsible for accelerating corrosion. The finishing and polishing of restorative dental materials are important steps in the fabrication of clinically successful restorations. Whereas cleansing techniques are meant to remove food and other debris from a surface without damaging it. Polishing and cleaning are routine procedures for maintaining the health of the natural dentition.[1]

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Basic principles of tribology as it relates to abrasive science in dentistry

The mechanisms involved in mechanical finishing and polishing using abrasive particles are part of tribology, the discipline associated with material science, physics, chemistry and surface-contact engineering. A description of a tribological system consists of a set of experimental parameters (e.g., applied load, velocity, and duration of motion) and the system structure (e.g., the two bodies in contact, the interfacial media, and the surrounding media).

Tribology is the study of friction, lubrication, and wear of the surface.[2] In the polishing procedure, an abrasive agent creates friction and wear when it comes in contact with the substrate. The abrasive agents either can be embedded on the surface of polishing instruments or it is available in the form of a paste. Based on the mode of abrasive wear, it can be classified as:[3]

1. Two body abrasive wear (sliding abrasion)
2. Three-body abrasive wear (rolling abrasion)

1.Two-body abrasion: In these types of abrasive wear, abrasive particles are solidly bonded to the abrading instrument such as a dental bur, disk, wheel, strips, or in rubber cups impregnated with abrasive agents that do not require polishing paste.[4] In two-body abrasion, the particle is firmly attached to one surface will necessarily slide over the counter-surface. Therefore, it is also known as sliding abrasion. Two body wear refers to the abrasion by bonded abrasives.[5]

2.Three-body abrasion: It occurs when abrasive particles move in a space between the surface being polished and the application device.[3] In these types of abrasion particle is unattached and form third bodies. Therefore, it is also known as rolling abrasion.[5] The best example of three-body abrasion is polishing with a rubber cup and prophylaxis paste. The abrasive particles are mixed in the prophylaxis paste. The abrasive particles move in the space between the tooth surface being polished and the surface of the rubber cup. Dental hygienists primarily use three-body abrasion. Three body wear is taking place when the abrasive particles freely move or rotate on the substrate (e.g., brushing the tooth surfaces using brushes and pastes or powder slurries).[3]

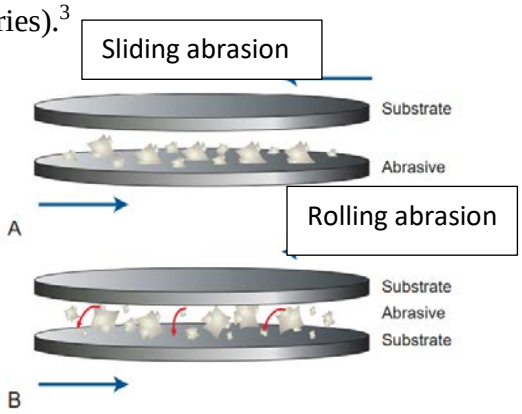

Illustration 1. Illustration of the differences between (A) Two-body abrasion, (B) Three-body abrasion.[6]

DESIRABLE CHARACTERISTICS OF ABRASIVE AGENTS

- **Hardness:** Abrasive material must be harder than the material it abrades.[5]
- **Shape:** Abrasive should possess an irregular shape. Irregular and jagged particles are more

efficient as compare to the smooth round particles.[6,7]

- **Impact strength:** Higher the impact strength, better the abrasive properties. Abrasive particle should fracture rather than dull out, so there is availability of new sharp edges that in turn increase the abrasive ability.[7]
- **Attrition resistance:** Abrasive should have attrition resistance so that it doesn't wear quickly.[3]
- **Abrasive grit:** Grit size is important for a proper finishing and polishing procedure. Coarse grit removes the material quickly while fine-grit gives a better finish to the restoration.[7]

TYPES OF ABRASIVES

- **Diamond:** Diamond is a transparent, colorless mineral composed of carbon It is the hardest known substance.[8] Naturally occurring diamond is the hardest material, with surface hardness number 10 in the Mohs scale.[6] Fine-particle diamonds come in a paste for polishing composite and porcelain restorations. They are used for crown and bridge preparations and to finish and polish composite restorations.[9]
- **Synthetic diamond:** Synthetic diamond less hard than the natural diamond and does not undergo attrition during cutting any other materials. Diamond has a Mohs ranking of 10.[6] The advantages of synthetic diamonds over natural diamonds include their controllable, consistent size and shape, as well as their lower cost compared with natural diamonds.[8] This abrasive is used in the manufacture of diamond wheels and burs.[10]
- **Emery:** Corundum is a natural aluminum oxide mineral abrasive. It has surface hardness number of 7-9 on Mohs scale.[6] It looks like greyish-black sand that is prepared in a fine grain form. It is predominately used in a form of a coated disk. It is available in a variety of grit sizes. It is used to finish metal alloy or acrylic resin materials.[9]

- **Sand:** Sand is a natural abrasive composed of quartz and silica. It has surface hardness score of 7 on Mohs scale.[6] It may be seen in various colors and particles are rounded or angular in shape. They are applied under air pressure to remove refractory investment materials from base metal alloy castings.[11] They are also coated onto paper disks. It is used for the grinding of metal alloys and acrylic resin materials.[4]

- **Quartz:** It is very hard, colorless, and transparent. It has surface hardness score 7 on Mohs scale.[6] Sharp, angular particles of quartz that are useful in making coated abrasive disks. Quartz abrasives are used primarily to finish metal alloys, and they may also be used to grind dental enamel.[9]

- **Pumice:** These are abrasives as well as polishing agents. Pumice is volcanic silica manufactured as a loose abrasive. It has surface hardness score 6 on mohs scale.[6] It is available in an extremely fine flour. Their hardness is similar to sand. Pumice is also found in clay, is the most common abrasive used in commercially prepared prophylaxis polishing paste.[4]

- **Tripoli:** This abrasive is derived from a lightweight, friable siliceous sedimentary

rock. Tripoli can be white, grey, pink, red, or yellow. The grey and red types are most frequently used in dentistry. The rock is ground into very fine particles and formed with soft binders into bars of polishing compound. Tripoli is used for polishing metal alloys and some acrylic resin materials.[8]

- **Chalk:** A mineral form of calcite is called chalk. It is white abrasive composed of calcium carbonate.[4] This is a very mild polishing agent. It has a low surface hardness number of 3 on Mohs scale.[6] It is used for final finishing direct filling gold, tooth enamel, amalgam, and acrylics.[8]

- **Cuttle:** Cuttle is a fine grade of quartz. It is manufactured from the bones of fish. This form is no longer used in the dentistry. Presently, cuttle is a trade name that refers to a fine grade of quartz. It has surface hardness score 7 on Mohs scale.[6] They are available in coarse, medium, and fine grits. It is available as a coated abrasive. It is used for polishing metals and amalgam restorations.[8]
- **Garnet:** Garnet includes several different minerals that possess similar physical properties and crystalline forms as other minerals. It has surface hardness score 8-9 on mohs scale.[6] These minerals are the silicates of aluminium, cobalt, iron, magnesium, and manganese. Garnet is usually dark red in color. It is very hard and highly effective abrasive. It is used in grinding metal alloys and acrylic resin materials.[4]

- **Zirconium silicate:** Zirconium silicate is a natural mineral often used as a polishing agent in strips, disks, and prophylactic pastes[9]. It has surface hardness score 6.5-7.5 on mohs scale.[6] It is ground to various particle sizes and is used to make coated abrasive disks and strips. It is frequently used as a component of dental prophylaxis pastes.[12]

- **Carbide:** These are also synthetically prepared hard abrasives. Abrasives in the form of carbide compounds include silicon carbide, boron carbide, and tungsten carbide. It has surface hardness score 9 on Mohs scale.[6] They are used for the preparations of the crowns or to finish composite restorations. Silicon and boron for finishing instruments typically are supplied as particles pressed with a binder into disks, cups, points, or wheels for use on low-piece handpieces.[12]
- **Aluminium oxide:** Aluminium oxide is a chemical compound of aluminium and oxygen with the chemical formula Al_2O_3. It has surface hardness score 9 on Mohs scale.[6] Aluminium oxide is a commonly used abrasive in dentistry. Aluminium oxide is widely used in dentistry to make bonded abrasives, coated abrasives, and air-propelled grit abrasives. It is used to adjust enamel or to finish metal alloys and ceramic materials.[11]

- **Silicon dioxide:** The chemical compound silicon dioxide, also known as silica. It is synthetic abrasive. It is oxide of silicon with chemical formula of SiO_2. Silicon dioxide has a surface hardness score 6-7 on Mohs scale.[6] It is commonly found in prophylaxis paste for heavy stain removal. It is used for finishing and polishing composite restorations. It is also used as a hard abrasive in toothpaste.[11]

- **Rouge:** Rouge is iron oxide. It is available in fine red powder. It has a Mohs hardness value of 5 to 6.[6] It is frequently found in block form

and not used intraorally. It is usually used in cake form. It is used with rag wheel to polish precious or semi-precious metal. It is used to polish high noble metal alloys. It may also impregnate into paper or fabric known as crocus cloth.[4]

FINISHING AND POLISHING PROCEDURE

The finishing and polishing procedures of the most of the restorative materials follows the same principles. Finishing and polishing instruments are used to finish and polish the dental material to improve the aesthetics. Finishing and polishing in restorative dentistry refers to the following steps[12]

(1) Gross contouring of the restoration to obtain the desired anatomy,

(2) The reduction and smoothing of the surface roughness and scratches created by finishing instruments in the process of gross reduction and initial polishing, and

(3) The process of producing a highly smooth, light-reflective, enamel-like surface through final polishing.

There are many finishing and polishing instruments used in the dentistry such as diamond burs, discs, strips, grinding stones, sand paper, etc.[9]

FINISHING AND POLISHING OF RESTORATIONS

1.COMPOSITE RESIN: -

Dental composite is one of the most difficult types of material to finish and polish. Because they contain a relatively soft resin matrix and hard filler particles in their structures. Any attempt to abrade or polish will pluck out the hard fillers and easily wear of soft matrix occur. For the finishing and polishing of the composite, selection of abrasives and polishing agent should be carefully decided.[8]

Finishing of the composite restoration should be carefully done in wet field with water soluble lubricant to prevent damage to the newly formed enamel/ dentin/ composite bond. For the gross reduction diamonds, carbide finishing burs, finishing discs or strips of alumina can be used.[13]

The sequence of polishing resin composite would be as follows: -

Finishing and polishing of the restoration always first start with coarse abrasive and sequentially proceeding to superfine abrasives. Marginal and occlusal excesses are first removed in initial finishing with diamonds or multi-fluted carbide burs. Intermediate finishing is done with flexible disk, cups and strips. Final polishing is carried out with submicron aluminium oxide based polishing paste. It is applied with rubber polishing disk or cups.[11]

Illustration 2: Clinical sequence of composite restoration polishing.[14]

2.AMALGAM: -

An amalgam is an alloy of mercury and one or more other metals. Dental amalgam is produced by mixing liquid mercury with solid particles of an alloy of silver, tin, copper, and sometimes gold, indium, palladium, platinum, selenium, and zinc. This

combination of solid metals is also known as amalgam alloy.[14]

Prior to the carving of amalgam, burnishing is carried out to remove the excess mercury and improves the marginal adaptation. Burnishing alone will not provide a completely scratch free surface for amalgam restorations. Slow speed handpiece should be used for the finishing and polishing of the amalgam restoration. Amalgam restoration should require 24 hours for proper setting. Hence, it is believed that amalgam restoration should not be polished before 24 hours. The amount of finishing and polishing required depends on the care taken in carving and burnishing the amalgam at the time of the insertion and the effect of the oral environment on the older restoration.[15]
Sequence of the finishing and polishing of amalgam restoration are as follows: -

Once the restorations have been set completely, carving is done by using Wartz or Hollenbeck carver to obtain the proper occlusal anatomy. Carefully burnishing is done with ball burnisher. Smoothening is done with cotton pledget or rubber polishing cups. Final polishing is carried out after 24 hours. Zinc oxide, pumice, rouge etc are used for finishing and polishing of the restoration. These very fine powder is made into thick slurry and applied. Dry powder should not be used because it raises the temperature. Polishing with bonded, coated or loose abrasive particles diameter from 20 micron to submicron size. It gives the amalgam restoration mirror like luster.[11]

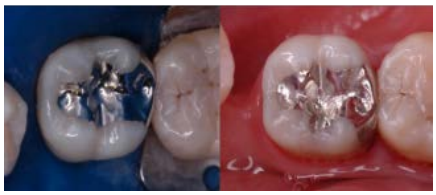

Illustration 3: Final aspect of the amalgam restoration after[14]. finishing/polishing[62].

3.GOLD ALLOY: -

Precious and non-precious crowns, inlays and onlays are finished and polished in the dental laboratory before they are delivered to the dental office for final fitting and cementation. In the process of final fitting, minor adjustments made with abrasive stones and diamonds are necessary. It is important that the scratches are removed before final cementation.[6]
Sequence of the finishing and polishing of gold alloy restorations are as follows: -
Initial contouring is done with silicone carbide green stones and carbide burs. Finishing is carried out by using pink stones or medium grade abrasive impregnated rubber wheels and points. Apply fine abrasive impregnated rubber wheels, cups and points if necessary and then apply Tripoli or rouge with leather wheels.[11]

Illustration 4: A, clinical example of direct gold restoration. B, finished gold restoration.[16]

4.CERAMIC (PORCELAIN): -

Ceramic is very brittle material. It requires careful finishing to remove surface cracks

and pores before glazing.[9] The best way to achieve glossy smooth surface of ceramic is by glazing procedure at high temperature. Chairside adjustments of the restoration are carried out with diamonds.[14] Clinician must finish and polish the rough surface after making an adjustment.

Sequence of finishing and polishing of ceramic restorations are as follows: -

Contouring of the restoration is done with diamond points and discs, silicon carbide burs. Finishing of ceramic is done with alumina white stones or abrasive impregnated rubber discs, cups and points. Once the finishing procedure has been completed, polishing is carried out by using fine abrasive incorporated rubber discs or cups or diamond pastes. Overglazing of ceramic restoration is the final step after doing the polishing.[17,18,19]

5.ACRYLIC RESIN: -

The acrylic denture base is ready for finishing and polishing once it has been processed and deflasked. Any gypsum material that remains on the denture can be removed by light scraping or with a shell blaster. Feathered edge of acrylic can be smoothened and rounded with an acrylic finishing bur.[13]

Sequence of finishing and polishing of acrylic resin are as follows: -

Contouring of the acrylic denture base is done by carbide burs and sandpaper. Rubber points are used to remove scratches. After removing the scratches, apply pumice with a rag wheel, felt wheel, brittle brush or prophy cup on the area to be polished. Final polishing is done by using French chalk paste in alcohol or water. Overheating during finishing and polishing is avoided because it affects the appearance of acrylic denture base. Acrylic denture base teeth must be protected from the pumice because they are abraded easily. After the polishing, the denture should be washed with soap and water and stored in water until it is inserted into the patient's mouth.[6,9,11,20]

Illustration 5: Polishing of acrylic denture with rag wheel.

6. GLASS INOMER CEMENT: -

Glass-ionomer cements have gained an increasing acceptance in clinical use since they were introduced in the early 1970s. Because of their adhesiveness to dental hard tissues, their anticariogenic properties, and their biocompatibility, they have become the materials of choice in many situations[21]. As restorative materials they have been used mainly in class-III and class-V preparations and in erosion and abrasion cavities. With the introduction of the glass-ionomer cements, in which metals are fused to the glass particles, it has also become possible to achieve acceptable clinical results in class-II preparations in primary molars.[14]

Margins on resin-bonded ceramic restorations are more susceptible to staining because of the properties of resin cements. Stains accumulating at the resin/cement interface must be evaluated carefully for actual staining or microleakage. If it is determined that the stain is within the cement and is not the result of leakage, it may be

removed in the same manner as in composite restorations.[11]

Sequence of finishing and polishing of Glass ionomer cement are as follows: -

The surface of the glass ionomer cement is sensitive to both dehydration and water contamination during initial setting. Hence, finishing and polishing of the restoration has been carried out 24 hours after insertion of the restoration. For finishing rotary cutting instruments are preferred than hand cutting instruments to prevent the tear of the material at the margins. Twelve fluted carbide finishing burs or fine diamond burs are preferred for finishing of the glass ionomer cement. After the finishing of the restoration, softex disks with petroleum jelly is used to produced smooth surface.[11]

CONCLUSION

Finishing and polishing techniques are important factors for the success of any restoration used in the dentistry. The procedure should begin with the coarse abrasive and end with fine ones. Clinically it is easier to control the rate of the speed rather than pressure and care must be taken to avoid over heating of the restorations. The uses of cleansing, finishing and polishing agents should be carefully considered before the application on the tooth structure or restorative material. The clinician must have appropriate knowledge of the properties of the material being abraded, the abrasive, and the factors that affect abrasion. Though knowledge will guide to select the particular agent for a particular purpose and help to provide better restoration which will be biologically and aesthetically acceptable. The process of abrasion can produce undesirable effects if not carefully controlled. Appropriate use of abrasion can also produce a surface that will contribute to the aesthetics and longevity of the restoration and the health of surrounding oral tissues.

REFERENCES

1. Gladwin M and Bagby M, Clinical aspect of dental material, Fifth edition 2013, Quintessence publications Canada, Pp 221- 240.
2. Dearnley PA, Matthews A, Leyland A. Tribological behaviour of thermochemically surface engineered steels. Thermochemical Surface Engineering of Steels. 2015;42:242-266.
3. Gladwin M and Bagby M, Clinical aspect of dental material,Fourth edition 2005, Quintessence publications Canada, Pp 530- 565.
4. Kern M. and Thompson VP. Effects of sandblasting and silica-coating procedures on pure titanium. J Prosthet Dent. 1994;22:300-306.
5. Zum Gahr KH. Microstructure and Wear of Materials. Tribology Series 10, Elsevier, Amsterdam, 1987.
6. Anusavice, Phillips Science of Dental Materials, 12th edition 2012, Elsevier publications, Florida, Pp 231-254.
7. Pintaude G. Characteristics of Abrasive Particles and Their Implications on Wear. Tribology International, 2011;41:117-130.
8. Anusavice, Phillips Science of Dental Materials, Eleventh edition 2007, Elsevier publications, Florida, Pp 351-400.
9. Bhat SM and Nandnish BT, Science of dental materials,2017 second edition.
10. Anusavice, Phillips Science of Dental Materials, fifth edition 1994, Elsevier publications, Florida, Pp 284-298.

11. Hatrick CD and Eakle W. Dental material: Clinical Applications for Dental Assistants and Dental Hygienists,2016, third edition.
12. Jefferies SR. Abrasive Finishing and Polishing in Restorative Dentistry: A State-of-the-Art Review. Dent Clin N Am 2007;51:379–397.
13. Lesage B. Finishing and polishing criteria for minimally invasive composite restorations. pract proced aesthet Dent 2011;16:422-428.
14. Powers C. and Wataha, Dental Materials, Properties and manipulation, Thirteenth edition,2012, Elsevier publications, India, Pp 141-160.
15. Scotti CK, Bastos N, Furuse A. Amalgam Restorations and Future Perspectives. J Odontol 2018,2:1-5.
16. Ritter AV. Studevent's art and science of operative dentistry. Seventh edition.2013, Elsevier publications. Pp 219-263.
17. Sorensen JA. Finishing and polishing of modern dental ceramics. J Dent Res 2013;9:80-85.
18. Silva TM, Salvia D et al. polishing for glass ceramic: which protocol? - A review article. J Prosthodont Res 2014;228:1-11.
19. Naylor WP. Introduction to metal-ceramic technology, Quintessence publications Canada, Pp 145-170.
20. Raybin NH. Polished surface of complete denture. J Prosthet Dent 1963;13:236-239.
21. Eide R. and Tveit AB. Finishing and polishing glass-ionomer cements. Acta Odontolo Scand 1990;48:409-412.

BONDED CERAMIC RESTORATIONS: A LITERATURE REVIEW

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ABSTRACT:

Modern dentistry is moving towards procedures which are minimally invasive and biomimetic. This approach can be conjugated with the philosophy of 'Less Is More'. The lesser the tooth structure is compromised, the better is the adhesion and higher is the clinical longevity in comparison to so called conventional approaches which included invasive tooth preparation for full coverage restorations. Since the advent of restorative dentistry, we have seen numerous materials used to replace the missing tooth structure. Ceramics are increasingly important materials for the restoration of teeth as the demands of patients for tooth-colored restorations and the availability of new dental ceramics has driven increased use of ceramic materials in a variety of restorative situations. The popularity of all-ceramic restorations has increased significantly in recent years due to better aesthetics and durability. The adhesive techniques in contemporary dentistry, and the development of ceramic materials, reproduces a match between substitution materials and natural teeth substrates. The acceptance of the emerging trends helps in enhancing the treatment approach and also helps in improving the quality of the treatment provided.

Keywords: *Bonded ceramic restorations, indirect adhesive restoration, bonding.*

INTRODUCTION

The realm of restorative dentistry deals with many procedures required to reinstate and rejuvenate teeth to their original state. Detrimental effects and causes of debilitation include carious lesions, abrasions, attrition, extensive coronal destruction secondary to endodontic treatment. These, along with the entire plethora of aesthetic enhancement scenarios are treated and addressed by restorative dentistry. Indirect restorative dental procedures are the preferred mode of treatment in such situations.[1]

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Typically dentistry had rigid dental materials in the past which lead to unnecessary removal of sound tooth structure. Modern dentistry is moving towards procedures which are minimally invasive and biomimetic.[2] The correct selection and use of ceramic materials with judicious adhesive procedures allows for a minimally or even non-invasive (i.e., additive) approach that is innovative, highly aesthetic, and predictable in terms of both result and long-term prognosis.[3] Dental ceramics are the most naturally appearing material for replacement of missing tooth structure available in a wide range of shades and translucency.[4]

The popularity of all-ceramic restorations has increased significantly in recent years due to better aesthetics and durability. The two major categories of all-ceramic materials are: silica-based (i.e, feldspathic, leucite-reinforced, and lithium disilicates) and non-silica–based (i.e, zirconia or yttria stabilized zirconia, alumina) high-strength ceramics. Aesthetically superior metal free porcelain systems have been developed and have gained popularity. In the last two decades the use of computer-aided design (CAD) and computer aided manufacturing (CAM) technologies has allowed manufacturing of highly resistant ceramic materials which serve satisfactory results in terms of aesthetics, durability and strength.[5] Adhesive dentistry has undergone great progress in the last decades. In light of minimal-invasive dentistry, this new approach promotes a more conservative cavity design, which relies on the effectiveness of current enamel-dentine adhesives.[6] An indirect technique is the first treatment choice when an adequate amount of residual sound tissue exists.[7]

Ultimately, all advancements with respect to materials and adhesives help the restoration in working harmoniously with the tooth substrate.

RATIONALE & INDICATIONS OF INDIRECT ADHESIVE RESTORATIONS

An "indirect adhesive restoration" has been defined as a partial crown restoration made in composite or full ceramic, which has to be seated passively, and adhesively cemented in a cavity characterized by specific attributes.[8] Selecting the appropriate technique and material to restore any teeth can be difficult with the array of choices available to modern practitioners. Adhesive technology has progressed recently to permit more conservative preparations that modify conventional retention and resistance forms.[9] The indications for conservative adhesive indirect restorations include: [9, 10]

- Extensive Class I or II preparations.
- Partial coverage preparations.
- Serial restorations in the same arch to be treated simultaneously.
- More distally located teeth.
- Stress-bearing teeth.
- In circumstances where the residual enamel is less than 0.5 mm thick or totally absent.
- Medium to large sized cavities where one or more cusps are missing.
- Cavities where the coverage of one or more cusp is advisable to improve the prognosis of complex restored tooth.
- Morphological modification and /or raising of posterior occlusal vertical dimension (OVD) in cases of oral rehabilitation on elements where a

full crown restoration would be too invasive.

- Cracked tooth syndrome, when the symptomatically needs to be managed with the aim of maintaining the vitality of tooth.
- Multiple medium to large sized cavities in the same quadrant.
- Abraded or eroded teeth.
- The patient's desire for a nonmetal restoration, making this indication essentially patient driven.
- Restorative considerations determined by the clinician.

Additionally, indirect fabrication of these restorations permits greater control over occlusal and proximal contacts; avoids the extended chair time necessary for multiple, large direct composites; reduces the negative effects of polymerization shrinkage; achieves superior marginal seal; and permits the use of materials better suited for long-term success.

CLASSIFICATION OF MATERIALS

Dental ceramics are known for their natural appearance and their durable chemical and optical properties. Dental ceramics can be classified according to one or more of the following parameters: [11]

(1) Indications:

- Anterior and posterior crown,
- Veneer,
- Post and core,
- Fixed dental prosthesis.

(2) Principal crystal phase and/or matrix phase

- Silica glass,
- Leucite based feldspathic porcelain,
- Leucite-based glass-ceramic,
- Lithia disilicate–based glass-ceramic,
- Aluminous porcelain,
- Zirconia.

(3) Processing method

- Casting,
- Sintering,
- Glass infiltration,
- Slip casting and sintering,
- Hot-isostatic pressing,
- CAD-CAM milling, and copy-milling.

(4) Firing temperature

- Ultra-low fusing,
- Low fusing,
- Medium fusing,
- High fusing.

(5) Microstructure

- Amorphous glass,
- Crystalline,
- Crystalline particles in a glass matrix.

(6) Translucency

- Opaque,
- Translucent,
- Transparent.

(7) Fracture resistance

- Low,
- Medium,
- High.

UNDERSTANDING ADHESION

First Generation[12, 13]

The first-generation dentin bonding agents were developed in the early 1960's. Bowen used a coupling agent, N-phenylglycineglycidyl methacrylate (NPG-GMA) as a primer or adhesion promoter

between enamel/dentin and resin materials by chelating with surface calcium, where one end would bond to dentin, and other would polymerize with composite resin. This generation led to very poor clinical results as well as low bond strength in the 1-3MPa range.

Second Generation[13, 14]

In 1970s, the second-generation systems were introduced. The majority of these incorporated halophosphorous esters of unfilled resins such as bisphenol-A glycidyl methacrylate, or bis-GMA, or hydroxyethylmethacrylate, or HEMA. The mechanism by which these second-generation systems bonded to dentin were postulated to be through an ionic bond to calcium by chlorophosphate groups. These were weak bonds; their bond strength was 4-6Mpa.

Third Generation[13, 15]

In the late 1970s and early 1980s, the third-generation bonding systems introduced a very important change that is, the acid etching of the dentin in an effort to modify or partially remove the smear layer. With this system, dentin is etched with an aqueous solution of 10% citric acid and 3% ferric chloride, followed by the application of an aqueous solution of 35% HEMA (hydoxyethyl methacrylate) and a self-curing adhesive resin containing 4-methacryloyloxyethy trimellitate anhydride (4-META), methyl methacrylate (MMA), and trin-butyl borane (TBB), the last as a polymerization initiator.

Fourth Generation[13, 16]

In 1980s and 1990s, fourth generation dentin bonding agents were introduced. The fourth generation is referred to as three-step etch-and-rinse adhesive and was the first to achieve complete removal of smear layer and is still considered as the gold standard in dentin bonding by some clinicians. In this generation, the three primary components (etchant, primer and bonding) are typically packaged in separate containers and applied sequentially.

Fifth Generation[13, 17]

In the 1990s and in the ongoing decade, the fifth generation bonding systems simplified the process of fourth generation adhesion by reducing the clinical steps which results in reduced working time. Combining the primer and adhesive into one solution to be applied on enamel and dentin simultaneously with 35 to 37% phosphoric acid for 15-20s. (Followed by application of one bottle containing primer and bonding agent which has a general composition of HEMA, Bis-GMA, dimethacrylate, patented polyalkenoic acid copolymer, water and ethanol).

Sixth Generation[16, 17]

The sixth-generation bonding systems introduced in the latter part of the 1990s and the early 2000s also known as the “self-etching primers”. The sixth-generation bonding systems eliminates the etching step, or includes it chemically in one of the other steps, i.e acidic primer (self-etching primer and adhesive) applied to tooth first, followed by adhesive.

Seventh Generation[13, 16]

The seventh-generation bonding systems was introduced in early 2005. The seventh generation or one-bottle self-etching system represents the latest simplification of adhesive systems. This simplified method combines conditioner, primer, and bonding resin into a single step. All the ingredients required for bonding are placed in and delivered from a single bottle.

Eighth Generation[18]

In 2010, 8th generation bonding agent was introduced, which contains nano sized fillers. In the new agents, the addition of nano-fillers with an average particle size of 12nm increases the penetration of resin monomers and the hybrid layer thickness, which in turn improves the mechanical properties of the bonding systems. It uses 10-MDP (methacryloyloxy-decyl-dihydrogen-phosphate) as its primary adhesive monomer.

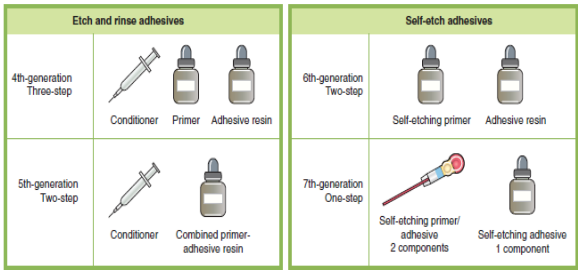

Illustration ***5:*** *Bonding agents*[11]

TOOTH PREPARATION[19]

Two major principles govern tooth preparation

Preparation must be conservative and Retention is solely by adhesion rather than tooth preparation.

Types of preparation for anterior teeth

Three different types of preparation include:

- Type 1: Contact lens preparation in which the preparation does not cover the incisal edges.
- Type 2: Classic or conventional preparation, which is commonly used by the practitioners. Here, the preparation covers the incisal edge and terminates lingually.
- Type 3: Wrap around preparation, which is almost similar to that of full coverage preparations, which is indicated for extensive color and contour.

Aesthetic Pre-evaluative Temporaries (APTs)

Porcelain laminate veneers are one of the most conservative and aesthetic techniques that can be applied when restoring the mouth for improved aesthetics. The longevity of veneers is good and they are durable, if the correct technique and right indications are in place. The fundamental concept in any restorative case is to keep it simple and conservation of the sound tooth structure. Unlike the conventional preparation techniques this concept introduced by Gurel is minimally invasive and conserves the sound tooth structure.[19]

Technique (Gurel Technique) [19,20]

A simple technique, which has great value for controlling the depth of the preparation in such special cases, can be easily used. This technique using a composite resin can simply be added to the facial surfaces of lingually positioned teeth with spot etching and bonding up to where the tooth needs to be buccally re-oriented or filled by volume. This is especially very efficient when dealing with

a single tooth or up to 2 to 4 teeth. It mimics the final outcome that we aim to restore with the PLVs. When the composite mock up is still on the tooth, it is logical to use the depth cutter over that composite build-up, so that the true depth will be reached when the depth cutter is used and thus preserve the maximum enamel on the tooth surface. This will limit the depth cutter to go only as deep as our smile design dictates, resulting in an even more conservative tooth reduction.

POSTERIOR INDIRECT ADHESIVE RESTORATIONS

An "adhesive indirect restoration" has been defined as a partial crown restoration made in composite or full ceramic, which has to be seated passively, and adhesively cemented onto a preparation characterized by specific attributes.[8]

The main indication of Posterior Indirect Adhesive Restorations[21]

- Preparations where the coverage of one or more cusps is advisable to improve the prognosis of the complex restored tooth (onlay restorations).
- Severely damaged teeth where coverage of whole occlusal surface is needed (overlay restorations).
- Tabletop restorations (type of overlay) used for restoring abraded and eroded teeth.
- Multiple medium or large-sized cavities present in the same quadrant.

Preparation principles for indirect restoration[8, 22]

The following parameters that influence and lead the cavity design are essential:

- Thickness of remaining walls (in order to maintain them) has to be ≥ 2.0 mm in vital teeth, and ≥ 3.0 mm in endodontically treated teeth.
- The width of occlusal isthmus has to be ≥ 2 mm for indirect composite and lithium disilicate glass-ceramic restorations.
- Presence or absence of marginal ridges, and, consequently, presence of interproximal box evaluated on three space planes.
- Thickness of the material for cuspal coverage has to be ≥ 1 to 1.5 mm for indirect composite and lithium disilicate (pressed or CAD/CAM), and ≥ 2 to 2.5 mm for feldspathic ceramic and leucite-reinforced glass-ceramic.
- Interproximal overjet has to be possibly ≤ 2 mm. The fracture risk of the restored marginal ridge increases when the overjet is too large.

Operative procedures for the indirect technique[23,24]

A simple and clear procedure for indirect adhesive restorations with chronological sequence of the clinical steps is:

1. Hard silicone matrix to impress the anatomy of involved teeth (when the anatomy is sufficiently preserved).
2. Removal of previous restoration and carious lesion removal.
3. Evaluation of enamel and dentin thickness, and consequently reduction of unsupported tissues.

4. Composite build-up with immediate dentin sealing (IDS), and, if necessary, cervical margin relocation (CMR).
5. Preparation and finishing of the cavity according to new modified principles (morphology driven preparation technique – MDPT).
6. Definitive impression with elastomers (for singular elements, even with a dual-arch technique through a bite check).
7. Preparation of the final restoration (composite or ceramic) in the laboratory or chairside.
8. Verification of restoration adaption before the application of rubber dam.
9. Application of rubber dam, and adhesive cementation procedure with heated light-curing composite.
10. Finishing, polishing, and occlusal control.

CONCEPTS IN BONDING INDIRECT RESTORATIONS

Etch–Rinse Adhesives[25, 26]

This system consists of etching the enamel and dentin with 35–37%phosphoric acid, which once it has achieved its objective is eliminated with a rigorous rinse, followed by the in situ polymerization of the adhesive by own effects of capillarity, it flows in the porosities created in the enamel forming macro tags of entangled resin around the enamel prisms, and in complement, the formation of micro tags that penetrate the cores of the enamel prisms, contributing effectively to the retention of the material. In the dentinal tissue the effect of the acid generates a network of micro pores in the collagen, where hydroxyapatite is almost absent. Therefore, the adhesion depends on the hybridization or infiltration of the adhesive within the exposed collagen mesh.

Self-Etch Adhesives[25, 26]

Due to the simplification of the operative times offered by this technique, it is probably one of the most promising and also involves reducing the sensitivity of the process; that is, a lower risk of making mistakes by not needing a phase of etching and washing. An important advantage in this method is that the infiltration of the adhesive system occurs simultaneously with the self-etching process, such that there is a reduction in the risk of discrepancies between the two processes. These can be applied in one or two steps, since the retentive capacity is in the partial elimination of the smear generated during the cavity preparation.

Bonding to ceramics[27, 28]

A reliable bond of composites to ceramics is also achieved by micromechanical retention. Feldspathic (silicon oxide) ceramics and lithium silicate ceramics contain a glass phase that can be etched with hydrofluoric acid or similar compounds, exposing the crystallites contained in the ceramic to create micro-retentions. Silane bonds to Si-OH on a ceramic surface by condensation reaction and the methyl methacrylate double bonds provide bonding to the adhesive. As long as there are adequate Si-OH sites on the ceramic surface, satisfactory bonding should be achievable.

FAILURES IN BONDED CERAMIC RESTORATIONS

All dental restorations are liable to failure during function. Restorative failures are a multi-factorial phenomenon as the failure may be biologic, aesthetic, mechanical or a combination of all of the aforestated.[29]

Failures of bonded ceramic restorations are:

- Fractures
- Hypersensitivity
- Secondary caries
- Marginal leakage
- Discoloration
- Bond failure

CONCLUSION

The interest in all-ceramic restorations has rapidly increased over the past decade as stronger, tougher and more aesthetic materials have developed, along with novel processing technologies such as hot pressing and CAD/CAM (computer-aided design/computer-assisted manufacture). Dental ceramics exhibit many desirable material properties, including biocompatibility, chemical inertness, aesthetics, compressive strength, diminished plaque accumulation, low thermal conductivity, abrasion resistance and colour stability. Hence, the clinical performance and longevity of these all-ceramic restorations is improving. Bonded ceramic restorations are attractive because of their long-lasting aesthetics and the ability to withstand the oral conditions, and are associated with the concepts of biomimetics and minimal invasion, which takes into account two attributes, tooth preservation and adhesion. Minimally invasive restorations are considered to be beneficial because they reduce the risk of devitalization, are kind to the tooth structure, and offer a high esthetic potential. The correct selection and use of ceramic materials with judicious adhesive procedures and preparation technique allows for a minimally or even non-invasive approach that is innovative, highly aesthetic, and predictable in terms of both result and long-term prognosis. Failures because of fracture are mostly related to the brittle nature of ceramic materials or inadequate restorative design. Secondary caries, fracture of the abutment and loss of periodontal support are biological complications may be reported clinically, but are not related to the ceramic materials, but to poor technique, wrong selection and inappropriate case planning. In order to minimize failures in all-ceramic restorations, dentists should pay attention to case selection, tooth preparation, material selection, restoration design, cementation technique, occlusion equilibration, and patient preservation. Thus, bonded ceramic restorations allow us to define a new line between conservative and prosthetic treatments, in favor of a more conservative approach.

REFERENCES

1. Lakshmi S, Krishna V, Sivagami G. Prosthodontic considerations of endodontically managed teeth. J Conserv Dent 2006;9:104-109.

2. Edelhoff D, Liebermann A, Beuer F, Stimmelmayr M, Guth J. Minimally invasive treatment options in fixed prosthodontics. Quintessence Int 2016;47:207-216.

3. Messer R, Lockwood P, Wataha J,Lewis J, Norris S, Bouillaguet S. In vitro cytotoxicity of traditional versus contemporary dental ceramics. J Prosthet Dent 2003; 90:452-458.

4. Piddock V, Qualtrough A. Dental ceramics-an update. J Dent 1990; 18: 227-235.
5. Korkmaz C, Sipahi C, Atay A, Gulses A, Saracoglu B. Marginal Fit Comparison of Hot Isostatic Pressed and Non-Hot Isostatic Pressed Zirconia Copings with Three Different Marginal Finish Lines Fabricated with Two Different CAD-CAM Systems. Adv Dent & Oral Health 2017;5:555-574.
6. Blatz M, Sadan A, Kern M. Resin-ceramic bonding: a review of the literature. J Prosthet Dent 2003;89:268-742.
7. Veneziani M. Ceramic laminte veneers: clinical procedures with a multidisplinary approach. Int J Esthet Dent 2017;12:426-448.
8. Veneziani M. Posterior indirect adhesive restorations: updated indications and the Morphology Driven Preparation Technique. Int J Esthet Dent 2017;12:2–28.
9. Blank J. Scientifically Based Rationale and Protocol for Use of Modern Indirect Resin Inlays and Onlays. J Esthet Dent 2000;12:195-208.
10. Ferraris F. Posterior indirect adhesive restorations (PIAR): preparation designs and adhesthetics clinical protocol. Int J Esthet Dent 2017;12:482–502.
11. Anusavice KJ. Phillip's science of dental materials. 12th edition; W.B. Saunders publication 2013.
12. Bowen RL. Adhesive bonding of various materials to hard tooth tissues II- Bonding to dentin promoted by a surface active co-monomer. J Dent Res 1965;44:895-890.
13. Kugel G, Ferrari M. The science of bonding: from first to sixth generation. J Am Dent Assoc 2000;13:20-25.
14. American Dental Association Council on Dental Materials. Instruments and equipment. Dentin bonding systems: an update. J Am Dent Assoc 1987;114:91-95.
15. Tao L, Pashley D, Boyd L. The effect of different types of smear layers on dentin and enamel bond strengths. Dent Mater 1988;4:208-216.
16. Sofan E, Sofan A, Palaia G, Tenore G, Romeo U, Migliau G. Classification review of dental adhesive systems: from the IV generation to the universal type. Annali di Stomatologia 2017;8:1-17.
17. Leinfelder KF. Dentin adhesives for the twenty-first century. Dent Clin North Am 2001;45:1-6.
18. Kasraei SH et al. Effect of nanofiller addition to an experimental dentin adhesive on microtensile bond strength to human dentin. J Dent 2009;6:91-96.
19. Vence BS. Sequential tooth preparation for aesthetic porcelain full-coverage crown restorations. Pract Periodont Aesthet Dent 2000;12:77-85.
20. Gurel G. The Science and Art of Porcelain Laminate Veneers. Quintessence Publishing Co Ltd 2003.
21. Ammanato R, Ferraris F, Marchesi G. The index technique in worn dentition: a new and conservative approach. J Esthet Dent 2015;10:68-99.
22. Dietschi D, Spreafico R. Adhesive Metal-Free Restorations: Current Concepts for the Esthetic Treatment of Posterior Teeth. Chicago: Quintessence publications 1997.
23. Dietschi D et al. Recent trends in esthetic restorations for posterior teeth. Quintessence Int 1994;25:659-677.
24. Rocca Et Al. Evidence-based concepts and procedures for bonded inlays and onlays. Part II. Guidelines for cavity preparation and

restoration fabrication. Int J Esthet Dent 2015;10:210-227.
25. Coronel C, Naranjo B. Adhesive systems used in indirect restorations: Review. Dent J 2019;7:71-89.
26. Souza G et al. Correlation between clinical performance and degree of conversion of resin cements: A literature review. J Appl Oral Sci 2015;23:358-368.
27. Russo D et al. Adhesion to zirconia: Current conditioning methods and bonding materials. Dent J 2019;7:48-61.
28. Khan A. Recent trends in surface treatment methods for bonding composites cement to zirconia - A review. J Adhes Dent 2017;19:7-19.
29. Bona A, Anusavice K, Mecholsky J. Failure analysis of resin composite bonded to ceramic. Dent Mater 2003;19:693–699.

OCCLUSION IN COMPLETE DENTURES

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ABSTRACT:

The introduction of the concept of Balanced occlusion has been the single largest step towards the development of physiologic complete dentures. The advantage of balanced occlusion is that there is distribution of occlusal stress over the greatest possible supporting area. However, the early workers started implementing this concept of balanced occlusion into natural dentition by grinding of the cusps of the teeth, they thought that just as in Complete Denture, the broader distribution of stress would result in maintaining the natural dentition for longer period which could not work. Hence balanced occlusion is unique, and man-made and should be implemented only in artificial teeth.

Keywords: Theories of occlusion, balanced occlusion, lingualised occlusion, monoplane occlusion.

INTRODUCTION

Occlusion has been described as the most important subject in all the disciplines of dentistry, and for good reason, because the way the teeth come together, and function together, is as important to most of us now as it was to our ancestors, who lived on diets much more difficult to cope with. When, as dentists, we are faced with the problem of replacing occlusal surfaces, either by restorations in natural teeth, or replacement of some or all the teeth, then a thorough knowledge of the way teeth come together and function together, is essential.[1]

Modern dentistry is vitally concerned with occlusion and occlusal equilibration. The general practitioner attempts to achieve proper occlusion in his various restorations, the prosthodontist desires balanced occlusion in his artificial dentures, the orthodontist attempts to move teeth into an ideal occlusion and the periodontist is concerned with the effects of occlusion and tooth alignment on the periodontium.

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The entire dental profession is concerned with various methods of occlusal equilibration and the resultant lessened stress as a means of preserving the natural dentition and supporting structures. Early spot grinding of artificial dentures eventually led to full occlusal equilibration of dentures to distribute stresses and prevent their dislodgment.

General dentistry has accepted the prosthodontist's enthusiasm for equilibration, and today the equilibration of the natural dentition is a commonly attempted procedure. Some confusion exists, however, as to the ideal occlusal requirements for a natural dentition and for artificial dentures.[2]

BONWILLS THEORY OF OCCLUSION:[3,4]

Variations in the size of Bonwill's triangle influence the cusp angulation for complete dentures. According to Bonwill, the joining of the two condylar processes of the mandible and the incisal point (at the midpoint of the lower central incisors) with straight lines, forms an equilateral triangle, and each side of the triangle is approximately 10 cm (4 inches). This is known as Bonwill's equilateral triangle theory; and it forms the basis of construction of some articulators.

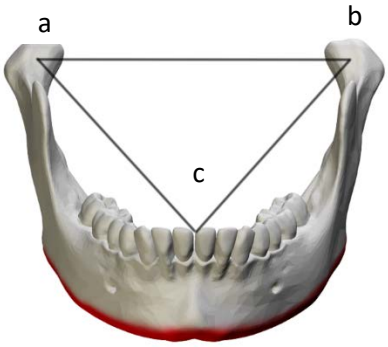

Illustration *1: Bonwill's triangle*

a and b: Condylar processes

c: Midpoint of the lower central incisors

CONICAL THEORY OF OCCLUSION BY R.E HALL:[5]

Hall proposed that the lower teeth move over the surfaces of the upper teeth as over the surfaces of a cone, generating an angle of 45° with the central axis of the cone tipped at 45° to the occlusal plane. The base of the cone lies posterior while its apex is the midpoint of the contact area of the lower central incisors.

It should be noted that Hall believed that an angle of 45 degrees would produce cusps of the highest efficiency in mastication. In natural teeth, this is found predominantly in the maxillary first bicuspids. Hall chose the 45-degree angle as the "generating" angle for the cone.

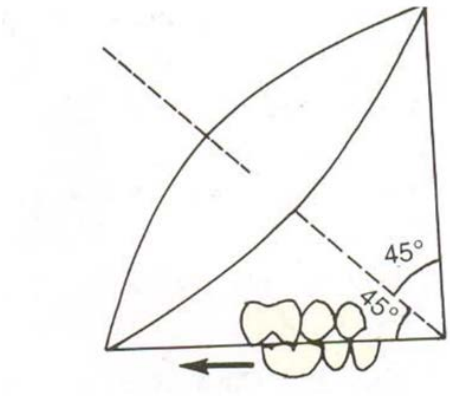

Illustration *2: Conical theory*

THE SPHERICAL THEORY OF OCCLUSION BY G.S MONSON:[6]

This theory was proposed by G.S. Monson in 1918 and was based on the observations of natural teeth and skulls made by Von Spee.

The spherical theory shows the lower teeth moving over the surface of the upper teeth as over the surface of sphere with diameter of 8 inches (20 cm). The centre of the sphere is in the region of glabella and surface of the sphere passes through the glenoid fossa along the articulating eminences or concentric with them.

It involves the positioning of teeth with anterior-posterior and medio-lateral inclines in harmony with a spherical surface. This form of occlusion is sometimes referred to have Monson's curve. This occlusion must be developed in curved form, the arc plane having its convex face downwards and its concave face upwards.

THE TETRAHEDRAL THEORY[7]

The 'tetrahedral theory' of occlusion states that a regular tetrahedron, derived from Bonwill's equilateral triangle, constitutes the unifying 3D geometrical figure of all well-known theories of occlusion (Bonwill's equilateral theory of occlusion, Spee's sagittal curves of occlusion,

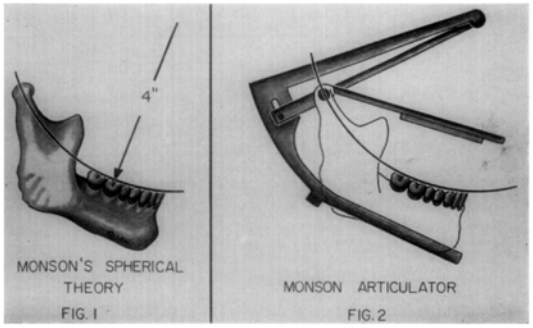

Illustration *3: Spherical theory*

Monson's spherical theory of occlusion and Hall's conical theory of occlusion); and the height of the regular tetrahedron represents the rest vertical dimension.

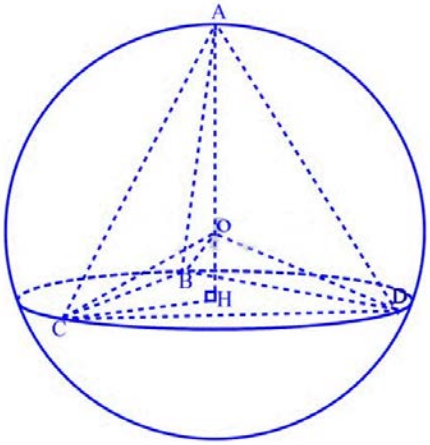

Illustration *4: A tetrahedron inside a circumsphere where its four vertices are lying on a segment of the circumsphere.*
• A, B, C and D represent the vertices of the tetrahedron
• AH represents the height of the tetrahedron
• O represents the centre of the tetrahedron
• ABC, ABD, ACD and BCD are the triangles that form the four surfaces of the tetrahedron
• AC, AB, CB, CD, BD, and AD are the edges of the tetrahedron
• CB, CD and BD are cords formed by the base of the tetrahedron a segment of the circumsphere of the tetrahedron

arrangement of tooth contacts in harmony with the mandibular movements. If the positions, dimensions and occlusal surfaces of the teeth are such that during functional jaw movements, mandibular cusps contact maxillary cusps throughout the dentures, those dentures can perform their masticatory function most effectively. Masticatory function and their occlusion are termed as 'physiologic occlusion or balanced occlusion 'and the necessity of balanced occlusion or distribution of occlusal stress over the greatest possible supporting area has for many years been emphasized by the prosthodontists.[8]

Characteristic Requirements of Balanced Occlusion:[9]

A balanced occlusion unit should have the following characteristics: -

- They should contact on the second molar when the incising units contact in function.
- They should contact at the end of the chewing cycle when the working units contact.
- They should have smooth gliding contacts for lateral and protrusive excursions.

Types of balanced Occlusion:

❖ Occlusion balance or balanced occlusion can be classified as follows: -

- Unilateral balanced occlusion
- Bilateral balanced occlusion
- Protrusive balanced occlusion
- Lateral balanced occlusion

Unilateral balanced occlusion:[10]
This is present when the occlusal surfaces of the teeth on one side articulate simultaneously, as a group with uninterrupted glide.

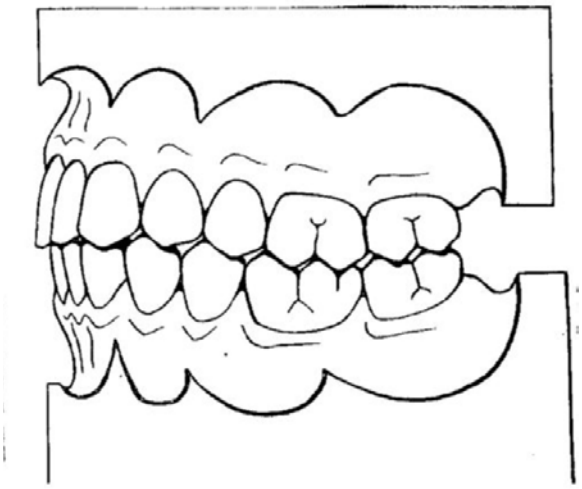

Illustration *5: Unilateral Balanced occlusion*

Bilateral balanced occlusion[10]: This is present when there is equilibrium on both sides of the denture due to simultaneous contact of the teeth in centric and eccentric occlusion within functional range. It requires a minimum of three contacts for establishing a plane of equilibrium. The more contacts, the more assured the equilibrium.

Illustration *6: Bilateral balanced occlusion*

Protrusive balanced occlusion:[10,11]

- This type of balanced occlusion is present when mandible moves in a forward direction and the occlusal contacts are smooth and simultaneous anteriorly and posteriorly. (Illustration 7)
- There should be at least three points of contact in the occlusal plane.
- Two of these should be located posteriorly and one should be in the anterior region.

This is absent in natural dentition.

Illustration *7: Protrusive balanced occlusion*

Lateral balanced occlusion:[10,11]

In lateral balance, there will be a minimal simultaneous three-point contact (one anterior, two posterior) present during lateral movement of the mandible.

Illustration *8: Lateral balanced occlusion*

FACTORS INFLUENCING BALANCED OCCLUSION:[10,12]

Though many authors questioned the necessity of all the five factors in a Hanau's quint, it is still considered as the basic determinant of balanced occlusion. The five basic factors that determine the balance of an occlusion are: - (Illustration 9)

i. Inclination of the condylar path or condylar guidance
ii. Incisal guidance
iii. Orientation of the plane of occlusion or occlusal plane
iv. Cuspal angulation
v. Compensating curves.

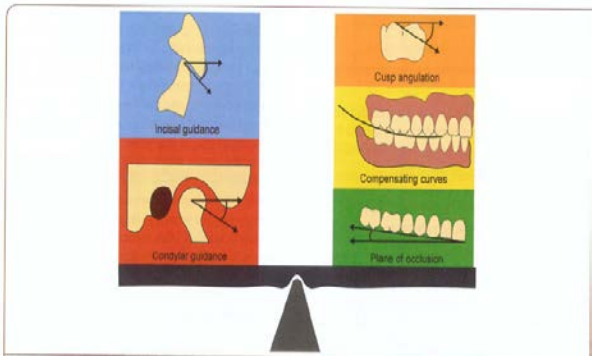

Illustration *9: Descriptive image of the relation between incisal guidance, condylar guidance, cuspal angulation, compensating curves and plane of occlusion.*

LINGUALIZED OCCLUSION

Lingualized Occlusion has been defined as "a form of denture occlusion that articulates the maxillary lingual cusps with the mandibular occlusal surfaces in centric, working, and non-working mandibular positions". While lingualized occlusion has been an option for

nearly a century, it has only been during the past 35 years that its popularity has rivalled anatomic and neutrocentric denture occlusion. The development of dental implants as common therapy to support fixed detachable overdentures, has forced the profession to re-evaluate occlusal choices for these unique, but less forgiving, restorations. Lingualized occlusion, because of esthetic, biomechanical, and technical advantages, has, for some, emerged as the logical choice.[13,14]

It was originally designed by Gysi. Payne in 1941 popularized this concept. Pound and Murrell – 1973 also advocated this concept of occlusion.

It is an attempt to maintain the esthetic and food penetration advantages of the anatomic form while maintaining the mechanical freedom of the non-anatomic form. This concept utilizes anatomic teeth for the maxillary denture and modified non anatomic or semi anatomic teeth for the mandibular denture.

Indications :[15]

1. when the patient places high priority on aesthetics but a non-anatomic occlusal scheme is indicated by severe alveolar resorption. Class II jaw relationship, or displaceable supporting tissue.

2. Where complete denture opposes a removable partial denture.

Principles of Lingualized Occlusion :[15]

1. Anatomic posterior teeth are used for maxillary denture.

2. Non anatomic or semi anatomic teeth are used for mandibular denture.

3. Modification of mandibular posterior teeth is accomplished by selective grinding and creating a slight concavity in the occlusal surface.

4. Maxillary lingual cusps should contact mandibular central groove in centric occlusion.

5. Balancing and working contacts should occur only on the maxillary lingual cusps.

6. Protrusive balancing contacts should occur only between maxillary lingual cusps and lower teeth.

Advantages of Lingualized Occlusion :[15]

1. Aesthetics and functional.

2. Bilateral mechanical balanced occlusion is readily obtained in a region around centric relation.

3. Vertical forces are centralized on the mandibular teeth.

MONOPLANE OCCLUSION

This occlusal scheme was first described by Dr. M. M. DeVan in 1951. Monoplane occlusion involves having non-anatomic denture teeth with a 0˚ incisal guidance angle, arranged on a flat occlusal plane.[1] As a consequence, when patients with monoplane occlusion occlude anteriorly, an interocclusal gap appears posteriorly. This is termed the 'Christensen phenomenon'[17] and forms the basis for categorising monoplane occlusion as non-balanced. Monoplane occlusion correspondingly requires having anterior

teeth with no vertical overlap thus resulting in suboptimal dental aesthetics. However, some studies have suggested that a monoplane occlusion can result in reduced masticatory ability.[16,17]

ADVANTAGES:[18]

It gives freedom of movement without interference especially in lateral movements since the mandible is not locked in a unique position. Horizontal forces are reduced, which cause, according to, more damages than vertical ones. Flat teeth are useful in reducing stress in complete lower denture. Monoplane occlusion is more adaptable for class II and III malocclusions

DISADVANTAGES:[18]

Monoplane teeth are not esthetically accepted. Patients may complain from phonetics' troubles due to tooth display' insufficiency related to a zero-degree incisal guidance. Masticatory efficiency is decreased.

In the monoplane occlusion, the non-anatomic teeth are more adaptable to unusual jaw relations such as the Class II and Class III malocclusions. They are used more easily when variations in the width of the upper and lower jaws indicate a crossbite setup. Zero-degree teeth impart to the patient a sense of freedom, because they do not lock the mandible in one position only. They eliminate horizontal forces that may be more damaging than vertical forces. Zero-degree teeth permit the use of a simplified and less time-consuming technique and offer greater comfort and efficiency for a longer period. They accommodate better to the inevitable negative changes in ridge height that occur with aging.[19]

CONCLUSION

Irresponsible selection and use of teeth in complete denture construction can produce forces that will compromise the stability of the bases, traumatize the oral supporting structures, and accelerate the rate of bone re-sorption. It is the professional responsibility of the prosthodontist to continue to study and understand the problems of occlusion and then apply intelligent procedures that will be the safest yet most efficient for each patient. It is obvious that the more comprehensive the understanding of the factors of occlusion, the more versatile the prosthodontist will be in treating the various problems of complete denture occlusion.

The various theories and concepts of occlusion should be considered for individual cases and the most suitable occlusal scheme should be provided, which meet the need of the patient, and which is in harmony with patients' orofacial structures.

REFERENCES:

1. S. Davies. What is occlusion? Br Dent J 2001;191:235-245.
2. Peter F. Cardinal differences in occlusion of natural teeth and that of artificial teeth. J Am Dent Assoc 1962;64:482-485.
3. Engelmier R L. Early designs for the occlusal anatomy of posterior denture teeth: part III. J Prosthodont 2005;14:131-136.
4. Christinen T F. The effect of Bonwill' triangle on complete denture. J Prosthet Dent 1959;9:791-797.

5. Starcke E N. The history of articulators: a critical review of articulators based on geometric theories of mandibular movement, part II: Rupert hall's conical theory. J Prosthodont 2002;11:211-222.
6. Weinberg L A. An evaluation of basic articulators and their concept's part II. J Prosthet Dent 1963;13:645-663.
7. Loto A O. Dental occlusion: A newly proposed tetrahedral theory of occlusion. Edorium J Dent 2017;4:26–35.
8. Hobo, Sumiya Takayama, Hisao. Oral rehabilitation: clinical determination of occlusion. Tokyo; London: Quintessence Pub Co 1997.
9. Winkler S. Essentials of complete dentures. 2nd edition. AITBS publication. Ch 13.
10. Arvin W, Lindsey D. "Oral rehabilitation: Part I. Use of the P-M instrument in treatment planning and in restoring the lower posterior teeth". J Prosthet Dent 1960;10:135–150
11. Veeraiyan D N et al. Textbook of prosthodontics. 2nd edition. Jaypee brothers' medical publishers. 2017.
12. Gysi A: Special teeth for cross-bite purposes. Dent Digest 1927;33:670–677.
13. Gysi A: Artificial Molar Tooth. U.S. Patent No. 1,657,673,1928.
14. Becker C M et al. Lingualized occlusion for removable prosthodontics. J Prosthet Dent 1977; 38:601-608.
15. D'Amico A. Functional occlusion of the natural teeth of man. J Prosthet Dent 1961;11:899–915.
16. Devan M. "The concept of neutrocentric occlusion as related to denture stability". J Am Dent Assoc 1954;48:165–169.
17. Engelmeier, Robert L. "The development of nonanatomic denture occlusion: part iv: nonanatomic denture occlusion development". J Prosthodont 2019;28:e159-e171.
18. Sabir S et al. Maintaining occlusal stability by selecting the most appropriate occlusal scheme in complete removable prosthesis. Jap Dent Sci 2019;55:145–150.
19. Jones P M. The monoplane occlusion for complete dentures. J Am Dent Assoc 1972;85:94-100.