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Faculty of Dental Science
Dharmsinh Desai University
NADIAD

# Faculty of Dental Science

## Dharmsinh Desai University

**NADIAD**


**Volume - IX Issue - 1 2019**

# FACULTY OF DENTAL SCIENCE
# DHARMSINH DESAI UNIVERSITY

## Mission

- 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 OF BEST PRACTICES.
- TO REDUCE DISPARITIES IN ORAL HEALTH BETWEEN DIFFERENT SOCIO-ECONOMIC GROUPS WITHIN COUNTRY AND INEQUALITIES IN ORAL HEALTH ACROSS COUNTRIES.

## Vision

- TO SPREAD EDUCATION GLOBALLY IN THE FIELD OF DENTAL SCIENCES USING EXISTING RESOURCES AND TECHNOLOGY.
- DEVELOPING EXEMPLARY CLINICIANS EDUCATORS AND SCIENTIST.
- 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

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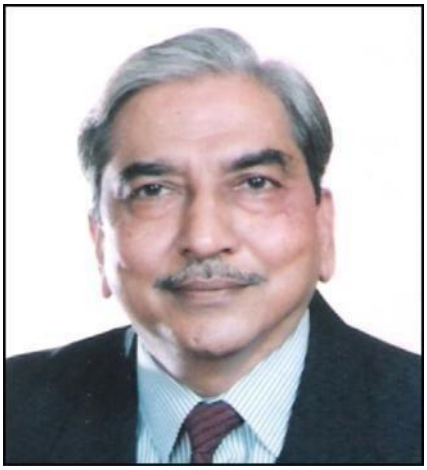
# Vice Chancellor's Message



We continually face challenges in life, how we view them defines us. I am proud to see that Faculty of Dental Science, choose to see challenges as stepping stones and opportunities that help them climb greater heights. I congratulate the editorial committee for coming up with yet another issue of the annual journal, which brings out the master works of students and staff members of the college, enriched with the scientifically reasoned information.

Dr. H.M Desai,

Vice Chancellor,

Dharmsinh Desai University,

Nadiad

# Trustee's Message

Faculty of dental science has paved its path to a greater success. I have been part of it ever since it was established and wish to look forward to its incremental success. My heartfelt congratulations to each of the students as well as the faculty members who have poured their strength into bringing out the current issue of the journal.

Mr. Ankur Desai

Trustee

Dharmsinh Desai University

Nadiad.

# Coordinator's Message

Discoveries and inventions are a part of constantly growing world. With the innovative ideas and procedures, we at the Faculty of Dental Sciences, provide a platform for the students as well as for the Faculty members to showcase their scientific abilities, opening a new horizon of knowledge. I, congratulate all the students and staff members for their active indulgence in bringing out the current issue of the journal.

Dr. Bimal.S. Jathal,

University Co-Ordinator,

Dharmsinh Desai University,

Nadiad

# Dean's Message

**"*If there is no struggle, there is no progress*."- Frederick Douglass**

The progress in our communities, in our world can only happen when brilliant minds decide to become engaged for the emergence of extraordinary work. We at the faculty of dental science, provide a platform for the younger and creative minds to share the best of their knowledge, creating an upgradation of an intellectual levels, leading to introduction of finer techniques and an academic leap.

I congratulate all the students and the faculty members for adding yet another pearl to the ocean of wisdom.

Dr. Hiren Patel
Dean
Faculty of Dental Science
Dharmsinh Desai University
Nadiad.

# From the Editor's Desk

The documentation of clinical work is an important aspect of academic training. The journal of dental science provides a platform for the faculty members and students to publish their work so as to benefit the entire dental fraternity.
The editorial committee has been working hard in a hope to keep our readers updated and motivated for the current and ever evolving trends in dentistry.
Looking forward for more knowledgeable articles in future too…

***"Together we can."***

**Dr. Shalini Gupta**

Editor

Journal of Dental Sciences
Dharmsinh Desai University
Nadiad

# Dharmsinh Desai University
# Faculty of Dental Science
# JOURNAL OF DENTAL SCIENCES
## Editorial Committee Members

# SONIC AND ULTRASONIC IRRIGATION: A REVIEW

*Dr. Shivani Doshi **Dr. Jhanvi Vaviya ***Dr. Dipti Choksi
****Dr. Barkha Idnani

**ABSTRACT**

Complete debridement of root canal system is a critical component of endodontic therapy. Ultrasonic and sonic activation of endodontic instruments have been suggested as a means to enhance canal debridement. When a file is ultrasonically activated and placed passively in canal, a phenomenon called acoustic streaming produced. It may produce shear stresses that are capable of disrupting biological cells and removing debris. Several studies have shown that ultrasonically or sonically prepared teeth have significantly debris free canals. This may be due to the fact that, when power driven files are used to instrument a canal, they can bind or contact the canal walls in a way that restricts their vibratory motion and cleaning efficacy. This may be particularly true for the fine and/or curved canals. Perhaps a more effective method for canal debridement would be to passively activate a file, sonically or ultrasonically, inside the canal as a final step in root canal preparation. Passive activation suggests that no attempt is made to instrument, plane, or contact the canal walls with the file. This should enable maximum benefits from acoustic streaming. The purpose of this review is to evaluate the cleaning efficacy of passive ultrasonic activation and passive sonic activation.

***Keywords:*** *Ultrasonic irrigation, sonic irrigation, root canal, smear layer, irrigation, activation.*

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## INTRODUCTION

The main aim of a Root Canal Treatment is the complete elimination of the connective tissue and thedestruction of residual microorganisms found in infected root canals and an effective seal in order toprevent recolonization of the root canal system with bacteria.[1] Thus the primary endodontic treatment goal must be to ensure complete root canal disinfection and to prevent re-infection. Irrigating solutions play a very important role in disinfecting the root canals. Presence of numerous dentinal tubules in the roots, the complexity of the root canal system, invasion of the tubules by microorganisms, presence of dentin as a tissue and formation of smear layer during instrumentation are the major obstacles in achieving the primary objectives of complete cleaning and shaping of root canal systems.[2] At present, no single irrigant combines all the ideal characteristics, even when they are used with an increased temperature, lower pH, or added surfactants to increase their wetting efficacy.[3,4] No single irrigant has demonstrated an ability to demineralize the calcified organic portion and dissolve organic pulp material of canal walls.

Throughout the history of endodontics, ongoing efforts have been made to evolve more effective systems to send and agitate irrigant solutions in the canal system. These systems can be categorized into manual and mechanical agitation techniques. Machine-assisted procedures include using rotary brushes, simultaneous irrigation with rotary instrumentation of the canal, pressure alternation devices and sonic and ultrasonic systems.[5] Several studies have shown that ultrasonically or sonically prepared teeth have significantly cleaner canals than teeth prepared by hand instrumentation.[6-8] Other studies have failed to demonstrate the superiority of ultrasonic or Sonics as a primary instrumentation technique.[9-13]This may be due in part to the fact that, when power-driven files are used to instrument a canal, they can bind or contact the canal walls in a way that restricts their vibratory motion and cleaning efficacy.[14] Perhaps a more successful technique for canal debridement would be to passively activate a file, sonically or ultrasonically, inside the canal as a final step in root canal preparation.

The purpose of this review is to evaluate the cleaning efficacy of passive ultrasonic activation and passive sonic activation.

Desired functions of irrigating solutions[15]

- Washing action (helps remove debris)
- Dissolve inorganic tissue (dentin)
- Penetrate to canal periphery
- Reduce instrument friction during preparation (lubricant)
- Facilitate dentin removal (lubricant)
- Dissolve organic matter (dentin collagen, pulp tissue, biofilm)
- Kill bacteria and yeasts (also in biofilm)
- Do not irritate or damage vital periapical tissue, no caustic or cytotoxic effects
- Do not weaken tooth structure

**SONIC IRRIGATION:**

Efficacy of sonic/subsonic activation of irrigants has been evaluated as a manner to improve overall canal cleanliness. By definition, sonic frequency is anything in the audible hearing range of a human. The major systems available to produce sonic/subsonic agitation are the Micromega® Sonic Air®1500 handpiece with an attached Rispi-Sonic® file, the Vibringe® sonic irrigation system (Vibringe B.V.) and the EndoActivator® system with attached polymer tips (Dentsply Tulsa Dental Specialties)[16]


***Illustrarion 1:***

***(a) Micromega® Sonic Air® 1500 handpiece.***

***(b) Rispi-Sonic® fi le (Micromega)***

*Courtesy:John M. Nusstein. Sonic and Ultrasonic Irrigation,B. Basrani (ed.), Endodontic Irrigation: Chemical Disinfection of the Root Canal System,2015:173-197*

*Endodontic Irrigation: Chemical Disinfection of the Root Canal System,2015:173-197*

***Illustration 2:***

***EndoActivator® system with polymer tips (Dentsply Tulsa Dental)***

*Courtesy:John M. Nusstein. Sonic and Ultrasonic Irrigation,B. Basrani (ed.), Endodontic Irrigation: Chemical Disinfection of the Root Canal System,2015:173-197*

***Illustration 3:***

***Vibringe irrigation system (Vibringe)***

*Courtesy:John M. Nusstein. Sonic and Ultrasonic Irrigation,B. Basrani (ed.),*

Conventionally, a Rispisonic file attached to a MM 1500 sonic handpiece (Medidenta International, Inc, Woodside, NY) is used to perform sonic irrigation after canal shaping. The Rispisonic files have a variable taper that increases with file size. Because they are barbed, these files might inadvertently engage to the canal wall and damage the finished canal preparation during agitation. A more recently introduced sonically driven canal irrigation system is EndoActivator System (Dentsply Tulsa Dental Specialties, Tulsa, OK).[17] It consists of 3 types of disposable polymer tips of different sizes and a portable handpiece. These tips are claimed to be flexible and strong and do not break easily. They do not cut dentin,because they are smooth. The EndoActivator System was reported to be able to effectively remove the smear layer, clean debris from lateral canals, and dislodge clumps of simulated biofilm within the curved canals of molar teeth.[18]The action of the EndoActivator tip frequently produces a cloud of debris during use, that can be observed within a fluid-filled pulp chamber.

Vibrating the tip, in combination with moving the tip up and down in short vertical strokes, synergistically produces a powerful hydrodynamic phenomenon.[19] In general, 10,000 cycles per minute (cpm) has been shown to optimize debridement and promote disruption of the smear layer and biofilm.[18]Polymer tips used in the EndoActivator system are radiolucent and it is a possible disadvantage of them. Although these tips are designed to be disposable and do not break easily during use, it would be difficult to identify them if part of a tip separates inside a canal. Apparently, these tips might be improved by incorporating a radiopacifier in the polymer. The Vibringe® irrigation system consists of a battery-operated plunger and thumb ring which is placed into a disposable, 10 ml, nylon syringe. An endodontic irrigating needle of varying size, depending on the root canal preparation, is attached. The reported frequency of agitation is 150 Hz. As the irrigant is delivered into the root canal, the thumb ring is activated causing vibration of the irrigating needle.[16]

**Frequency and Oscillating Pattern of Sonic Instrument:**

*Tronstad et al.*[20] were the first to report the use of a sonic instrument for endodontics in 1985. Sonic irrigation is different from ultrasonic irrigation in that it operates at a lower frequency (1–6 kHz) and produces smaller shear stresses.[21] The sonic energy also generates significantly greater back-and-forth tip movement or higher amplitude. A minimum oscillation of the amplitude might be considered as an node, whereas a maximum oscillation of the amplitude considered as an anti-node. They have 1 nodenear the attachment of the file and 1 anti-node at the tip of the file.[22]The sideway oscillation disappears when the movement of the sonic file is constrained. This results in a pure longitudinal file oscillation. For root canal debridement this mode of vibration is efficient, because it is largely unaffected by loading and exhibits large displacement amplitudes.

**Debris and Smear Layer Removal:**

Research into the improved cleaning of the root canal walls, isthmuses, lateral canals, and, as well as removal of pastes (mainly calcium hydroxide) and smear layer removal, has provided rather mixed results with sonic activation of irrigants. *Stojicic et al.*[23] reported on the effect sonic agitation of NaOCl has on dissolution of tissue. They reported that increasing the concentration of the NaOCl had the greatest impact and that

agitation (sonic) had the second greatest effect (more than increasing the temperature of the solution). *DeGregorio et al.*[24]reported that sonic activationwith the EndoActivator® equaled the effectivenessof PUI/UAI in getting irrigant solution intolateral canals 2–4.5 mm from the root apex whenEDTA was used.*Merino et al*.[25]found that Passive Ultrasonic Irrigation (PUI/ UAI) was superior to the EndoActivator® in getting irrigant to the canal apex in variously

tapered, curved canals. They found that the taper of the preparation had no impact on the irrigant movement.*Rödig et al*.[26] stated that use of the Vibringe® resulted in a cleaner apical 1/3 of the canal as compared to needle irrigation alone. *Kanter et al*.[27]found that the use of the EndoActivator® removed more debris and cleaned lateral canals better than PUI/ UAI and needle irrigation. *Johnson et al*.[28] stated that using Vibringe® cleaned canals and isthmuses filled with artificial collagen to the same degree as needle irrigation although there were some differences at various levels of the canals.

In removing smear layer, sonic activation has also had mixed results. *Uroz-Torres et al*.[29] stated no differences between needle irrigation and the use of EndoActivator® in removing smear layer when using EDTA and NaOCl. *Rödig et al*.[30] found that the addition of PUI/ UAI or EndoActivator® to activate the irrigants (NaOCl and EDTA) in curved canals resulted in superior smear layer removal, especially in the coronal portion of the canal. *Bolles et al.*[31]compared fluorescent dye-labeled sealer penetration in dentinal tubules following the use of EndoActivator® and Vibringe® on 17 % EDTA. They stated that the use of the activators did not improve sealer penetration (therefore smear layer removal was absent) in the apical 4 mm of the root canal compared to needle irrigation with 17 % EDTA. Calcium hydroxide and other paste and sealer removal have also been evaluated utilizing sonic activation. *Chou et al*.[32]found EndoActivator® resulted in more complete removal of the pastes as compared to needle irrigation. There was no difference in calcium hydroxide removal. *Grischke et al.*[33] evaluated the use of the EndoActivator® to remove set AH Plus sealer from artificial grooves in roots. The group reported that the EndoActivator® scored poorly in removing the sealer with PUI/UAI providing better results. *Goode et al*.[34] and *Khaleel et al*.[35]also evaluated the efficacy of the EndoActivator® to remove calcium hydroxide from root canals, Khaleel reported better results with the

EndoActivator® and PUI/UAI (similar results) than needle irrigation, while Goode's group reported no difference between the techniques.

**Bacteria and Biofilm Removal:**

*Brito et al*.[36] stated that the use of the EndoActivator® was similar to needle irrigation (NaOCl as the irrigant) in reducing artificially placed *Enterococcus faecalis* counts in extracted teeth. *Tardivo et al*.[37] found no difference in removal of *Enterococcus faecalis* between the EndoActivator® and PUI/UAI (Irrisafe™ system) from the root canal system. Neither technique could remove all the bacteria. *Shen et al*.[38] utilized infected hydroxyapatite discs to study chlorhexidine in killing bacteria. They reported that the addition of EndoActivator® agitation improved the killing effect of the chlorhexidine, but did not remove biofilm from the disc samples. In terms of biofilm removal, *Ordinola-Zapataet al.*[39] stated that EndoActivator® agitation and needle irrigation were similar in results and were both inferior to PUI/UAI and Photon.

**Safety:**

The safety of sonic irrigation has been evaluated in terms of extrusion of the irrigant past the apex of the root canal. Mitchell et al.[40] stated that the use of the EndoActivator® and MicroMega® Sonic Air® 1500 systems did result in extrusion of irrigant but that this occurred less frequently with the EndoActivator®. *Boutioukis et al*.[41] found that flow rate of the irrigant had a direct correlation with the amount of irrigant extrusion.

**ULTRASONIC IRRIGATION Nature of ultrasound:**

Ultra-Sound (US) is a vibration or acoustic wave of the same nature as sound but at a frequency higher than the highest frequency perceptible to the human ear (approximately 20,000 Hz).

There are two basic methods for producing ultrasound. Firstly, by magnetostriction that converts electromagnetic energy into mechanical energy. Different strips of magnetostrictive metal in a hand-held piece are joined to a stable, alternating magnetic field producing vibrations as a result. The second method is based on the piezoelectric principle and uses a crystal which changes size when an electrical charge is applied. Once the crystal deforms, it goes into mechanical oscillation without producing heat. Magneto strictive units create figures of eight (elliptical movement), which is not

ideal for endodontic use and another drawback with these units is that heat is generated, so adequate cooling is required. Piezoelectric unitsproduce more cycles per second, 40 as against 24 kHz so they have some advantages over magnetostrictive units. The tips of these units work in a linear movement from back to front like a piston which is ideal for endodontic treatment.[42]

**Ultrasound Application:**

Ultrasound was first used in dentistry for cavity preparations. The concept of "Minimally Invasive Dentistry" meant a new application of ultrasound for cavity preparation. *Richman* first introduced ultrasonic instrumentation to endodontics in 1957 for endodontic therapy with Cavitron© as irrigation and obtained good results. However, ultrasonically activated K files were not used for preparing canals before filling until the study by *Martin et al.*[43] The term "endosonic" was coined by Martin and Cunningham[44] and was defined as the ultrasonic synergistic system of instrumentation and canal disinfection. The use of ultrasonic energy for facilitating disinfection has a long history in endodontics. In several earlier studies, the comparative effectiveness of ultrasonics and hand-instrumentation techniques has been evaluated. Most of these studies concluded that ultrasonics, together with an irrigant, contributed to a better cleaning of the root-canal system than hand instrumentation and irrigation alone.acoustic streaming and cavitation of the irrigant contribute to the biologic chemical activity for maximum effectiveness. Analysis of the physical mechanisms of the hydrodynamic response of an oscillating ultrasonic file suggested thattransient and stable cavitation of a file, steady streaming, and cavitation microstreaming all contribute to the cleaning of the root canal. Ultrasonic files must have free movement in the canal without making contact with the canal wall Several studies have shown the importance of ultrasonic preparation for optimal debridement of anastomoses between double canals, fins and isthmuses.[45-47]The effectiveness of ultrasonics in the elimination of dentin debris and bacteria from the canals has been shown by several studies.[48-52] However, not all studies have supported these findings. *Van der Sluis* and colleagues concluded in a study that a smooth wire during ultrasonic irrigation is as effective as a size 15 K-file in the removal of artificially placed dentin debris in grooves in simulated canals in resin blocks. It is possible that preparation complications are less likely to occur with

an ultrasonic tip with a smooth, inactive surface.[15] Two types of ultrasonic irrigation is described in the literature. The first type referred to as combination of simultaneous ultrasonic instrumentation and irrigation (UI). The second type, is passive ultrasonic irrigation (PUI), operates without simultaneous instrumentation. UI devices have significantly cleaner canals than teeth prepared by conventional root canal filing alone.[53] In addition, it is difficult to control the cutting of dentin during ultrasonic irrigation and hence the shape of the prepared root canal. Highly irregular-shaped canals as well as strip perforations were frequently produced.[54] Therefore, UI is not generally perceived as an alternative to conventional hand instrumentation.[51] On the contrary, the endodontic literature supports that it is more advantageous to apply ultrasonics after completion of canal preparation.[55]

**Irrigant Application Methods During PUI:**

Two flushing methods might be used during PUI, namely a continuous flush of irrigant from the ultrasonic handpiece or an intermittent flush technique by using syringe delivery.[56]In the intermittent flush technique, the irrigant is injected into the root canal by a syringe and replenished many times after each ultrasonic activation cycle. The amount of irrigant flowing through the apical region of the canal can be controlled because both the volume of irrigantadministered and the depth of syringe penetration are known. This cannot be possible with the use of the continuous flush regime. Both flushing methods have been shown to be equally effective in removing dentin debris from the canal in an ex vivo model when the irrigation time was set at 3 minutes.[57]

**Continuous Ultrasonic Irrigation:**

A needle-holding adapter to an ultrasonic handpiece has been developed by *Nusstein*.[58]During ultrasonic activation, a 25-gauge irrigation needle is used instead of an endosonic file. This enables ultrasonic activation to be performed at the maximum power setting and does not cause needle breakage. The main feature of this needle-holding adapter is that the needle is simultaneously activated by the ultrasonic handpiece, while an irrigant is delivered from an intravenous tubing connected via a Luer-lok to an irrigation-delivering syringe. The irrigant can thus be delivered apically through the needle under a continuous flow instead of being intermittently replenished

from the coronal access opening.[59] 1 minute of continuous ultrasonic irrigation produced significantly cleaner canals and isthmi in both vital and necrotic teeth.[60]It also resulted in a significantly greater reduction of colony-forming unit.

**Intermittent Flush Ultrasonic Irrigation:**

In intermittent flushed UI, the irrigant is delivered to the root canal by a syringe needle. The irrigant is then activated by an ultrasonically oscillating instrument. The canal is then flushed with fresh irrigant to

remove the dislodged or dissolved remnants from the canal walls.

***Illustration4:***

***Brasseler file holder E12 (Brasseler)***

*Courtesy:John M. Nusstein. Sonic and Ultrasonic Irrigation,B. Basrani (ed.), Endodontic Irrigation: Chemical Disinfection of the Root Canal System,2015:173-197*


***Illustration 5:***

***Satelec Acteon Irrisafe™ tips. Note serrated wire with non-cutting sides and irrigation port near attachment hub (Satelec)***

*Courtesy:John M. Nusstein. Sonic and Ultrasonic Irrigation,B. Basrani (ed.), Endodontic Irrigation: Chemical Disinfection of the Root Canal System,2015:173-197*

***Illustration 6:***

***Satelec Sonofi le with no irrigation port (Tulsa Dental Products)***

*Courtesy:John M. Nusstein. Sonic and Ultrasonic Irrigation,B. Basrani (ed.), Endodontic Irrigation: Chemical Disinfection of the Root Canal System,2015:173-197*

**Debris and Smear Layer Removal:**

PUI/UAI has been reported to be more effective than simple syringe and needle irrigation *Goodman et al.*[45] and *Lev at al.*[59] reported that the addition of 3 min of PUI/UAI per canal (using NaOCl as an irrigant) significantly enhanced the cleanliness of the isthmuses of the mesial roots of mandibular molars in vitro at the 1 and 3 mm levels from the canal apex. Looking at the effect of the size of the canal preparation on cleaning with PUI/UAI, *Lee et al.* and *van der Sluis et al*. concluded that the greater the taper of the canal, the more debris that is removed with the PUI/UAI file. *Rödig et al,* however, found that apical size had no impact on canal cleanliness when utilizing PUI/UAI.[16]*De Gregorio etal.*[61] reported that irrigant penetrated artificially made lateral canals much better when PUI/UAI was used than needle irrigation or negative pressure irrigation. *Liang et al.*[62] evaluating 86 patients 10–19 months after root canal treatment, showed an improvement in the reduction and resolution of apical pathosis following the use of PUI/UAI compared to needle irrigation. When NaOCl was used alone, studies have reported almost complete smear layer removal from various levels of the root canal. When NaOCl was combined with EDTA, the research has shown a marked improvement in smear layer removal.[16] Studies looking at the use of PUI/UAI to remove either calcium hydroxide or other paste fillers from the canals have given mixed results. The addition of PUI/UAI to remove calcium hydroxide and Ledermix was found to improve overall removal, but did not assure complete removal of all material.[63] The effect of canal curvature on the effectiveness ofPUI/UAI is also reported. Significantly improved cleaning of isthmuses and canals occurred at the apical 5 mm in curved canals versus needle

irrigation. *Malki et al.* report that the flow of irrigant beyond the ultrasonic file tip was not affected by curvature of the canal.[16]

**Bacteria/Biofilm Removal:**

*Bhuva et al.*[64] reported no improvement in removal when utilizing an artificially produced biofilm of E.faecalis . *Shen et al.*[65] reported an increase in killing of artificial biofilm when PUI/UAI was utilized with chlorhexidine on dentin discs. *Gründling et al.*[66] reported that PUI/UAI helped reduce E.faecalis biofilm only when NaOCl was used as an irrigant. *Joyce et al.*[67] looked at the mechanism of action of ultrasonics on biofilm and stated that PUI/UAI caused deagglomeration of the biofilm via the cavitation effect.

**Safety:**

There is potential risk of extrusion of debris and irrigants during the use of PUI/UAI. Fluid movement and cleaning extends 3 mm beyond the ultrasonic file tip.[68] The use of PUI/UAI does transport irrigant solution to the apex of the root canal.[69]More extrusion of irrigant and debris out the apex of the root canal following the use of PUI/UAI as compared to needle irrigation.[70,71] No extrusion of irrigant out the root apex when the PUI/UAI file was kept at 3 and 5 mm from the apex. However, extrusion did occur when the file was placed within 1 mm of the apex.[72]

**CONCLUSION:**

Effective irrigant delivery and agitation are prerequisites for successful endodontic therapy. This article presents an overview of the irrigant agitation methods and their debridement efficacy. Technological advances during the last decade have brought to fruition new agitation devices that rely on different mechanisms of irrigant transfer, soft tissue debridement, and, depending on treatment philosophy, removal of smear layers. When a file is passively activated in a canal by sonics or ultrasonics for 3 min after hand instrumentation, it results in a significantly cleaner canal than that for hand instrumentation alone. There is no significant difference in cleaning efficacy between ultrasonically and sonically activated files.

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# NANODENTISTRY: BIOACTIVE GLASS AND NANOPARTICLES AS INTRACANAL MEDICAMENTS: A REVIEW

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**ABSTRACT**

The primary goal of endodontic therapy is thorough disinfection of the root canal system through thermomechanical debridement. Intracanal medicaments have been widely used for multipurpose like disinfection, regeneration, trauma, pain control. Newer research has been focused to combat the drawbacks like antimicrobial resistance, dentin discoloration, alteration in microhardness of dentin. Nanotechnology been the upcoming future scope focuses on development of new such materials like bioactive glass and nanoparticles. These materials not only are biocompatible but are target specific in their mode of action.

***Keywords:*** *intracanal medicaments, bioactive glass, nanoparticles, future scope.*

## INTRODUCTION

Several root canal irrigants have been used to eradicate the root canal microbiota, however there exists no particular literature stating its complete efficacy. Bacterial resistance, complex root canal anatomy, leads to incomplete efficiency of the root canal irrigant. Also, the protective layer formed by necrotic tissue, debris, inhibit the penetration of the irrigant, thereby inhibiting the antibacterial activity of the irrigant.[1]

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Regardless of single sitting or multiple visit root canal treatment[2], root canal disinfection is time dependent, even if fast acting biocides such as sodium hypochlorite are used.[3]As such the standard treatment protocol for treating apical periodontitis with two visit using interim root canal dressing is followed. However, leakage of resident or transient microbiota via temporary dressing/filling material into the canal space intervenes the disinfection, which happens to be the disadvantage of this two-visit protocol.[4] *Enterococcus. faecalis* (E.*faecalis*), an enteric bacteria are hard to eliminate once present. They can recontaminate the pulp less root canal being the monoinfectants and/or an unsealed root canal.[5,6] Among the materials used aqueous calcium hydroxide being used happens to be the most efficient. Nevertheless, it has its own disadvantages such as: Firstly, it could alter the dentin strength of the tooth because of its nonspecific proteolytic action of the hydroxide ion. Hence decreasing the flexural strength of the dentin. Secondly, inefficient action against alkali resistant microbiota such as E. *faecalis*.[7] Bioactive material is said to be one when it bonds the material and the tissue and as an outcome provides the appropriate biological response.[8] Recently, the use of bioactive glass and nanoparticles as intracanal medicaments has been suggested owing to their antibacterial action against endodontic pathogens and has been evaluated in many in vitro studies.[1]

## BIOACTIVE GLASS

Biomaterials are the materials which are either natural or manmade, that replace or supplement the functions of living tissues.[9] Biomaterials should possess properties such as bioinert, bioactive, biostable and biodegradable.[10] The first bioactive material belonging to the $SiO_2$-$Na_2O$-CaO-$P_2O_5$system (Bio glass VR), was developed by Hench in 1969, where he discovered that certain glass compositions could bond to the bone and had excellent biocompatibility.[11] A bioactive material is synthesized such that it induces target specific biological activity.[12] This material acts upon interaction once in the body with this twostep process: First step, on interaction with simulated body fluids (SBF) it undergoes specific surface reaction. Second step, interaction within hard and soft tissue through the formation of hydroxyapatite (HAp) like layer.[13] The desired parameters for a bioactive glasses/glass–ceramics to function as asuitable biomaterial are that they should be nontoxic. They should promote cell adhesion, causing cell proliferation, hence making biocompatibility an indispensable property. They should not cause any

cytotoxic effect or hamper any bioactive process inside the cell/tissue. There must be a formation of a hydroxyapatite layer, when these glass contact the SBF, the bio glass scaffolds must exhibit mechanical properties that are comparable to those of the tissue to be replaced for better compatibility to withstand any kind of pressure or strain in order to prevent any structural failure during handling of the material and during the patient's normal routine activities. For bone engineering, bioglass should possess controllable interconnected porosity to support vascularization so as to direct cells to grow into the required physical structure. Bioglass scaffold should have a porous three-dimensional (3D) structure for cell proliferation, vascularization and diffusion of nutrients which provides a regulated microenvironment for new tissue synthesis, while still maintaining the desired features, bioactive glass should be cost effective for commercialization.[14]

**The Mechanism of Hap Layer Formation on Bioactive Glasses**

Hydroxyapatite interacts with the collagen fibrils of damaged bone to bond with it, thus mimicking the bone mineral. Formation of HAp layer-bone bond involves incorporation of collagen fibrils, protein adsorption, attachment of bone progenitor cells, cell differentiation, the excretion of bone extracellular matrix and its mineralization. Dissolution products of the glass on osteoprogenitor cells, stimulates new bone growth causes osteogenesis.[15] The mechanism of Hap layer formation includes several stages: calcium ions dissolve from the bioactive glass into the body fluid while a silica-rich interlayer forms on the glass surfaces. The surrounding fluid is supersaturated with respect to HAp due to the dissolution of the calcium ions, hence nucleation of HAp is possible. The reactions of the calcium, phosphate, and hydroxide ions leads to continuous process of nucleation and growth of HAp layer.[16]

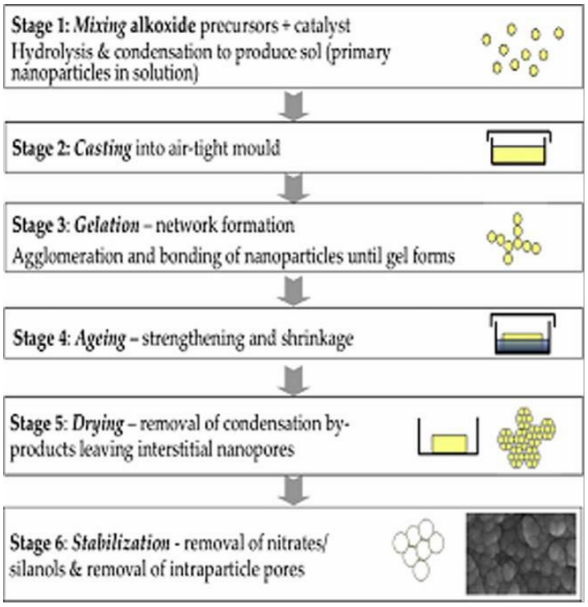
**Processing methods.**

For years conventional glass technology has been used to manufacture bioactive glass. For the glass component, mixture of oxides and carbonates are homogenously melted at high temperatures

up to 1250-1400 $^{0}$C in a platinum crucible. Then the molten glass is cast in a steel or graphite mold to form a bulk mass. Finally, a final grind and polish is necessary for the required tolerance of the material. To produce small fragments, the molten bulk is poured in water or some other liquid medium. Powdered bioactive glass is implied in periodontal lesions.[1] Bioactive glass produced by conventional glass technology has the disadvantage such as that it requires high temperature for production, contamination can occur during the processing, compositional limit due to presence of $SiO_2$ and increased production cost.[16,17]

**Sol Gel Process:**[18]

Simply by changing the pH of the process (illustration 1) bioactive glasses can be made as nonporous powders or monoliths or as nanoparticles. Interconnected porous networks can now be non-destructively imaged and quantified by micro CT imaging and image analysis; and the atomic structure of glasses and hybrids can be understood through nuclear magnetic resonance (NMR) spectroscopy, X-ray and neutron diffraction and particle-induced X-ray emission (PIXE).




*(Courtesy: Dr. Julian Jones)*

***Illustration 1: sol gel process***

Bioactive glass is indicated in various purposes such as repair of hard tissue, as scaffolds, in dentinal hypersensitivity, antimicrobial, dentin demineralization, removal of stains, caries removal. [8]

**As Intracanal Medicament**

During dissolution of bioactive glass, the pH rises due to cation release and such condition can kill the microbes. For instance, S53P4, as one kind of bioactive glass, can kill pathogens connected with enamel caries (*Streptococcus mutans*), root caries (*Actinomycesnaeslundii, S. mutans*) and periodontitis (e.g. *Actinobacillusactinomycetemcomitas*)

Silver is one of the elements known as antimicrobial. Silver ions can easily be introducedinto a glass and then released during dissolution. The sol-gel derived composition of 76 % $SiO_2$, 19% CaO, 2% $P_2O_5$ and 3% $Ag_2O$ (by weight) is the first antibacterial glass which contains silver. Less than 1 mg/ml of this glass in culture is needed to kill bacteria such as *Escherichia coli*, *Pseudomonas aeruginosa* and *Staphylococcus aureus*.[16] The antibacterial activity of BAG depends on the following factors acting simultaneously: High pH; An increase in pH because of release of ions in an aqueous environment, Osmotic effects; An increase in osmotic pressure above 1% is inhibitory for many bacteria.Ca/P precipitation as it induces mineralization on the bacterial surface. Furthermore, the release of $Ca^{2+,}$ $Na^{+}$, $PO_4^3$, and $Si^{4+}$ could lead to the formation of bonds with the mineralized hard tissues. Copper and its alloys, such as brass, bronze, copper, nickel and copper-nickel-zinc can also be used in antimicrobial applications. The strong antimicrobial ions of copper can be doped to different matrices such as polymers or ceramics. Copper not only is an excellent antimicrobial agent but also has an essential role in bone formation and healing. This metal can also stimulate wound healing responses and improves the vascular density in and around subcutaneously implanted allografts and hyaluronan based hydrogel.

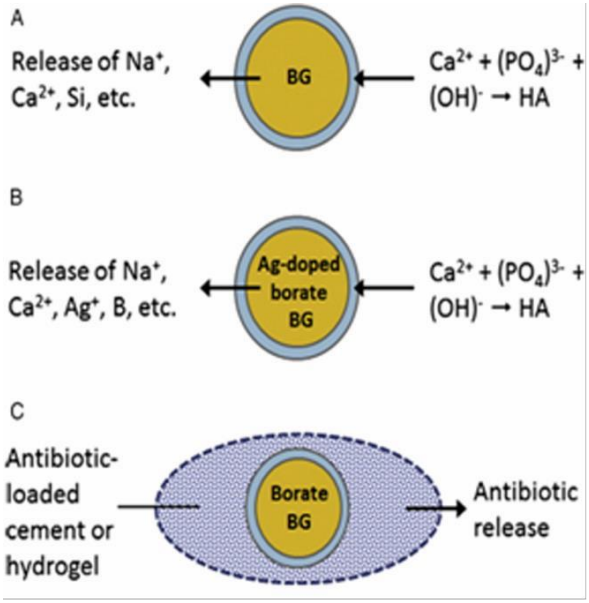



***Illustration 2: Approaches for BAG***

*(Courtesy: Abbasi Z, Bahrololoom ME, Shariat MH, Bagheri R)*

*(A) One approach BAGs that can change the local physiological conditions when they areimplanted to produce a bactericidal effect.(B) Another approach is to dope the BAG during its manufacture with trace quantities of elements (e.g, Ag) that are known for their antibacterial activity, and, as the glass degrades, those elements are released at a clinically desirable rate. (C) The third approach is to use BAG in conjunction with antibiotics.*[16]

Copper sulfate can induce the formation of cord-like and tubular structures and potentiate the effect of endogenous growth factors, which makes it a perfect additive for blood vessel ingrowth. Zinc is another metal which is thought to have antibacterial properties and beneficial cellular response, but it can also cause toxicity.[16]

## NANOPARTICLES

Nanoparticles have different forms and shapes[19] and are categorized according to their dimensions as: zero dimension such as nanoparticles, one dimension such as nanorods, two dimensions such as thin films and three dimensions such as nanocones. They show increased chemical reactivity when compared to their bulk form. [20] The term nanodentistry is defined as "the science and technology of diagnosis, treating and preventing oral diseases, relieving pain, preserving and improving dental health using nanostructured material. [21] Nano dentistry can be used in different areas of dentistry likemanufacturing of dental materials, prevention of oral diseases such as dental caries and periodontal diseases, as therapeutic agents for the treatment of dentine hypersensitivity, oral cancer and endodontic diseases, in the technology of tissue engineering.[22]

### Antibacterial Mechanisms of Nanoparticles

The antibacterial activity of nanoparticles are different against different microorganisms when compared to its original bulk form and may vary related to its different types of nanoparticles.[23] The two different mechanisms that attribute the efficacy of nanoparticles to eliminate bacterial cells is either they bind to the bacterial cell membrane through the electrostatic forces and change their electric potential causing disruption of membrane thereby disturbing cell functions leading to cell death [24] or by production of oxygen free radicals such as reactive oxygen species that influences the survival of bacterial cell.[25]

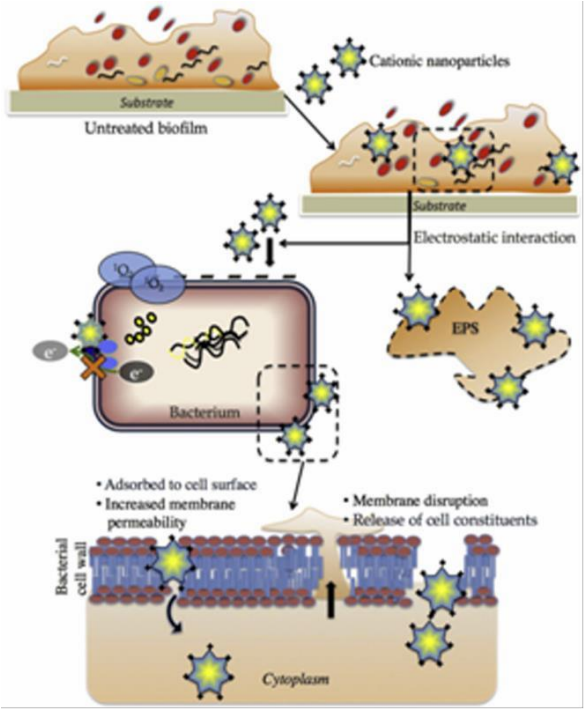
### Chitosan Nanoparticles.

The deacetylated derivative of chitin- CHITOSAN is the second most abundant natural biopolymer. There are different methods to synthesis or assemble nanoparticles of Chitosan depending on the physical characteristics required or the end of application in the Nanoparticles.[26] It has excellent antibacterial, antiviraland antifungal properties.Gram positive bacteria were more susceptible than gram-negative bacterias.[27] Depending on the organism, pH, degree of deacetylation

(DD), molecular weight, chemical modifications, and presence of lipids and proteins. The minimum inhibitory ranges from 18–5000 ppm.[28]

**Clinical Implication:**

Significantly reduced adherence of Enterococcus faecalis was noted in the dentin treated with Nanoparticles. These nanoparticles eliminated biofilm on a concentrationand time-dependent manner and also retained their antibacterial properties after aging for 90 days. [29]




*(Courtesy: Dr. Annie Shreshta)*

***Illustration 3: Antibacterial mechanism of chitosan.***

CS-NPs can be delivered within the anatomic complexities and dentinal tubules of an infected root canal to enhance root canal disinfection.[30] Biofilm bacteria are known to express efflux pumps as a resistance mechanism to antimicrobials.[31] The antibacterial efficacy of CS-NPs was not affected against bacterial biofilms with known efflux pump inhibitors.[32] The neutralizing effect of different tissue inhibitors is another challenge in using antibacterial agents inside the root canal space.[33] Pulp and serum albumin inhibit the antibacterial effect of CS-NPs[34] whereas dentin, dentin matrix and lipopolysaccharides do not affect the efficacy of CS-NPs.[35]

**Silver Nanoparticles**

Silver produces an antibacterial effect by acting on multiple targets starting from interaction with the sulfhydryl groups of proteins and DNA, alter the hydrogen bonding/respiratory chain, unwind DNA, and interfere with cell-wall synthesis/cell division.[36,37] Silver Nanoparticles (Ag-NPs) destabilize the bacterial membrane and increases permeability that leads to leakage of cell constituents.[38]

**Clinical Implication:**

There is prolonged interaction between positively charged Ag-NPs and negatively charged biofilm

bacteria/structure resulting in this difference, when used as a medicament. When Ag-NP suspension is combined with calcium hydroxide it shows significantly reduced E. faecalis from root canal dentin.[39] In addition, these Ag-NPs were found to be cytocompatible to fibroblast cells.[40] The potential discoloration of dentin and toxicity toward mammalian cells are two main issues associated with Ag-NPs.[41]

**Functionalized Antimicrobial Nanoparticles**

The word functionalize means to organize (as work or management) into units performing specialized tasks. Functionalization could alter the surface composition, charge and structure of the material wherein the original bulk material properties are left intact.[42] In a functionalized nanoparticle, the inorganic or polymeric materials usually form the core substrate. Functionalized nanoparticles containing various reactive molecules and decorated with peptides or other ligands have led to new possibilities of combating antimicrobial resistance.[43,44] Nanoparticle-based photosensitizers have been considered to potentiate photodynamic therapy efficacy.[45,46] Functionalized Nanoparticles along with photosensitizer molecules offer unique physicochemical properties such as ultra-small sizes, large surface area/mass ratio and increased physical/chemical reactivity. The combination of nanoparticles with photosensitizers can be achieved by: [47]

**1.** Photosensitizers supplemented with nanoparticles

**2.** Photosensitizers encapsulated within nanoparticles

**3.** Photosensitizers bound or loaded to nanoparticles

**4.** Nanoparticles themselves serving as photosensitizers

An invitro test on E. faecalis biofilm and human dental plaque bacteria in combination with PDT was done by Methylene blue–loaded poly (lactic-co-glycolic) acid (MB-PLGA) Nanoparticles. The cationic MB-PLGA nanoparticles exhibited significantly higher bacterial phototoxicity in both planktonic and biofilm phases. It was concluded that cationic MB-PLGA nanoparticles have the potential to be used as carriers of photosensitizer photodynamic therapy (PDT) within root canals.[48] Photosensitizer-bound polystyrene beads with rose bengal (RB) were used after activation with light which improved

bacterial elimination with reactive oxygen species.[49] The Antimicrobial PDT Efficacy is enhanced by Combinations of Nanoparticles with Photosensitizer due to several factors such as higher concentration of photosensitizer which thereby increases resultant ROS, reduced efflux of photosensitizer so drug resistance reduces, greater possibility of targeting bacteria,post conjugation stability of photosensitizers increases.[50,51]

## CONCLUSION

Antibacterial activity along with the potential of healing and regeneration of defect areas is the prime property of bioactive glasses. Hence making it a unique material in the field of dentistry. Unique characteristics can be achieved by doping some elements to this composition such as zinc, copper or silver. Nanoparticles via surface modifications provide target specificity by intimately and selectively targeting the bacteria and the biofilms. Newer multifunctional nanoparticles are being developed based on the clinical requirements in collaboration with engineers, clinicians, and biologists.

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# TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION THERAPY IN TEMPOROMANDIBULAR JOINT DISORDER –OVERVIEW

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## Abstract:

Temporomandibular joint disorder (TMD) is a term to describe a group of diseases functionally affecting the masticatory system, especially masticatory muscles and the temporomandibular joint (TMJ). It has different etiologies and specific treatments, including transcutaneous electrical nerve stimulation (TENS). Hence the purpose of this article is to overview its applications in dentistry for method of pain alleviation. Tens offers a modest, safe and noninvasive technique, which has minimal or no side effect. It can be concluded that to achieve better response in patients, combination of conventional (medication, soft diet and hot fomentations,) and TENS therapy should be given

***Keywords:*** *TENS, TMJ, orofacial pain, TMJ disorder*

## Introduction

Temporomandibular joint disorder (TMD) is a generic term to describe a group of disorders or diseases affecting masticatory muscles, the temporomandibular joint (TMJ) and associated structures[1] TMD can be divided into two broad categories as myogenous or muscle related TMD and arthrogenous or joint related TMD[2] They are the most common orofacial pain conditions of non-dental origin. That frequently encountered in clinical practice, and them prevalence in the general population has been reported as being as high as 12%[3] It worsens with stress or may intensify with cold. It may be associated with bruxism, trauma from occlusion, and/or with jaw manipulation in any form.[4] Skeletal muscles are major sources of undiagnosed pain. There may be areas of hyperirritability called myofascial trigger points which are sensitive sites in muscle bands, tendons or ligaments which may generate local or referred pain with atypical pattern.

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These motor end plates connect to a group of sensitized sensory neurons in charge of transmitting pain information from the spinal cord to the brain. Temporomandibular joint disorder patients present with a number of signs and symptoms, including pain, malocclusion, altered joint function with or without deviation, clicking and/or restricted movement.[6] Based on [1]It is currently hypothesized that these trigger points contain areas of sensitized low-threshold nociceptors (free nerve endings) with dysfunctional motor end plates. multifactorial etiology, treatment of TMD usually involves more than one modality; main goal is pain reduction and restoration of normal jaw fuction.[7]Dentists, physicians, psychologists and physical therapists work together to cope with such condition afflicting patients. [1] Various treatment modalities that have been tested over time are analgesic and anti-inflammatory medications, muscle relaxants, massage therapy, occlusal splints, and cognitive behavioral therapies[2]. Numerous physical therapy methods are moist heat, ultrasound, TENS, microwaves, laser, exercises and manual therapy techniques[1]

Among these, transcutaneous electrical nerve stimulation (TENS) deserves special attention, as it provides decreased pain and electromyography activity (EMG) of masticatory muscles at rest in TMD patients.[1,6] In dentistry, though TENS has potential applications, it is not used that frequently. Hence the purpose of this article is to overview its applications in dentistry for method of pain alleviation so as to raise awareness among dental fraternity regarding its applications.

**Transcutaneous electrical nerve stimulation therapy:**

(TENS) is defined as the application of electrical stimulation to the intact surface of skin for pain control. [6] Maximal analgesia occurs when TENS generates a strong but non-painful electrical paranesthesia beneath the electrodes [8] Shane and Kessler [1967], first described use of TENS in dentistry, yet to gain the acceptance. It's a safe, noninvasive, effective and swift method of analgesia.[7,9] and produce a positive relaxing effect on the masticatory muscals.[2]

**Principle:** TENs works on the principle that, electrical stimulation is directed to pain areas via surface electrodes, and current passed through these areas which reduces or eliminates pain. [7,9]

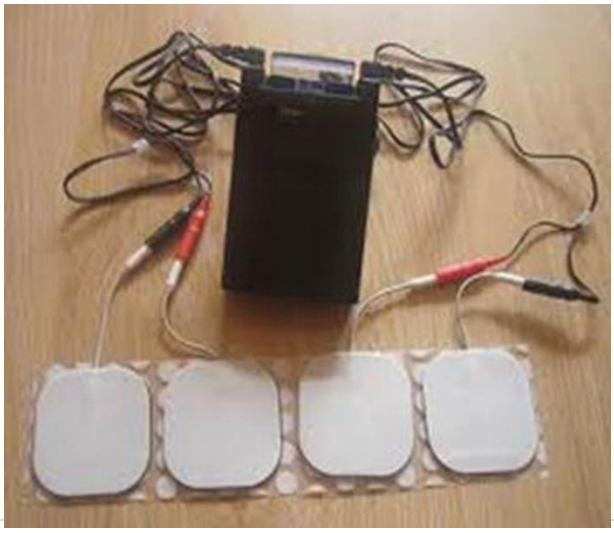
**Method:**

This consists of a battery-powered hand-held stimulating device which generates pulsed electrical currents which are delivered through the skin using electrode pads. Users can adjust the pulse amplitude (mA), frequency (pulses per second - pps), width or duration (μs) and pattern of the currents[8].Electrodes are connected to the skin surface aimed to unwind hyperactive muscles and alleviate pain. Electrodes may be silicone based that are used either with gel application mechanism or self-adhesive. They are placed at the origin of pain or close to the site of highest pain, within the same dermatome, myotome and/or myofascial trigger points. [6] There is also the option of placing them on pathway of peripheral nerves involved with pain genesis.[1]

**Types:**

There are different pulse frequencies, intensities and durations. They are classified in two groups: high frequency, higher than 50 Hz and low frequency, lower than 10 Hz. Those used in dentistry are in generally mixed. In case of high frequency (50 to 150 Hz) and low intensity, the action seems to be essentially central. Low frequency has essentially peripheral action being indicated for muscle relaxation.[10]

Surface electode over pretragus region for transcutaneous stimulation



Transcutaneous electrical nerve stimulation device

Three main types of TENS are described in the literature

1. Conventional TENS
2. Acupuncture-like TENS [ALTENS]
3. Intense TENS.

**Different TENS techniques are used to selectively activate different afferent nerve fibers:**

1. Conventional TENS –Most commonly used method.[5] high frequency and low intensity characteristics of stimulation are those which allow us to call this kind of application "conventional". The mechanisms of pain relief with conventional TENS are based on gate control theory.[8]

2. Acupuncture-like TENS [AL-TENS] It uses low frequency; high intensity pulsed currents AL-TENS can be used for about 30 minutes at a time as fatigue may develop with ongoing muscle contractions. [11]

3. Intense TENS It uses high frequency, high intensity pulsed currents and produces extra segmental analgesia which has a rapid onset [< 30 min after switch-on] and delayed offset [>1 h after switch-off]. Intense TENS can be used for about 15

minutes at a time as the stimulation may be uncomfortable.[11]

**Mechanism of action:**

The mode of action of TENS has been attributed to neurological, physiological, pharmacological and psychological effect.

The neurologic action of TENS is based on Melzack and Wall‟s gate control theory of pain.[6] It suggests that TENS stimulates the thick, myelinated, and sensory fibers (A-fibers) which in turn blocks the impulses of thin pain-modulating fibers (C-fibers) and closes the gate to pain signals at their level of entry into spinal cord[12]

Physiologically it affects muscle movements, the fasciculation of muscle may result in increased circulation, a decrease in oedema and a decrease in resting muscle activity.[13]

Pharmacologically it involves the stimulated release of endorphins, which are endogenous morphine like substances.[13,14,12]

TENS may have played a passive role in the improvement of the patients' pain. This would mean that the effect of TENS was limited to a placebo effect and the only benefit of this treatment modality was to address the psychological aspect of the patient[15] A placebo is defined as a positive response to unknown[7]

**Advantages:**

TENS is remarkably free from side effect. there is no potential for overdose and has no known drug interactions.[8] and so can be used in combination with pharmacotherapy to reduce medication, medication-related side effects and medication costs. The greatest advantage of TENS is its ability to be used as an outpatient treatment .[12 16]TENS has a superior quality in reducing pain severity in a short period of time even with a low voltage setting.[2]It can be used effectively throughout all the stages of TMDs.[4]

**Contraindication:**

The absolute contraindication for TENS is patients with pacemaker or other implanted electrical devices. Usage of TENS is also contraindicated in apprehensive patients, epileptic patients, pregnant women's and patient with cardiovascular problem.[5]Skin irritation and contact dermatitis beneath the electrodes may occur[8]

**Review of studies:**

In his article Dr pal cited that TENS was efficient in reducing pain intensity but not pain unpleasantness. TENS also produced a significant additive effect over repetitive treatment sessions.[4]Several types of TENS, based on different combinations of frequency, pulse duration and intensity, exist. The precise mechanism of action and the relevance of combinations of stimulus parameters are still unclear and do need further study and evaluation [1]

Hina et al in her study stated that TENS is used as a main treatment modality for the management of MPDS along with counseling and jaw exercises[5] Grossman et al in his review article observed that TENS has improved mouth opening and decrease pain immediately after therapy. there has been significant decrease in electromyography levels for the group involving masseter muscle[1]

According to Rahman et al TENS has a superior quality in reducing pain severity in a short period of time even with a low voltage setting[2]

According to Bajjaragi et al they found encouraging results in their study. Active TENS therapy showed favorable results in pain management in TMD patient, especially in muscular or chronic pain and mouth opening,[7] In contrast various study recommended that in order to provide faster and longer lasting relief from pain, limited mouth opening and muscle tenderness the judicious combination of TENS therapy and conventional therapy can be given. This will provide the patients with beneficial effects of both the therapies.[3,13,]

TENS is a frequently applied therapy in chronic pain although evidence for effectiveness is inconclusive. If a proper study and evaluation is done, patients might be benefitted by this non-invasive safer device for alleviating pain.

**Conclusion:**

Pain reduction and masticatory muscles relaxation are the main goal in the treatment of TMDs.Tens offers a modest, safe and noninvasive technique, which has minimal or no side effects. Proper use and monitoring would help the patients suffering from chronic pain.It can be concluded that to achieve better response in patients, combination of conventional (medication, soft diet and hot fomentations,) and TENS therapy should be given which would provide patients the benefits of both the therapy. TENS is good alternative for poor tolerance to medications or poor gastrointestinal tolerance.

Superior results may be expected if TENS is applied to reduce the pain severity and then low doses analgesics are prescribed to eliminate mild to moderate types of pain.

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# SIALOLITHIASIS – A CASE REPORT

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## ABSTRACT

Sialolithiasis accounts for the most common cause of diseases of salivary glands. The majority of sialoliths occur in the submandibular gland or the Wharton's duct. This article discusses the review of the literature, predisposing factors, signs and symptoms, diagnostic methods and various modalities available for the management of sialolithiasis. This case report presents a case of sialolith in the left Wharton's duct, which was explored and removed via an intra-oral approach.

***Keywords:*** *Sialolithiasis, Wharton's duct, Transoral sialolithotomy*

## INTRODUCTION

Salivary duct lithiasis refers to the formation of calcareous concretions or sialoliths in the salivary duct causing obstruction of salivary flow resulting in salivary ectasia, sometimes even dilatation of the salivary gland.[1]Sialolithiasis is the most common (50%) disease of salivary glands.[5] It is estimated to have a frequency of 0.15% in the adult population with a slight male predilection. [3] Sialolithiasis usually appears between the age of 30 and 60 years, and it is uncommon in children. [4]

Salivary calculi are generally unilateral, clinically they are round or ovoid, rough or smooth with yellow in color. [5] Bilateral or multiple gland sialolithiasis is occurring in less than 3% of patients. [6] Sialolith consists of mainly calcium phosphate with smaller amounts of carbonates in the form of hydroxyapatite, with minor amounts of magnesium, potassium, and ammonia. This mix is distributed evenly throughout. Submandibular stones are 82% inorganic and 18% organic material whereas parotid stones are composed of 49% inorganic and 51% organic material.

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The organic material is composed of several carbohydrates and amino acids. There was no identification of bacterial elements at the core of a sialolith.[11] Sialoliths are always found in the distal portion of the duct or at the hilum of the submandibular gland with a few in parenchyma's. Commonly, sialolith measures from 1mm to 1cm. They rarely measure more than 1.5 cm. Giant sialoliths are rare.[3] About 40% of parotid and 20% of submandibular stones are not radio-opaque and sialography or other imaging techniques (computed tomography scan, ultrasound) may be required to locate them.[5] Generally, conservative techniques are recommended for small sialoliths, such as patient's hydration, application of internal and external heat, milking, massage of the gland with acid fruit (lemon), and removal of small stones close to the duct orifice through dilating with the aid of a catheter. More invasive techniques, such as surgical removal via intraoral access are indicated for greater salivary stones and/ or those located in the gland parenchyma, mainly when the stone is at the distal third of the gland, and it can be easily touched. The affected duct is exposed through an incision on the floor of the mouth. Thus, the stone is seen and removed. The duct is sutured to the oral mucosa, and left open for proper drainage. Also, tissue trans fixation or suture thread anchorage involving the duct to promote the obstruction prevents the sialolith displacement towards the gland.[9]

**CASE REPORT:**

A 43 years old male patient came to Department of Oral and Maxillofacial Surgery, Faculty of Dental Science, Dharmsinh Desai University with a chief complaint of pain and swelling in lower left back region since 3-4 days. (Illustration 1)

***Illustration 1: Facial Profile***

***Illustration 2: Intraoral View*** Before $1^{1}/_{2\text{-month}}$ patient had extraoral and intraoral swelling (Illustration 2) on the left side. The patient had difficulty in chewing, drinking, and speech at that time. He even had mild and intermittent pain which got aggravated while eating. Detailed medical histories, dental history, family history, history for allergy or habit history were noncontributory. On examination non-tender, about 2x2 cm round and hard swelling was

present at the left side of the face below the lower border of the mandible. Lymph nodes were non-palpable. Intraorally firm and tender swelling were seen at the floor of the mouth on the left side, mesial to the second premolar. Bleeding or discharge from the site was absent.

## INVESTIGATIONS:

Routine blood investigations, ECG and chest X-Ray were carried out and Mandibular Occlusal radiograph (Illustration
3) and USG of the left submandibular region (Illustration 4) was carried out.

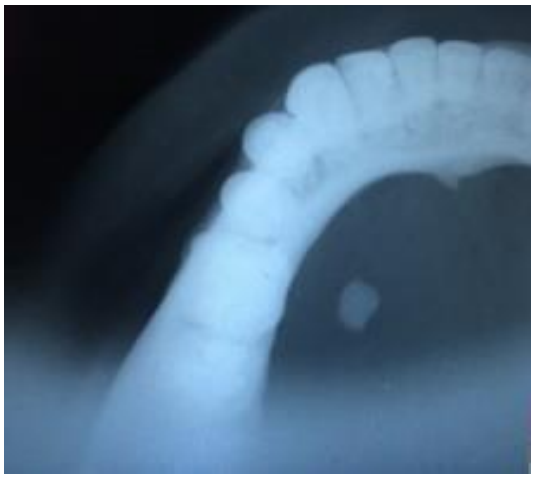

***Illustration 3: Mandibular Occlusal View***


***Illustration 4: USG of Left Submandibular Region***

Mandibular Occlusal radiograph shows well-defined radio opacity mesial to mandibular left first molar. USG report suggested slightly enlarge left submandibular gland with reduced echogenicity and a small hypoechoic focal lesion in the left submandibular gland.

## MANAGEMENT:

Approval for the management of the lesion was taken from the patient in form of written consent. Physician and anesthetic clearance were obtained. The patient was deemed fit for surgery which was performed under general anesthesia via the intra-oral approach. Injection glycopyrrolate or atropine was avoided during under general anesthesia via the intra-oral approach as it tended to dry up salivary secretions.

A deep stop suture was secured in the floor of mouth distal to the last palpable stone encircling the duct to avoid slippage of stones posteriorly. A small amount of local anesthesia was infiltrated for hemostasis. A tongue suture, at the tip, was taken to pull the tongue on contralateral side and make it firm. Incision of 2.5-3 cm was taken in the floor of the mouth on left side longitudinally to the submandibular duct which was followed by blunt dissection and tying of the duct at the second molar region. Sialolith was palpated between second premolar and first molar region medially towards the tongue. After palpation of the sialolith, an incision was taken and a 5mm sialolith was removed (Illustration 5). Stop suture was removed. Ductal lavage was done with saline and clear flow of saliva was observed. Reacannulation of the duct was done with a small diameter polyethylene tube. One end of the tube was directed towards substance of gland and another end was made to come out through the natural ductal opening. On milking the gland, salivary flow was confirmed and established by aspirating through the tube lumen with a hypodermic needle & syringe. The wound was closed primarily with 3-0 silk interrupted sutures and tongue tip suture was also removed finally. A ductal wall was left unsutured. Use of sialagogues like citrus fruits and candy were advocated. Post-operative healing was uneventful. Normal salivary flow was established after one weekend was easily visualized on external

pressure.


***Illustration 5: Sialolith***

## DISCUSSION:

Most sialoliths (80–90%) develop in the submandibular gland. 5–10% develop within the parotid gland and the remainder in the sublingual and minor salivary glands.[3] Several factors tend to favor submandibular gland stones: [6, 7, 13]

- Longer submandibular duct and larger duct caliber
- Tortuous course of Wharton's duct
- The dependent position of the gland, which leave them more prone to stasis.
- Saliva flows against gravity
- Slower salivary flow rate compared to the other ducts.
- The presence of more alkaline saliva
- Mainly mucous type of secretion
- Higher calcium and phosphate levels

The right and left glands and ducts are equally affected, although bilateral occurrence is rare. However, multiple sialoliths in the same duct or gland are common.[2] Marchal et al. reported the outcomes of analysis of 120 submandibular

glands and the sphincter were situated within the first 3mm of Wharton's duct. Another special structure is a basin-like structure within the submandibular gland, which expands into the region of hilus on sialo endoscopy. It is also called pelvis-like or coma area. It may slow down the flow of saliva and cause the sediment of inorganic substance to sink and induce the gradual formation of a sialolith if a nidus such as a mucus plug or a foreign body exists.[3,13] Submandibular gland sialoliths have been reported to be radiopaque in 80–94.7% of cases.[2] A study conducted by Sheman and McGurk indicated no link between water hardness and sialolithiasis or sialadenitis, suggesting that high calcium intake might not lead to sialolithiasis. Patients with gout and patients on diuretic therapy may be predisposed to sialolithiasis.[2] Gout is the only systemic disease which can cause calculi of uric acid composition 50% of parotid gland sialoliths and 20% of submandibular gland sialoliths which are poorly calcified.[7] Calcified concretions in salivary ducts or glands are formed by deposition of calcium salts around a central nidus, which may consist of desquamated epithelial cells, bacteria, foreign bodies or products of bacterial decomposition. The foreign bodies reported in association with sialolith formation include a toothbrush bristle, fingernail sliver, wood splinter, hair, the blade of grass, and a fish bone. Generally, sialoliths are thought to begin from retention of saliva in the salivary duct.[3] However, there are two main theories that attempt to explain the formation of salivary stones. The first theory postulates that a local inflammatory process results in calcification of a mucus plug. The second theory assumes that micro sialoliths, produced by autophagosomes in the salivary gland, form a nidus for calcium precipitation.[10] Latest studies with sialo endoscopy revealed more chances of saliva retention in the submandibular duct. The lining of the duct seen endoscopically is white and avascular, and the duct could itself cause partial obstruction. During sialo endoscopy, some special features were found in the lumen and wall of the duct by Yu et al. One special structure is a sphincter-like mechanism or muscle like structure. This has a valve-like function and can prevent the foreign body from entering the duct, which is located on the anterior side of the submandibular duct, which can be related to the formation of sialolith in the submandibular gland.[3] There are various radiological methods for diagnosis of submandibular sialolithiasis. The conventional methods for detecting obstructions in the salivary ductal system are occlusal films for the sialolith in the Wharton's duct, lateral oblique mandibular films or panoramic radiographs for sialoliths in the hilum or substance of the submandibular gland. In the early stages, sialoliths may be too small or insufficiently mineralized to be evident radiographically. Sialoliths in ducts appear as elongated or smooth cylindrical radiopaque structures, and round or oval when located within the gland. The reported incidence of radiolucent submandibular sialoliths is 20–43%. The other advanced imaging modalities also used include sialography, xeroradiography (especially for radiolucent sialoliths), ultrasonography, scintigraphy, and

computerized tomography and magnetic resonance imaging. The treatment depends on the number, size, and location of the sialolith, or whether it is present in the duct or the gland. There are various modalities of treatment employed. If the sialolith is small and single, conservative management may be attempted with local heat, massage, and sialagogues. Smaller sialoliths which are located sufficiently peripheral; near the orifice of the duct, are removed by manipulation or milking of the gland. This can be done with the aid of lacrimal probes and dilators for opening the duct. The sialoliths in the anterior part of the duct are treated under local anesthesia while in the posterior part of the duct are treated preferably under general anesthesia. Multiple sialoliths in the duct, or below the posterior edge of mylohyoid muscle, or at the hilum of the gland or within the gland, or if the gland has been damaged by recurrent infection and fibrosis, may require surgical removal, and those patients who do not respond to conservative therapy. It is performed preferably through an extraoral approach and under general anesthesia. There are two approaches to submandibular sialoliths that avoid the use of surgery. These are Extracorporeal Shortwave (ESW) lithotripsy, and Intracorporeal Endoscopic lithotripsy, or sialendoscopy or sialo endoscopy. ESW lithotripsy refers to a non-invasive method of application of shock waves from an externally applied lithotripter, which causes fragmentation of the sialoliths. These fragments then pass through the duct, as the saliva is stimulated and enhanced by the use of sialogogues; or are removed by normal salivary flow or rinsing with the aid of a catheter. The first report on the use of shock waves to fragment sialoliths was in 1986 by Mammary. In ESW lithotripsy, the average size of fragments produced was about 0.7 mm. Sialendoscopy or Sialo endoscopy is a minimally invasive technique, in which shock waves are delivered directly to the surface of the sialolith lodged within the duct without damaging the adjacent tissues. Micro endoscopes are introduced into the duct systems, to allow direct visualization and evaluation of the intraductal and intraglandular microanatomy.[2]

## CONCLUSION:

Sialolithiasis is not an uncommon disorder of the ducts and parenchyma of salivary glands. The correct diagnosis necessitates a careful history and use of correct imaging techniques to define the position and size of sialolith. Although several advanced diagnostic and treatment modalities have developed in the management of sialolith. The conventional modalities retain their popularity to date. This case report has illustrated a case of submandibular sialolith that was diagnosed clinically and radiographically and treated surgically with no postoperative complications.

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# EPULIS FISSURATUM OF MAXILLA: CONSEQUENCES OF ILL-FITTING PROSTHESIS: A CASE REPORT

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**ABSTRACT**

Epulis fissuratum, reactive fibrous hyperplasia/denture-induced fibrous hyperplasias are the various names attributed to reactive tissue response to chronic irritation and trauma caused by an ill-fitting prosthesis. Persistent trauma to oral mucosa may predispose the patient to carcinoma. Mucosal lesions related to the wearing of poorly adapted dentures are frequent. Chronic irritations with sharp or excessive edge lead to hyperplasic reaction. Epulis fissuratum represents 15% of benign tumour of the jaws, is a pseudo tumour growth located over the soft tissues of the vestibular sulcus. It has female predilection over males. Treatment indication for these lesions is surgical excision with appropriate prosthetic rehabilitation. We present a case of faulty denture and the resultant epulis fissuratum in a 62-year-old female patient.

***Keywords:*** *Epulis fissuratum, fibrous tissue, pre-cancerous, surgical excision, complete denture.*

## INTRODUCTION:

Denture-induced hyperplasia otherwise called epulis fissuratum is a hyperplastic condition of the oral mucosa caused by low-grade chronic trauma from ill-fitting dentures.[1] It is a reactive lesion of the oral mucosa to excessive mechanical pressure on the mucosa.[2]

Epulis fissuratum also known as Granuloma fissuratum is an oral pathologic condition thatappears in the mouth as an overgrowth of fibrous connective tissue. It is also known as inflammatory fibrous hyperplasia, denture epulis, and denture fibrous hyperplasia.

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One of the major reasons for epulis to form is the ill-fitting flanges of denture which constantly traumatize the tissues of vestibule. It may become very large and be composed of several layers. The size of the lesion varies from localized hyperplasia which is less than 1cm in size to larger lesions that involve most of the length of the vestibule, almost the entire length of tissue around a denture. It is more common in women and it can appear in either the mandible or maxilla but is more commonly found on the facial aspect of alveolar ridge.[3] When the cause (ill-fitting denture) is removed, a peculiar fissure bounded by hyperplastic soft tissue on both sides is seen. The chronic nature of the process means that discomfort and pain is often not a prominent feature and therefore the patient may continue to wear the offending denture until hyperplastic lesions of considerable size develops before the patient becomes aware of the lesion and need for treatment.[4] However, the lesion may be associated with discomfort and pain when ulceration occurs.[5,6] It occurs in 5-10% of the jaws with patients wearing complete dentures and more in maxilla.[2] Denture-induced hyperplasia can be treated in both the ways; conservatively or surgically depending on the size of the lesion.1

**CASE REPORT:**

A 62-year-old female patient visited Department of Oral and Maxillofacial Surgery, Faculty of Dental Science, Dharmsinh Desai University, Nadiad with a complain of swelling and mild pain since last 15-20 days. Patient had a history of small soft tissue mass in relation to the upper arch which has developed to the present size over a 12-month period. The patient has been wearing upper removable complete denture for 15 years. Pain was moderate and intermittent. The patient used to wear the denture during night at times. Patient had medical history of hypertension since last 7 years and was on medication for same. Intraoral examination revealed multiple hyperplastic tissue folds in the right maxillary buccal vestibule extending from the right lateral incisor region to the third molar area with maxillary denture flange fitting in between the tissue folds. (Illustration 1) Palatal mucosa was normal. The size of the lesion was 3x4cm approximately. Lesion was erythematous and tender on palpation. Texture of the lesion was smooth with soft consistency. Provisional diagnosis was made to be denture induced epulis fissuratum/hyperplasia.

**Illustration 1- Pre-Operative Picture**

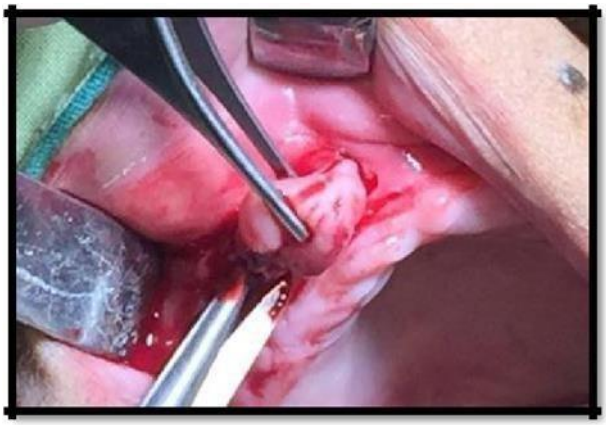

**Illustration 2-Lesion excision**

using tissue forceps and vestibule was retracted. Using a no. 15 surgical blade an outline for excision was made along the length of the lesion. (Illustration 2) Complete excision of the lesion was carried out. Haemostasis was achieved through pressure pack. The field was cleaned with betadine and saline solution. A primary closure was achieved using Mersilk suture material. (Illustration 3 and 4) Simple interrupted sutures were taken. Vestibule depth of maxilla was preserved. Postoperatively, antibiotics and analgesics were prescribed. The patient was instructed not to wear the denture. She was advised to rinse the mouth with chlorhexidine (0.2w/v) mouthwash. The excised specimen (Illustration 3) was sent for histolopathological examination. It revealed hyperplastic epithelium in most of the areas, and the underlying connective tissue was fibrous, with moderate inflammatory infiltrate consisting of predominantly lymphocytes. The patient was recalled for suture removal after a week.

**Illustration 3- Removal of lesion**

**Illustration 4- Closure Done**

**Illustration 5- Post-operative Picture**

The post-operative healing was satisfactory after follow-up of 1 month. The new denture was fabricated after 3 months. The patient is on regular follow-up for 6 months and there was no recurrence of the lesion till date. (Illustration 5)

**DISCUSSION:**

The term 'epulis' was coined by Virchoff, and its dictionary meaning is 'over the gums'. However, the affected mucosa is usually the oral mucosa of the vestibular sulcus or of the palatal region and not the gingival mucosa. Thus, another term, 'denture-induced fibrous hyperplasia' is considered to be a much-preferred term. Denture-induced fibrous hyperplasia is a reactive growth caused by chronic irritation from badly adapted prosthesis with variable hypertrophy and hyperplasia.[7] Trauma and irritation are the two main aetiological factors responsible for occurrence of epulis. Clinically, it presents as a raised sessile lesion in the form of folds with a smooth surface with normal or erythematous overlying mucosa. Because of chronic irritation, it may get traumatised and present with an ulcerated surface.[2,8] Firoozmand et al.[6] reported that 78% of females had denture-induced hyperplasia which is mostly seen in maxilla. The size of the lesion has a wide range from being as small as few millimeters to massive lesion involving the entire vestibule. It is asymptomatic in nature but sometimes severe inflammation and ulceration can occur. Denture-induced hyperplasia may be treated conservatively or surgically. In the early stages of fibrous

hyperplasia, when fibrosis is small in size of few millimeters, nonsurgical treatment with a denture in combination with a soft liner is frequently sufficient for reduction or elimination of this tissue. When the condition has been present for some time and significant fibrosis exists within the hyperplastic tissue, this will not respond to nonsurgical treatment. Excision of hyperplastic tissue is the treatment of choice in such cases. Since the lesion was large it was treated with surgical excision followed by fabrication of new denture.[1] Three techniques have been widely used successfully for the treatment of inflammatory fibrous hyperplasia. When the area to be excised is minimally enlarged, electrosurgical or laser techniques provide good results for tissue excision.[1] If the tissue is extensive, simple excision and reapproximation of the remaining tissue is preferred. Electrosurgical techniques in such cases may result in excessive vestibular scarring. The redundant areas of tissue are grasped with tissue forceps, a sharp incision is made at the base of the excessive fibrous tissue down to the periosteum, and the hyperplastic tissue is removed. The adjacent tissue is gently undermined and re-approximated using interrupted or continuous sutures.[9]

When areas of gross tissue redundancy are found, simple excision frequently results in total elimination of the vestibule. In such cases, excision of the epulae, with peripheral mucosal repositioning and secondary epithelialization, is preferable or secondary vestibuloplasty may be planned.[9] A surgical splint or denture lined with soft tissue conditioner is inserted. This conditioner is worn continuously for the first 5-7 days. Secondary epithelialization takes place and denture impressions can be made within 4 weeks/1month.[1] Laser excision of large epulis allows complete removal without excessive scarring or bleeding.[10] Most of the patients are not aware that dentures should be rectified on a regular basis because of the resorption of the alveolar bone, which is a continuous process, leading to unfitted denture that causes the growth of fibrous hyperplasia. It not only produces pain and discomfort but negatively affects the mastication, aesthetics and overall well-being of the patient. Chronic trauma to oral mucosa may predispose the patient to carcinoma. Bone loss and resorption are accelerated if dentures are worn for 24 hours including night. Wearing dentures at night times, when the salivary flow is naturally diminished leads to inflammatory reactions, which

predisposes to hyperplastic conditions.[11] Treatment includes immediate withdrawal of the ill-fitting prosthesis followed by topical application of anaesthetics with local analgesics.

**CONCLUSION:**

A case of successfully managed extensive denture-induced hyperplasia is presented. The need for regular maintenance visits and good denture hygiene habits is also highlighted. Patients with epulis fissuratum should be educated about the benign nature of the condition, treatment options, and importance of not to wear the dentures at night time.

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# PATTERNS OF RUGAE IN GENDER IDENTIFICATION

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**Abstract:**

Palatoscopy or palatal rugoscopy is the study of palatal rugae for person's identification.

**Aim:**

The aim of the present study is to assess the pattern of palatal rugae to identify gender using shape, length and number. Materials and methods: 30 casts of patients from age 10-60 years were made from type 3 plaster poured in alginate irreversible hydrocolloid impressions of maxillary arch. The palatal rugae was examined based on shape, length and number. The rugae were delineated using thin black marker pen. Results: Females had a greater number of rugae compared to males. The length of palatal rugae was more in males compared to females. The straight pattern was found most in both males and females while the circular pattern was found the least. Conclusion: This study has showed significant difference in distribution of rugae pattern among the genders, the uniqueness and stability of rugae makes it ideal forensic identification marker and hence palatal rugae can be used to identify gender.

## INTRODUCTION

Forensic odontology is a specialty in dentistry which occupies a primary niche within the total spectrum of methods applied to medico-legal identification. Forensic odontology can be defined as a branch of dentistry which deals with the appropriate handling and examination of dental evidence and with proper evaluation and presentation of dental findings in the interest of justice.1

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The basis of forensic odontology is establishing individual identity by identification of human remains. Positive identification methods and exclusionary methods aid in personal identification.[2] Widely used methods to identify are analysis of deoxyribonucleic acid, dactylogram, and comparing dental record ante and post mortem. When the body is burnt or decomposed these methods are not helpful.[2] At such instance palatine rugae come into place in establishing identity. According to glossary of prosthodontic terms, palatal rugae are defined as anatomical fold or wrinkle usually in pleural sense, irregular fibrous connective tissue ridges located in anterior two-third of palate.[3] They are also known as "plica palatinae" or "rugae palatinae".[4] Palatoscopy or rugoscopy is the name given to the study of palatal rugae in order to establish a person's identity.[4] Palatal rugae appear towards the third month of intrauterine life and its development and growth is controlled by epithelial-mesenchymal interactions. Due to stability uniqueness it has been considered as one of the relevant parameters for human identification in forensic science.

## AIM:

Aim is to assess the pattern of palatal rugae for gender identification using number, shape and length.

## MATERIALS AND METHODS:

This study consists of total number of 30 casts of patients from age 10-60 years. Casts were made from type 3 plaster poured in alginate irreversible hydrocolloid impressions of maxillary arch. The candidates were randomly selected and were free of congenital abnormalities, infectious diseases, lesion causing mucosal or bony changes in maxillary anterior region. Individuals with orthodontic treatment or history of palatal surgeries were excluded. The stone models were free of voids and discrepancies especially in anterior two third of palate.

## METHOD OF IDENTIFICATION:

The rugae in each half were highlighted using thin black marker pen under spot light. To reduce intra-observer variation each cast were analyzed twice.

The patterns of rugae were determined using THOMAS AND KOTZE CLASSIFICATION.[5] It is classified as straight, circular, curved, unification, and wavy. The length was determined by LYSELLL'S CLASSIFICATION.[6] It classifies rugae patterns into 3 categories primary (5mm or more), secondary (3-5mm), & fragmentary (2-3mm). Rugae smaller than 2mm were disregarded. The length of each rugae was measured using orthomax Vernier caliper in millimeters.

## Results:

The shape of rugae were recorded as straight, curved, circular, wavy and unification. Table 1 shows 93% wavy rugae pattern present in females and 80% in males. Table 2 shows circular pattern was absent in females and present in 13% males. Table 3 shows distribution of curved patterns where both males and females shared the same ratio by 93%. Table 4 shows 53% unification rugae pattern present in males and 17% in females. Table 5 shows straight patterns were

equal in both males and females. The length of rugae was measured with the help of Vernier calipers which was further categorized into primary, secondary and fragmentary. Table 6 shows 11 primary rugae are found in 27% males and 13% females which indicates that total number of primary rugae were more in males as compared to females. Table7 shows 6 secondary rugae are found in 21% of females and 8% males which indicates that total number of secondary rugae are more in females compared to males. Table 8 shows absence of fragmentary rugae in males and 100% presence in females. Table 9 shows the comparison of total number of rugae between males and females in which 15 rugae were found in 25% of females while male showed 20% of rugae which indicates that total number of rugae were more in females compared to males.

## Discussion:

Palatal rugae facilitate personal identification procedures with its uniqueness, postmortem resistance and constancy; therefore, it is an ideal forensic parameter.[7] In our study, stone models are used as ante-mortem record due to simplicity in analysis and minimum fabrication cost. Apart from Thomas and Kotze classification used for the study purpose, the other classification devices are Silver, Carrea, Lysell classification.[8,9] The present study investigated on difference in shape, number and length of rugae pattern in 15 males and 15 females. The rugae pattern was classified according to Thomas and Kotze for difference in shape and Lysell for difference in length of rugae pattern. In our study straight pattern was seen to be prevalent inboth the genders this result confirms with the study performed by Ibeachu et al[10] and contraindicates with the findings of a study conducted by Nayak et al[11], Kumar et al[12], Kapali et al[13] and Surekha et al[14] in which wavy and curved pattern were predominant. In our study the wavy pattern was higher in females than in males which was similar to study conducted by Harjeet Kaur et al.[15] In our study curved pattern was equally present in both males and females which was contradictory to study performed by Nayak et al.[11] In our study unifaction was higer in males compared to females which was similar to study performed by Rani S Thaba et al.[16] Circular pattern was least common in both the genders. In our study total number of rugae were more in females than males which is in association with the study performed by Dhoke and Osato who performed study among Japanese population.[17] Similar study was performed by Surekha et al. in which total numbers of rugae were more in males compared to females which was contradictory to our study.[13] According to present study length of rugae is higher among males compared to females these findings are contraindicated by the study performed by Selvamani et al. in which there was no significant difference in length of rugae among males and females.[18]

### Conclusion:

This study clearly shows that palatal rugae are unique to each individual and patterns of rugae with its different parameter can be used successfully as a tool of identification. The only limitation is that large scale studies are necessary. Besides that, research among different ethnic groups is essential for more comprehensive understanding of palatal rugae in forensic odontology.

**Table 1: Distribution of wavy rugae pattern**

| Gender | Absence | | Presence | | Total |
|---|---|---|---|---|---|
| | N | % | N | % | |
| Male | 3 | 20% | 12 | 80% | 15 |
| Female | 1 | 7% | 14 | 93% | 15 |
| Total | 4 | 87% | 28 | 13% | 30 |

**Table 2: Distribution of circular rugae pattern**

| Gender | Absence | | Presence | | Total |
|---|---|---|---|---|---|
| | N | % | N | % | |
| Male | 13 | 87% | 2 | 13% | 15 |
| Female | 15 | 100% | 0 | 0% | 15 |
| Total | 28 | 93% | 2 | 7% | 30 |

**Table 3: Distribution of curved rugae pattern**

| Gender | Absence | | Presence | | Total |
|---|---|---|---|---|---|
| | N | % | N | % | |
| Male | 1 | 7% | 14 | 93% | 15 |
| Female | 1 | 7% | 14 | 93% | 15 |
| Total | 2 | 7% | 28 | 93% | 30 |

**Table 4: Distribution of unification rugae pattern**

| Gender | Absence | | Presence | | Total |
|---|---|---|---|---|---|
| | N | % | N | % | |
| Male | 7 | 47% | 8 | 53% | 15 |
| Female | 11 | 73% | 4 | 27% | 15 |
| Total | 18 | 60% | 12 | 40% | 30 |

**Table 5- Distribution of straight rugae pattern**

| Gender | Absence | | Presence | | Total |
|---|---|---|---|---|---|
| | N | % | N | % | |
| Male | 0 | 0 | 15 | 100% | 15 |
| Female | 0 | 0 | 15 | 100% | 15 |
| Total | 0 | 0 | 30 | 100% | 30 |

**Table 6: Distribution of primary rugae pattern**

| Total no of primary rugae | Male | | Female | | Total | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| 5 | 1 | 7% | 1 | 7% | 2 | 7% |
| 6 | 0 | | 1 | 7% | 1 | 3% |
| 8 | 4 | 26% | 3 | 20% | 7 | 24% |
| 9 | 2 | 13% | 5 | 33% | 7 | 23% |
| 10 | 2 | 13% | 2 | 13% | 4 | 13% |
| 11 | 4 | 27% | 2 | 13% | 6 | 20% |
| 12 | 1 | 7% | 0 | | 1 | 3% |
| 13 | 1 | 7% | 1 | 7% | 2 | 7% |
| Total | 15 | 100% | 15 | 100% | 30 | 100% |

**Table 7: Distribution of secondary rugae pattern**

| Total no of secondary rugae | Male | | Female | | Total | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| 1 | 1 | 8% | 2 | 15% | 4 | 15% |
| 2 | 4 | 33% | 1 | 8% | 5 | 19% |
| 3 | 1 | 8% | 2 | 15% | 3 | 12% |
| 4 | 3 | 25% | 3 | 21% | 6 | 23% |
| 5 | 1 | 8% | 2 | 14% | 3 | 12% |
| 6 | 1 | 8% | 3 | 21% | 4 | 15% |
| 7 | 1 | 8% | 0 | | 1 | 4% |
| Total | 12 | 100% | 13 | 100% | 26 | 100% |

**Table 8: Distribution of fragmentary rugae pattern**

| Total no of fragmentary rugae | Male | | Female | | Total | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| 1 | 0 | 0 | 5 | 63% | 5 | 63% |
| 3 | 0 | 0 | 3 | 37% | 3 | 37% |
| Total | 0 | 0 | 8 | 100% | 8 | 100% |

**Table 9: Comparison of total number of rugae pattern between males and females**

| Total no of rugae | Male | | Female | | Total | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| 7 | | | 1 | 7% | 1 | 3% |
| 9 | 1 | 7% | 2 | 13% | 3 | 10% |
| 10 | 4 | 25% | 1 | 7% | 5 | 17% |
| 11 | 3 | 20% | | | 3 | 10% |
| 12 | 1 | 7% | 1 | 7% | 2 | 7% |
| 13 | | | 3 | 20% | 3 | 10% |
| 14 | 1 | 7% | 2 | 13% | 3 | 10% |
| 15 | 3 | 20% | 4 | 26% | 7 | 23% |
| 16 | 1 | 7% | | | 1 | 3% |
| 17 | 1 | 7% | | | 1 | 3% |
| 18 | | | 1 | 7% | 1 | 3% |
| Total | 15 | 100% | 15 | 100% | 30 | 100% |

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# Orthodontic space closure in carious 1st molar extraction case- a preferred treatment option in young patients

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**ABSTRACT**

Orthodontic treatments involving missing or compromised first permanent molars are often challenging cases to treat considering the loss of potential anchor tooth. The case presents orthodontic treatment in a patient with mutilated dentition & carious first permanent molar. The treatment goals were to be accomplished by extraction of compromised tooth and retention of healthy dentition. The diagnosis and problem list needed extractions to accomplish the treatment goals. The possibility of extracting compromised first permanent molars instead of other healthy teeth was considered. Fixed appliances were used with simple mechanics without any additional anchorage devices. Case-based retention protocols were followed. The patient achieved the predetermined treatment objectives of improved esthetics and healthy and stable functional occlusion. This kind of treatment approach in young patients has triple advantage- avoidance of an artificial prosthesis at a young age, preserving healthy dentition as against a carious tooth and allowing more room for the eruption of third molar.

***Keywords:*** *Space closure, Prosthetic replacement, Asymmetric extractions, Mutilated, Molar extractions, Friction mechanics.*

## INTRODUCTION

Due to increased intake of processed, soft & sugary[1] diet in the young population, incidence of caries has increased. The 6-year molars are the early permanent teeth to erupt and they have high prevalence of caries. If unattended, this may lead to eventual loss of the tooth & consequent prosthetic replacement of the natural tooth. After the loss of tooth, if lot of time is elapsed, it may lead to supra-eruption of antagonist & tipping of adjacent teeth into edentulous area. Prosthetic replacement of this mutilated condition is one treatment alternative; & orthodontic ally correcting supraeruption, tipping of teeth & closing the space without any artificial teeth is another treatment alternative.

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Case report is presented in this article in which patient reported to the clinic with carious mandibular left first molar. Detailed intraoral examination revealed the presence of severe imbrication, deep bite, proclination of maxillary teeth, & supraeruption of maxillary left 1st molar. Special attention and precautions were taken as it became an asymmetric extraction[2,3,4] case involving one molar & three premolar extractions. Orthodontic space closure using simple mechanics[5,6,7] & no skeletal anchorage[8,9] was used to treat the case.

**Case Report:**

*Diagnosis & Problem list*

A 14 year, 3 months old boy reported with chief complain of crowding & protruded teeth. He also had a complain of occasional pain in relation to mandibular left posterior region & now is having difficulty in chewing on left side. He had a convex profile with incompetent lips. Lower lip was thick & everted with deep mentolabial sulcus (Illustration 1). The mandibular arch exhibited severe crowding in anterior region with Class II molars & canine relationships; 6mm of overjet & 5mm of overbite was present. Due to enormous amount of loss of the crown structure in 36, supraeruption of 26 was observed. 35 was in lingual crossbite. Orthopentamogram(OPG) showed full complement of teeth

**Illustration 1**

Pretreatment extraoral & Intraoral photographs.

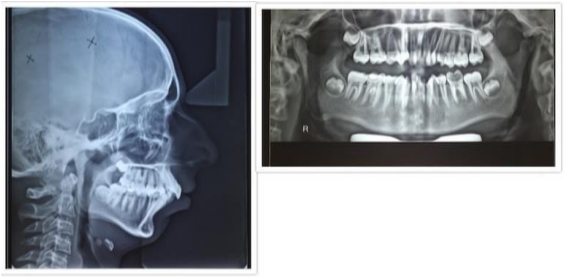

**Illustration 2**

Pretreatment Lateral cephalogram & OPG xrays. including all developing 3rd molars also; 37 had erupted partially. Cephalometric evaluation showed a Class II skeletal base, average growth pattern, & proclined maxillary & mandibular incisors (Illustration 2).

## Treatment objectives:

**1.** Alignment of upper & lower teeth

**2.** Correct overbite & overjet relationship

**3.** Retraction of anterior teeth to improve facial profile
**4.** Camouflage the existing skeletal deformity
**5.** Improve smile esthetics & functional occlusion
**6.** Proper retention plan
**7.** Alignment of upper & lower teeth
**8.** Correct overbite & overjet relationship
**9.** Retraction of anterior teeth to improve facial profile
**10.** Camouflage the existing skeletal deformity
**11.** Improve smile esthetics & functional occlusion
**12.** Proper retention plan.

## Treatment alternatives:

**1.** Conventional orthodontic treatment plan of Extraction of four first premolars, one in each quadrant. However, this plan would mean extraction of healthy teeth and retention of first molars on the mandibular left side which is badly carious and would need elaborate endodontic treatment & prosthetic crowns.

**2.** Extraction of 14, 24, 36 & 44. This plan inherently implies the closure of space of extracted 36; this would mean no artificial prosthesis at a young age & also increase the chance of eruption of 38. Henceforth, patient opted for this treatment alternative

**Illustration 3**

Finishing & detailing stage (Stage-3) extraoral & intraoral photographs.

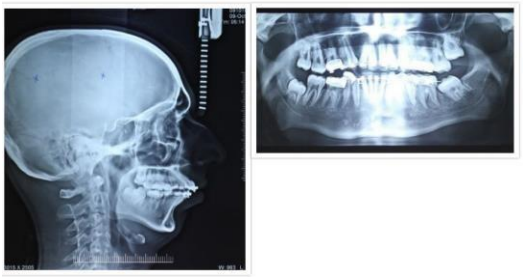

**Illustration 4**

Finishing & detailing stage Lateral cephalogram & OPG x-rays. mandibular molar being bodily moved into the occlusion. Lateral cephalogram (Illustration 4) also shows reduced proclination of maxillary & mandibular anterior teeth.

**Discussion:**

Orthodontic treatment with extraction of molars is technically more complex due to number of factors. The space to be closed is greater than premolar spaces but relief of incisor crowding that can be

achieved is less[10] as evident from Table-1; also, amount of incisor retraction that can be achieved is much less rendering it to be a critical anchorage case (Table-1). The decision of asymmetric extraction of molars on one side versus premolars on the other was taken in the above case as this molar was broken down because of caries & had poor prognosis. Extraction of a compromised tooth than a healthy tooth was aimed considering the longevity of dentition. The presence of healthy third molars with normal anatomy will compliment first molar extractions to provide an occlusal table sufficient for function[11]. The ideal alveolar dimensions to succeed in closing first molar space is 6 mm or less in the mesio-distal direction and 7 mm in the bucco-lingual direction[12]. A longstanding extraction space makes space closure difficult due to multiple reasons viz. narrowing of alveolar ridge bucco-lingually, supra-eruption of antagonist tooth & change in axial inclination of teeth mesial & distal to the edentulous space. Hence, one can resort to the temporary anchorage devices to assist the tooth movements planned in cases with longstanding extraction spaces which is commonly seen in adults. A split- crest technique for narrow ridge expansion can also be done as for implant placement[13,14]. Retention in first molar extraction case should include a bonded wire on buccal surface of second premolar and molar to avoid opening of extraction spaces in first molar region. This bonded wire is kept at least till the third molars erupt or even after.

**Conclusion:**

Orthodontic space closure treatment in patients with extracted or compromised first molars can be done with simple mechanics to obtain good clinical results if the patient is young. This should be a preferred approach as it has an advantage of extracting carious teeth & hence avoiding lengthy, elaborate restorative treatment along with a prosthesis in a young patient.

**Declaration of patient consent:**

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient's guardian has given her consent for his images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

**Conflicts of interest:**

There are no conflicts of interest.

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**Table-1**

| SPACE FROM VARIOUS EXTRACTIONS | | | | | |
|---|---|---|---|---|---|
| | RELIEF OF INCISOR | INCISOR RETRACTION | | POSTERIOR FORWARD | |
| EXTRACTION | CROWDING | MAXIMUM | MINIMUM | MAXIMUM | MINIMUM |
| Central Incisor | 5 | 3 | 2 | 1 | 0 |
| Lateral Incisor | 5 | 3 | 2 | 1 | 0 |
| Canine | 6 | 5 | 3 | 2 | 0 |
| First Premolar | 5 | 5 | 2 | 5 | 2 |
| Second Premolar | 3 | 3 | 0 | 6 | 4 |
| First Molar | 3 | 2 | 0 | 8 | 6 |
| Second Molar | 2 | 1 | 0 | - | - |

Values in millimeters

With typical anchorage management (not skeletal anchorage)

# Association between diabetes mellitus and risk of peri-implant diseases

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****Dr. Hiral Purani

## Abstract:

Dental implant surgery has developed to a widely used procedure for dental rehabilitation and is a secure and predictable procedure. But some local and systemic risk factors can result in higher failure rates and affect implant survival. Diabetes mellitus is a chronic disease that goes in with hyperglycemia and causes multifarious side effects. India leads the world today with largest number of diabetic patients in any given country. Along with all other complications diabetes also affect the peri-implant tissue. Peri-implant diseases, namely peri-implant mucositis and peri-implantitis, have been extensively studied in present era. However, little is known about the association between diabetes and peri-implant diseases. Present review narrates role of diabetes as a risk factor in developing peri-implant diseases, which may lead to implant failure in future.

***Key words:*** *diabetes mellitus, peri-implant mucositis, peri-implantitis.*

## Introduction:

Over the past few decades, oral osseointegrated implants have been widely accepted as an effective treatment for missing teeth.1

Under care and attention of indications, anatomical and intra-individual limiting factors, insertion of dental implants seems to represent a “safe” treatment option.

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Nevertheless, despite the high success and survival rates of dental implants, there are several risk factors and complications that could lead to their ultimate failure, such as local and implant related factors like poor oral hygiene, history of periodontitis, implant design (length and implant surface), lack of keratinized gingiva and smoking status.[2-4] Moreover, numerous conditions including general systemic diseases (diabetes, osteoporosis, immunosuppression and coronary heart disease) are also considered to affect the treatment outcome for patients with dental implants.[5] Implant loss may occur as "early implant loss" up to one year after implant insertion and "delayed implant loss" with a time period of more than one year after implant insertion. Diabetes mellitus is a chronic disease that goes in with hyperglycemia and causes multifarious side effects. Till date diabetes as a relative contraindication for implant surgery is controversially discussed. Because the number of patients suffering from diabetes increases, there are more diabetic patients demanding implant procedures. One fourth of total diabetic population of world is in India, and incidence increasing at an alarming rate.[6] Along with five major complications of diabetes retinopathy, nephropathy, neuropathy, macro vascular disease & altered wound healing American Diabetes Association (ADA) has officially recognized periodontitis as the "Sixth complication of diabetes" and established a direct link between diabetes and periodontitis.[7] Present review, provides the information about susceptibility of peri-implant diseases and thereby explains peri-implant tissue response to plaque in diabetics.

**Diabetes and peri-implant diseases:**

Peri-implant diseases include peri-implant mucositis and peri-implantitis. Peri-implant mucositis has been described as a disease in which the presence of inflammation is confined to the soft tissues surrounding a dental implant with no signs of loss of supporting bone following initial bone remodelling during healing. Peri-implantitis has been characterized by an inflammatory process around an implant, which includes both soft tissue inflammation and progressive loss of supporting bone beyond biological bone remodeling[8]

(Illustration-1). The description of the inflammatory process of periimplant mucositis around an implant is quite similar to gingivitis around natural teeth.

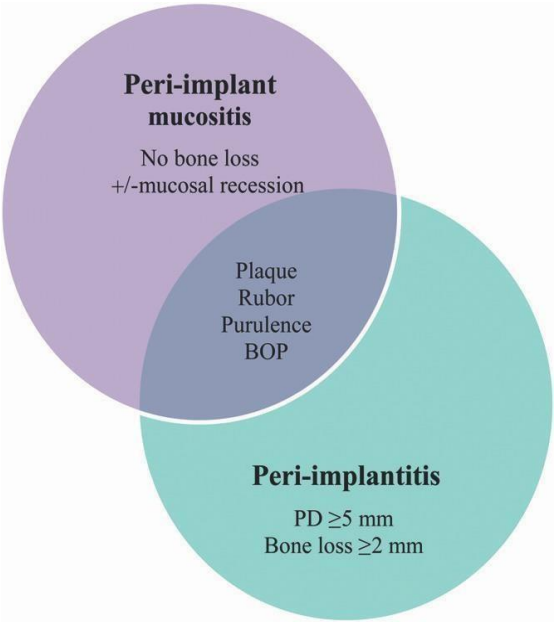


Illustration: 1, Diagnostic criteria of peri-implant diseases

Plaque – bacterial biofilm induced peri-implantitis has been implicated as one etiological factor associated with long term failure of endosseous implants. In contrast to mucositis, peri-implantitis is a progressive and irreversible disease of implant-surrounding hard and soft tissues and is accompanied with bone resorption, decreased osseointegration, increased pocket formation and purulence. It has been suggested that plaque represents an initiator of pathologic events similar to those seen in gingival/ periodontal disease with soft tissue inflammation and crestal bone loss. In a review of the literature, ***Meffert*** stated that endotoxin producing pathogens will initiate the same inflammation cascade leading to both implant or tooth sites if left untreated.[9] Crestal bone damage resulting from peri-implant soft tissue inflammation could progressively affect the bone implant interface and ultimately leads to integration failure. Depending on the configuration of the bony defect,

Schwarz et al. distinguished between an intraosseous class I defect and a supra-alveolar class II defect in the

crestal implant insertion area. Spiekermann characterized the type of bone resorption into horizontal (class I), key-shaped (class II), funnel- and gap-like (class III a, b) as well as horizontal-circular (class IV) forms. However, it is not possible to conclude progression and prognosis criteria from these classifications. In retrospective review of data accumulated through the United states department of Veteran affairs, Dental implant registry, peri-implant soft tissue complications were associated with a significantly increased risk for implant failure.[9-11, 17]

There are some human studies which suggest effect of diabetes or glycemic control on osseointegration of implants, but very few human trials give information about soft tissue seal around implants. Shortly after implants are placed, glycoproteins from saliva adhere to exposed titanium surfaces with concomitant microbiological colonization.[12,13] The formation of a biofilm plays a significant role in the initiation and progression of peri-implant diseases and is essential for the development of infections around dental implants.[14] Soft tissue maintenance, in turn, was associated with a number of variables that included oral hygiene levels. Thus, elimination of the biofilm from the implant surface is the prime objective when treating peri-implant mucositis. Peri-implantitis, like periodontitis, occurs primarily as a result of an overwhelming bacterial insult and subsequent host immune response. Diabetes can disrupt collagen homeostasis in the extracellular matrix of periodontal tissue, associated with neutrophil dysfunction and imbalance of immune system, which may lead to progression of peri-implant mucositis to peri-implantitis. The meta-analysis revealed a significant relationship between peri-implantitis and diabetes (OR, 1.89; 95% CI, 1.31-2.46) with no evidence of heterogeneity (P=0.872; I2=0%). Publication bias measured using Egger (P=0.69) and Begg's test (P=1.00) shows no evidence for diabetes bias in peri-implantitis. A significant relationship between diabetes and peri-implantitis was revealed in this meta-analysis.[15] According to one another meta-analyses, the risk of peri-implantitis was about 50% higher in diabetes than in non-diabetes (RR = 1.46; 95% CI: 1.21–1.77 and OR = 1.89; 95% CI: 1.31–2.46; $z = 5.98$; $p < .001$). Importantly, among non-smokers, those with hyperglycaemia had 3.39-fold higher risk for peri-implantitis compared with normoglycaemia (95% CI: 1.06–10.81). Conversely, the association between diabetes and peri-implant mucositis was not statistically significant (RR = 0.92; 95% CI: 0.72–1.16 and OR = 1.06; 95% CI: 0.84–127 ; $z = 1.06$, $p = .29$). This systematic review suggests that diabetes mellitus/hyperglycaemia is associated with greater risk of peri-implantitis, independently of smoking, but not with peri-implant mucositis.[16] According to one systematic review, which had included 22 clinical studies and 20 publications of aggregated literature, conclude that patients with poorly controlled diabetes suffer from impaired Osseo integration, elevated

risk of peri-implantitis, and higher level of implant failure. When diabetes is under well control, implant procedures are safe and predictable with a complication rate similar to that of healthy patients. The patients stratified by HbA1c levels as, well-controlled (HbA1c 6.1–8 %), moderately controlled (HbA1c 8.1– 10 %), and poorly controlled (HbA1c ≥10 %). The healthy control had HbA1c ≤6 %. So that, early diagnosis and treatment by regular oral hygiene maintenance visits are utmost important for diabetic patients, which can prevent the implant failure.

**Diabetes with periodontitis – increased risk of peri-implantitis:**

Zitzmann et al. quantified the incidence of the development of peri-implantitis in patients with a history of periodontitis almost six times higher than in patients with no history of periodontal inflammation.[17] Based on an established model of pathogenesis, the bacterial biofilm alone is insufficient to explain periodontal disease initiation and progression. Evidence suggests that periodontal tissues destruction is mainly due to the host's inflammatory response to the bacterial challenge. In addition to other factors, diabetes mellitus has been shown to modify the host response to the bacterial challenge and may increase the risk for periodontal disease. A number of epidemiologic studies have reported that the prevalence, severity and extent of periodontal disease are higher in patient with diabetes mellitus (DM) than in non-diabetic controls.[18-22] The association between diabetes mellitus and periodontitis has long been discussed with conflicting conclusions. Accumulation of AGEs (Advance Glycated End Products) in alter collagen metabolism, the collagen become less soluble and less likely to be normally repaired and replaced. (i.e. less resistant to destruction by periodontal infections). AGE-modified collagen accumulates in the walls of larger blood vessels, resulting in to thickening the vessel wall and narrowing the lumen. In addition, AGE-modified vascular collagen has an affinity for low-density lipoprotein (LDL) and causes the accumulation of LDL in the vessel wall, contributing to atherosclerotic changes characteristic of macrovascular complications of diabetes. The basement membranes of endothelial cells also accumulate AGE-modified collagen macromolecules, which can result in increased basement membrane thickness in the microvasculature, altering normal homeostatic transport across the membrane. This increased basement membrane

thickness is seen in the blood vessels of the periodontium in people with diabetes. Upregulation of proinflammatory cytokines from monocytes/ polymorphonuclear leukocytes and down regulation of growth factors from macrophages also present in diabetics.[23-27] The alterations in periodontal connective tissue carbohydrate metabolism uncouple the restorative and formative responses, and responsible for attachment loss. Degradation of collagen fibers commonly seen in diabetics by MMPs (MMP-8 & 9), which are elevated in diabetic tissues, including the periodontium. Impaired osseous healing and bone turnover are in association with hyperglycemia.[25,26] In subjects with diabetes, chronically elevated blood glucose levels lead to the accelerated formation of advanced glycation end products (AGEs). Endothelial cells and monocytes possess specific receptors for AGEs (i.e. RAGEs) located on their cell surfaces. There is strong indication that the interaction of AGEs with their receptors plays an important role in the development of diabetic complications. The interaction of macrophages with AGEs has been shown to stimulate increased secretions of pro-inflammatory mediators such as tumour necrosis factor a (TNF-α) and interleukin-1 (IL-1). In subjects with type 2 diabetes, deterioration of periodontal status was associated with elevated serum levels of AGEs.[28] An analysis of the National Health and Nutrition Examination Survey (NHANES) III data set confirms the previously reported significantly higher prevalence of periodontitis in diabetics than in non- diabetics (17.3% versus 9%). The analysis of the data also shows that the prevalence of diabetics in patients with periodontitis is double that seen in the non-periodontitis patients (12.5% versus 6.3%) and that, this difference is also statistically significant. Both of these diseases have a relatively high incidence in the general population (diabetes 1% to 6% and periodontitis 14%) as well as a number of common pathways in their pathogenesis (both diseases are polygenic disorders with some degree of immunoregulatory dysfunction). Endotoxin producing pathogens will initiate the same inflammation cascade leading to both implant or tooth sites if left untreated. Presence of diabetes in the patients with chronic periodontitis may also increase risk of peri-implantitis.[29] It is suggestive of the fact that diabetic patients with periodontitis form a specific group of patients, which are not prefeferable candidates for implant syrgey and have higher risk of developing

peri-implantitis in future. Crestal bone damage resulting from peri-implant tissue inflammation could progressively affect the bone implant interface and ultimately leads to integration failure. But the risk of peri-implant mucositis can be decreased with proper oral hygiene maintenance in the such group of patients.

**Conclusion:**

Peri-implant inflammations represent serious diseases after dental implant treatment, which affect both the surrounding hard and soft tissue. And evidences suggest that, in patients with diabetes mellitus, the tissue repair ability and defensive mechanisms against the insult of dental plaque are impaired which may increase the risk of peri-implantitis independently of smoking, but not of peri-implant mucositis. The survival rate of implants in diabetics does not differ from the survival rate in healthy patients within the first 6 years, but in the long-term observation up to 20 years, a reduced implant survival can be found in diabetic patients. Patients
with poorly controlled diabetes seem to have delayed osseointegration following implantation. Additional prospective cohort studies are needed to clarify the implant survival rate in patients with diabetes and to measure risk of peri-implantitis, in context of type and duration of diabetes, glycemic control, role of antimicrobial rinses and systemic antibiotics. Specific continuous check-ups with evaluation and elimination of risk factors (e.g. smoking, systemic diseases and periodontitis) are effective precautions for the high success rate of implant therapy. To that end, routine monitoring of soft tissue around dental implants as a part of a comprehensive periodontal evaluation and maintenance is essential in patients with diabetes.

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# AMNIOTIC-CHORIONIC MEMBRANE: HYPE OR HOPE

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## Abstract:

Periodontitis is a serious concern for clinicians. Several methods have been used for achieving periodontal regeneration. Regenerative technique can be subdivided into two major types: non bone graft associated, bone graft associated and combination of both. The placental membrane used as a non-bone graft associated regenerative technique; possesses numerous growth factors, proteins and stem cell reserves that accelerates wound healing and regeneration. This review article unfolds placental membrane's potential for regeneration specially in the field of periodontal surgeries.

***Keywords:*** *Regeneration, fetal membrane, stem cell reserves.*

## INTRODUCTION

Regenerative medicinal therapy has emerged as a powerful tool to generate biological substitutes and repair damaged tissues, by either transplanting exogenous or stimulating endogenous stem cells with highly proliferative and differentiative capacity to restore proper function and provide better aesthetics.1

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Three different methodological approaches for regeneration can be distinguished: (1) Cell-based therapy, (2) The use of biomaterials or acellular scaffolds, and (3) Cell-seeded scaffolds.[2] The cells can be from autologous, allogenic (same species, different individual), or heterologous (different species) origin.[2,3] Mesenchymal stem cells (MSC) are one of the major cell populations, to mediate regeneration due to their multipotential properties.[4] They can be obtained from various tissues such as bone marrow, periosteum, peripheral blood, adipose tissues and skin. MSC obtained from these tissues have a few limitations, relatively invasive procedure and poor quality of cells if taken from elderly or medically compromised patients[5]. Therefore, newer developments in tissue engineering are focused on alternate sources of MSC. The human placenta is a rich source of stem cells that are capable of differentiating into three forms of germ layers. The fetal portion of the placenta is made up of the placental disk, the amniotic and chorionic membranes. The innermost of the two human fetal membranes is the amnion and it is in contact with the contents of the amniotic sac, namely the amniotic fluid, the fetus and the umbilical cord. The chorionic membrane, which is attached to the outer surface of the amniotic membrane, separates the amnion from the decidua and the maternal uterus. Current research in the field of regenerative medicine and tissue engineering has suggested the potential role of human amniotic and chorionic mesenchymal stromal cells (hAMSC) in mediating each phase of the wound healing.[6](Illustration:1) Advantages of hAMSC over autogenously derived stem cells are: no morbidity in its procurement procedures, unlimited amount available[7] and isolation of hAMSC does not sacrifice the embryo, as in the case of embryonic stem cells, thus no legal or ethical issues arise.[8] Based on these factors amniotic membrane (AM), can be preserved and used as a source of stem cells in various tissue regenerative modalities.[1]

**History:**

The use of placental tissue in treating the wound started more than 100 years ago when Davis in 1910 first used these fetal membranes as skin substitutes for treating open wounds.[9] Sabella and Stern in 1913 described its use for burnt and ulcerated skin surfaces.[10] In 1940, De Röth first reported use of fetal membranes in the ocular surface[11]. He

used a biological dressing material made of fresh amnion and chorion for management of conjunctival defects. The use of these membranes was very limited. Kim and Tseng in 1995 gave the preservation method for maximal maintenance of biologic properties of membranes.[12] In 1965, Dino et al demonstrated for the first time that amniotic membrane could be separated, sterilized and

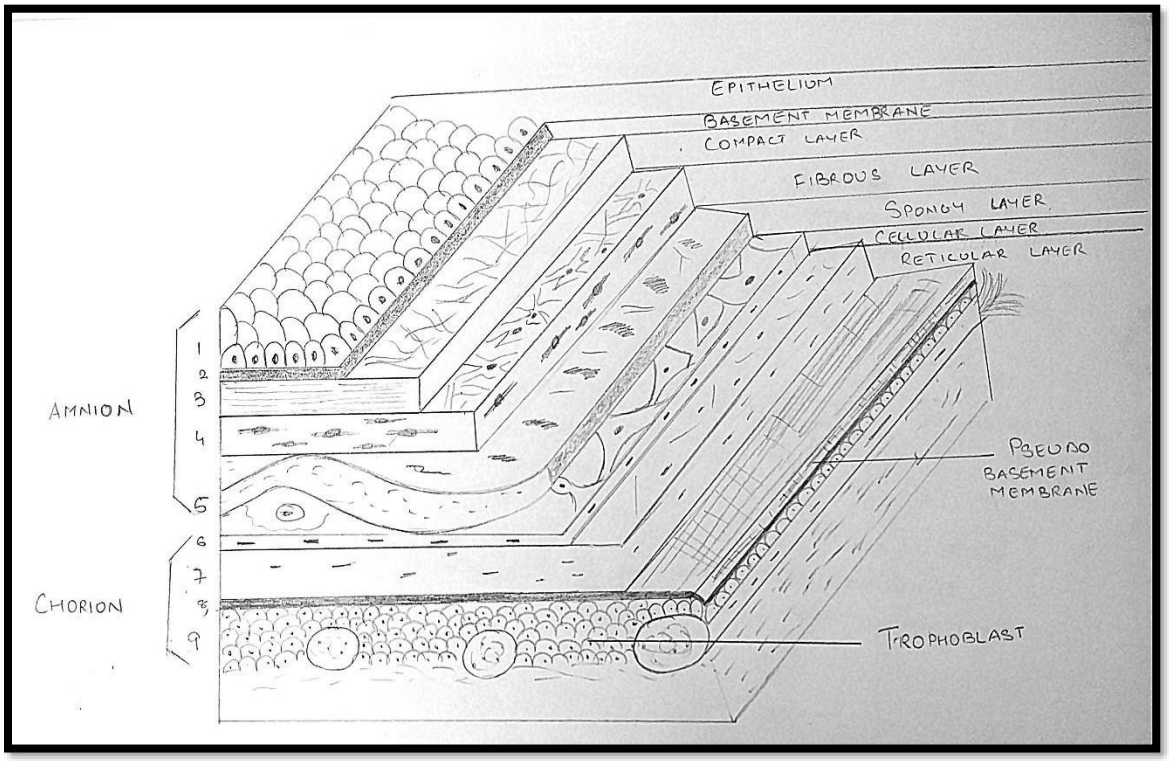


**Illustration :1** Composite diagram to illustrate the appearances of the layers of reflected amnion and chorion when examined by both membrane preparations and routine cut sections.

safely used at a later date.[13] The utilization of amniotic membrane waned in the early 1980's because of increase in the communicable diseases such as H.I.V./A.I.D.S., Hepatitis, etc. Amnion re-appeared in the cryopreserved form for the treatment of ophthalmic wounds in the late 1990's and early 2000's. Lawson in 1985 was the first who studied the use of amniotic membrane along with pectoralis major muscle for oral cavity reconstruction.[14] He concluded that placement of amnion over the deep aspect of the muscle that is exposed to the oral cavity resulted in a more rapid development of mucosa. Amniotic

membrane (AM) is now used successfully in the treatment of burns; creation of biologic surgical dressing; reconstruction of the oral cavity, bladder, and vagina; tympanoplasty; arthroplasty; abdominal surgery; and corneal transplantation. It has also been introduced in dentistryas a suitable membrane for vestibuloplasty. Currently it is also used in regenerative procedures in periodontics. [15]

**Preparation:**

Fresh membrane is obtained from the placenta at the time of delivery, either vaginal or caesarian section. The membrane is rinsed in a 0.025% solution of sodium hypochlorite and stored at 4°C in sterile solution containing penicillin. Robson and Krizekl showed that membranes remained sterile up to 6 weeks. Dinno *et al*. performed cultures to study the sterilization of amniotic membranes. Preservation with 1:40 dilution of sodium hypochlorite revealed no positive cultures until 30 days.[16]

**Processing:**

For clinical use, amniotic membrane can be prepared in the following forms-[17]

- Frozen membrane
- Freeze dried irradiated membrane
- Fresh membrane
- Stabilized amniotic membrane
- Cryopreserved membrane.

**Frozen membrane:**

Amniotic membrane is frozen by making it pass through liquid nitrogen at -196°F. Cooling preserves the membrane for an indefinite time, produces bacteriologically pure and immunologically almost inert material. Cryopreservation with dimethyl sulphoxide (DMSO) at -80°C allows retention cells in the AM at approximately 50% for several months. The several angiogenic growth factors and cytokines are removed during cryopreservation of the AM. However, if the AM is cryopreserved in 50% glycerol, the viability of Amniotic Epithelial Cells (AECs) is lost. It has been noted that storage of the AM in glycerol at 4°C results in immediate cell death.[18]

**Freeze dried irradiated (lyophilized):**

In this process, after obtaining membrane from placenta, it is freeze dried at -60°C under vacuum (atmospheric pressure 102) for 48 hours. It is then irradiated with 25 mega rads (25 K Gray) in a batch type cobalt-60 irradiator. By the method of freeze drying there is sublimation of liquid moisture of membrane to gaseous state without having undergone the intermediate solid stage. This

method helps the membrane to maintain its original size and shape with minimum cell rupture. The freeze-dried membrane can be readied for use by soaking it in normal saline for 1 minute.[18]

**Fresh membrane:**

The placenta was retrieved intact and processed under sterile conditions. The chorioamnion was stripped from the placenta and, following antibiotic decontamination, the amniotic membrane was separated from the chorion, cut into 2 cm squares and mounted on nitrocellulose backing paper. The grafts were then stored individually in sterile CPTES (Corneal Potassium TES) solution containing 2.5% chondroitin sulphate (CS) at +4°C.[19]

**Stabilized Amniotic Membrane:**

In this process, preservation and storage include spreading of AM on a plastic sheet and allowing it to dry, passing through liquid nitrogen at -19°F, keeping at -60°C under vacuum for 48 hours, then irradiated with 2.5 mega-rads and gluteraldehyde fixation.[20]

**Cryopreserved Membrane:**

To prepare cryopreserved AM tissues, donated full-term human placentas with the umbilical cord were recovered after cesarean-section delivery in compliance with American Association of Tissue Banks (AATB) standards and immediately stored at -80°C for up to one year. Prior to processing, the frozen placenta was thawed at room temperature for 8 hours in a Good Manufacturing Practice (GMP) facility before being placed at 8°C for an additional 16 hours. AM was affixed on a filter membrane and cut to 6 x 6cm. The AM tissue was finally packaged in a pouch containing 1:1 v/v Dulbecco Modified Eagle Medium (DMEM) and glycerol before storage at -80°C for up to two years.[21]

**Preservation:**

Glycerol has been used as a cryoprotective agent for a long time. Because of its high osmotic pressure, it extracts interstitial water from the amniotic membrane. In this method, 80% glycerol is used for drying the amniotic membrane, which can thereafter be preserved at 4°C for a long time, although it loses some of its biologic properties. This type of preserved amnion is used for dressing burn wounds.[16]

**STRUCTURE AND COMPOSITION**

**Amniotic membrane:**

It is about 10-15 micrometers thick and consists of two fetal membranes; the

inner amniotic membrane and the outer chorion. It is normally 0.02 to 0.5 cm in thickness and consists of five layers.[6]

These are, from within outwards:[6]

- Epithelium.
- Basement Membrane.
- Compact Layer.
- Fibroblast Layer.
- Spongy Layer.

There are two types of cells in amniotic membrane (AM) with different embryological origins: amnion epithelial cells derived from embryonic ectoderm and amnion mesenchymal cells from embryonic mesoderm. It is from this layer that amniotic MSC (AMSC) are isolated from amniotic epithelial cells and stored to be used for regenerating tissues. There are no nerves, muscles, or lymphatics in the amniotic membrane.[22,23] The amniotic mesoderm layer consists of macrophages and fibroblast-like mesenchymal cells. These human amniotic epithelial (HAE) cells and human amniotic mesenchymal cells (HAM cells) express pluripotency and are potent stem cells reservoirs.[23] Amniotic epithelial cells (AEC) secrete collagen type III and IV and non-collagenous glycoproteins like laminins, nidogen, fibronectin and vitronectin within the basement membrane that serve as adhesion ligands transmitting signals and interacting at cell surface receptors.[24] An array of growth factors is present in native human amnion/chorion membranes, which play critical roles in regulating tissue development and growth in utero. Epidermal growth factor (EGF), basic fibroblast growth factor (bFGF), keratinocyte growth factor (KGF), transforming growth factors alpha and beta (TGFα, β), nerve growth factor (NGF), and hepatocyte growth factor (HGF) are some of the growth factors that have been identified in fresh and preserved amniotic membrane tissues.[25]

**Chorion Membrane:**

The chorion consists of four layers. These are, from within outward: Cellular Layer, Reticular Layer, Pseudo-basement Membrane and Trophoblast. The reticular layer is in contact with the spongy layer of the amnion and forms a majority of chorion's thickness. The reticular network is composed of collagens I, III, IV, V, and VI. The basement membrane anchors the trophoblasts to the reticular layer with collagen IV, fibronectin, and laminin. The trophoblast layer is the deepest layer, consisting of 2–10 layers of trophoblasts which contact with the deciduas.[26] The chorionic villi of human

placenta is a rich source of mesenchymal stem cells (PMSCs), also known as human chorionic mesenchymal stromal cells. The Brescia Symposium has decided to call this type of cells from the placenta as "chorionic stromal mesenchymal cells", not stem cells as these cells have genetic and behavioural characteristics of both multipotent and adult stem cells.[27] The vascular niche of placenta harbors a pool of PMSCs that can give rise to committed progenitors for tissue maintenance and repair, and that PMSCs contribute to vessel maturation and stabilization.[28] The karyotyping analysis has shown chorionic stem cells maintain chromosomal stability after serial passage, demonstrating chorion as a promising source of cell for future therapy.[29] In addition, the chorionic villi contains abundant growth factors like insulin growth factor, Heparin-binding EGF-like growth factor (HBEGF),Vascular endothelial growth factor (VEGF), Transforming growth factor-α (TGF-α) and these factors work as endothelial cell mitogens and are required for cell signaling and prevent apoptosis of cells.[30]

**Properties Anti Inflammatory:**

The Mesenchymal Stem Cells (MSCs) in the AM decrease the secretion of proinflammatory cytokines like Tumor Necrosis Factor alpha (TNF-α) an

**Table 1: Structure and composition of placental membranes[31]**

| Placental membrane | Layers of placental membrane | Extracellular matrix component |
|---|---|---|
| Amnion | 1. Epithelium monolayer/amniotic epithelium<br>2. Basement membrane<br>3. Compact layer<br>4. Fibroblast layer<br>5. Intermediate/spongy layer | Single layer of cells<br>Collagen types III, IV, and V, fibronectin, laminin, and<br>nidogen<br>Collagen types I, III, V, and VI, fibronectin<br>Collagen types I, III, and VI, fibronectin, laminin, and<br>nidogen<br>Collagen types I, III, and IV, proteoglycans |

| | | |
|---|---|---|
| Chorion | Reticular layer<br>Basement membrane<br>Trophoblasts | Collagen types I, III, IV, V, and VI, proteoglycans<br>Collagen type IV, fibronectin, and laminin |

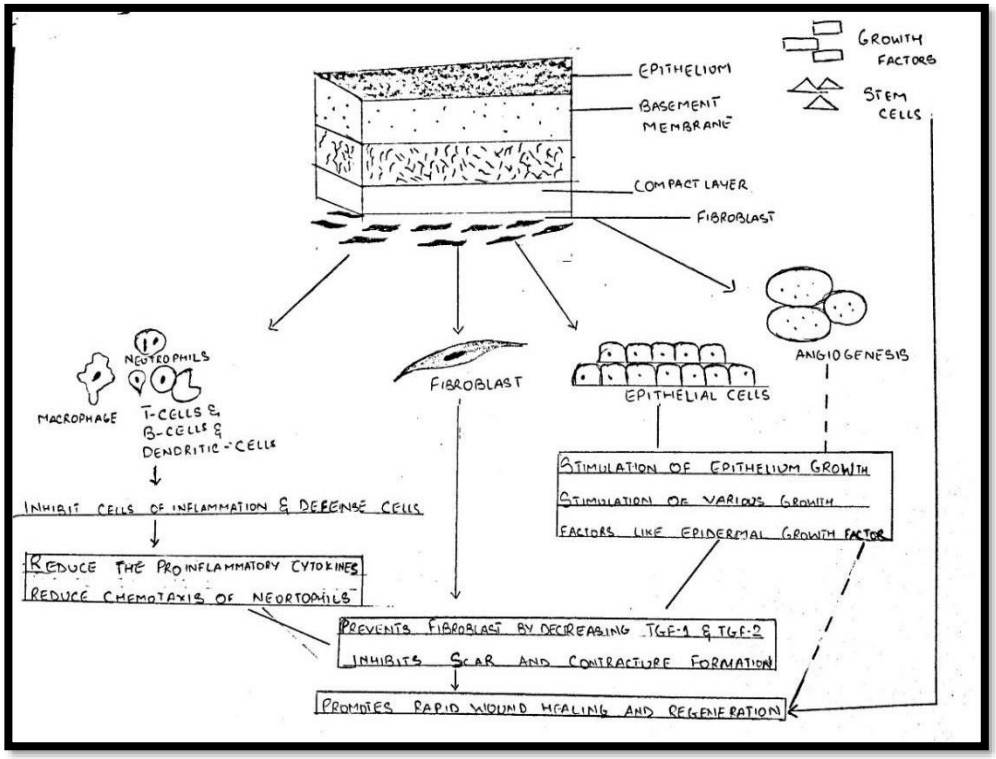


**Illustration:2** Mechanisms of action of amniontic membrane.

Interferon (INF) while increasing the production of anti-inflammatory cytokine, interleukin-10 and interleukin-4. The inhibitors of matrix metalloproteinases present in the amniotic membrane reduces matrix metalloproteinases (MMPs) released by infiltrating neutrophils and macrophages. Various tissue inhibitors of metalloproteinases 1, 2, 3, and 4, interleukin-10, and interleukin-1 receptor antagonists and endostatin which inhibit endothelial cell proliferation, angiogenesis, and tumor growth are also expressed by human amniotic epithelial and mesenchymal cells.32(Illustration:2)

**Angiogenesis:**

The cells of the AM enhance the production of Vascular Endothelial Growth Factor (VEGF) by activating the VEGF receptors 1 and 2. Extensive neovascularization after the application of AM is due to the liberation of angiogenic factor like insulin derived growth factor (IGF) that promotes epithelialization and granulation tissue formation. The increase capillary blood flow to the lyophilized amniotic membranes when used as graft material in vestibuloplasty promotes healing.33

**Immunomodulatory:**

The unique molecular surface architecture and biochemical properties of AM that is derived from the layer of trophoblast cells renders it unsusceptible to maternal immune attack.14,32 These mesenchymal stem cells are different from other nucleated mammalian cells as they show little allogenic reactivity when administered to MHC unmatched adult immune competent recipients.14 The cells of AM neither express the programmed cell death receptor 1 (PD1) (an inhibitory receptor that is normally expressed on activated T and B cells), nor its two ligands: programmed death ligands 1 and 2 (PD-L1 and PD-L2) and the immunoglobulin-like transcript receptors 2, 3, and 4 (ILT R-2, ILT R-3, and ILT R-4). Furthermore, they actively suppress T cell, dendritic cell and B cell function that down-modulate exuberant inflammation.14

**Antimicrobial and Antiviral:**

Amniotic membrane firmly adheres via fibrin and elastin linkages with the wound that seals the wound and prevent contamination. This tight adherence helps in restoring lymphatic integrity, protects circulating phagocytes from exposure and

allows faster removal of surface debris and bacteria from the wound. The antimicrobial activity of the MSCs in AM is mediated by two mechanisms: directly via the secretion of antimicrobial factors such as LL-37 and indirectly via secretion of immunomodulative factors which will upregulates bacterial killing and phagocytosis by immune cells. Defensins, mostly, secretary leukocyte proteinase inhibitor (SLPI), beta 3 defensins and elafin present in the amniotic cells act as components of the innate immune system to provide protection from infection. Its antiviral properties are exhibited by the presence of a powerful antiviral agent, Cystatin E which is an analogue of cysteine proteinase inhibitors.15

**Anti-Scarring:**

Vascular endothelial growth factor (VEGF), hepatocyte growth factor (HGF) are secreted by AM that maintains a proper balance between TGF-1 and TGF-3 that prevents scarring. It also down-regulates TGF-beta and its receptor expression by fibroblast that reduces fibrosis at the site. This also promotes tissue reconstruction by modulating the healing of a wound. Various immune cells like T cell, dendritic cell and B cell are also actively suppressed that prevents pathological remodeling and excessive fibrosis.32

**Promotion of Epithelialization:**

Amniotic membrane facilitates migration of epithelial cells, reinforces basal cell adhesion, promotes epithelial differentiation, prevents epithelial apoptosis, and promotes epithelialization in healing of wounds. Brain natriuretic peptide and corticotrophin releasing hormone are also produced by membrane epithelial cells which play roles in increasing cellular proliferation and calcium metabolism. Sufficient oxygenation for epithelial cells is provided by its good permeability in contrast to other synthetic materials. Thus, amniotic membrane is an ideal tissue which facilitates the growth of epithelial cells, helping in their migration and differentiation.34

**Reduction of Pain:**

Reduction of pain by AM is because, it diminishes inflammation and provides a

better state of hydration that soothes the wound bed to promote faster healing. The soft mucoid lining of amniotic membrane also protects the exposed nerve endings from external irritant that help to decrease pain sensation.14,32

**Increased extracellular matrix deposition:**

MSCs differentiation helps to regenerate the damaged tissue and regulate the local cellular responses to injury by paracrine signaling. It helps in cell survival, proliferation, migration and gene expression of epithelial cells, endothelial cells, keratinocytes, and fibroblasts. MSC-conditioned medium acts as a chemoattractant for macrophages, endothelial cells, epidermal keratinocytes, and fibroblasts which accelerate wound closure.14

**MECHANICAL PROPERTIES:**

Increase in stiffness enhances the stability of scaffold and prevents displacement that leads to uninterrupted healing as well as feasibility in exchange of metabolic products of involving cells during the early phase of healing. For maintaining the shear stresses of surrouding tissue the scaffold should also have sufficient elasticity. Collagen and elastin in extracellular matrix provide stiffness and elasticity for amniotic membrane, respectively. The mechanical response of amniotic membrane is viscoelastic in nature. Amniotic membrane is a semipermeable membrane and is an immunotolerant structure.16 The dehydrated amnion/chorion membrane allograft can also be micronized, that allows it to be used as a topical powder or mixed with saline to create an injectable solution or a topical gel.18 Mechanical testing reveals that the foetal membranes are elastic. Amniotic membranes have a tensile strength of 155 kPa and chorion membranes have a tensile strength of 95 kPa.35 In vitro degradation revealed that up to three weeks both the membranes resist degradation and maintain their physical form. At end of 3 weeks foetal membranes degraded completely. Amnion membranes were not totally degraded even at the end four weeks. The accumulated weight loss in percentage for the amnion membrane was 21% of its initial weight at the end of the first week, 24% of the initial weight at the end of second week, 31% at the end of third week and 70% at the end of the fourth week. Chorion membrane degraded 29% of its initial weight at the end of the first week, 35% at the end of the second week, 42% at the end of the third week and 84% at the end of the fourth week.35

**AMNIOTIC MEMBRANE IN OPHTHALMOLOGY:**

Amniotic membrane can also promote epithelialization of denuded areas of ocular surface.36 Amniotic membranes can be used in the treatment of persistent epithelial defects as a single layer or multilayer graft depending on the depth of lesions providing a substrate for epithelial cells to migrate and adhere to the basement membrane. Multilayer AM is used to treat non-traumatic corneal micro perforation and descemetoceles.37 Using a non-healing infective ulcers of ocular surface due to bacteria, fungi virus and protozoa, several studies suggested that AM possesses inhibitory effects on several proteolytic enzymes secreted by these microorganisms.38 Partial Limbal Stem Cell Deficiency (LSCD) can be treated with AM.39,40 AM can be used to reconstruct the surface of the conjunctiva. It is also reported that AM can be used to

reduce scarring at the time of filtering surgery, to repair early or late leaks in case of glaucoma.[41]

**AMNIOTIC MEMBRANE IN BURN HEALING:**

AM has several properties such as non-immunogenicity, bacteriostatic characteristics, anti-inflammatory, anti-angiogenesis, preventing collagen degradation and promoting epithelialization which make AM an ideal biological skin substitute for the treatment of burn.[42] Andonovska *et al*.[43] showed that, use AM provide significantly better result than conventional method in the treatment of dermal and sub-dermal burns.[44]

**USES OF CHORION AND AMNIOTIC MEMBRANES IN DENTISTRY**:

The amniotic and chorion membrane have the biological properties such as antimicrobial, anti-inflammatory, promotion of rapid vasculogenesis, epithelialization. Above all, as a source abundant stem cells these fetal tissues a suitable choice in the field of reconstructive and regenerative medicine. In the field of dentistry, these tissues find an application especially in Oral maxillofacial surgery and Periodontology.

Antiinflammatory and antiscarring property of AM have shown decreased necrosis and rapid healing of ulcers with herpes simplex virus (HSV), varicella zoster virus–infected tissues, erythema multiforme major (Stevens- Johnson syndrome) and cervical necrotizing fasciitis.[45] HAM (Human Amniotic Membrane) has been tried in the reconstruction of TMJ ankylosis as it prevents fibrosis and reankylosis when used as an interpositional material.[46] AM is even used as a carrier for local delivery of the

various drugs like antibiotic netilmycin (NTM) and antiviral drugs like acyclovir (ACV) and trifluridine. Cryopreserved amniotic membrane (CAM) has been known to promote periodontal soft tissue healing and is also effective in helping cicatrization, wound healing, epithelization, facilitated migration and reinforced adhesion.

## APPLICATIONS IN PERIODONTICS

### Preclinical Studies:

Gomes et al. (2001)[47] studied the use of amnion grafts to line the floors of cortical bone defects of skull in rabbits and to cover the superficial surface of the defects. At 90 days, amnion tissue was in direct apposition to newly formed bone. At 120 days, the amnion tissue grafts were no longer present and bone had completely filled the defects. The authors concluded that the use of amnion tissue grafts did not inhibit repair in guided bone regeneration and may have been beneficial for its antibacterial properties. Rinastiti et al. (2006)[48] histologically evaluated the use of amnion tissue in thirty 3- 4-month-old rabbits. Amnion tissue grafts in this study were made by layering 5 sheets (5 × 5mm) of freeze-dried, human amniotic membrane. Half of the wounds were covered with amnion grafts and the other half of the wounds served as the uncovered, control group. Compared to the control group, the amnion treated wounds had fewer polymorphonuclear cells at days 1 and 3; thicker epithelium and more fibroblasts at days 5, 7, and 10; statistically significant greater new blood vessel formation at days 7 and 10; and significantly more mature and dense collagen fibers at day 10.

### Clinical Studies:

Recently, the AM-based cell-culture system to culture PDL derived cells for regenerative therapy of periodontal tissue has been developed. These cells are considered capable of proliferation and potentially maintaining their PDL-like properties even on AM. Guler et al. (1997)[49] studied the use of a single layer of lyophilized, gamma irradiated amnion for vestibuloplasty in 20 patients. The graft was sutured in place and no stent was used to cover the graft. Observations of the graft sites 24 hours after amnion application demonstrated a hyperaemic appearance of the mucosal flaps. All patients showed some edema, which resolved by day 7. On day 10, epithelialization of the graft was observed and

the amnion graft could not be differentiated. Smooth granulation tissue covered the grafted areas by day 14; and the amnion had completely degraded. At day 21, the grafted areas were completely covered with oral mucosa. In addition, blood flow to the alveolar mucosa was measured in patients by clearance of intramucosal injections of radioactive xenon gas. At day 10, a significant increase in blood flow in the graft was detected, compared with the preoperative state. At 30 days, the blood flow decreased and was not significantly different from normal levels. Samandari et al. (2004)[50] suggested that the amniotic membrane graft might be used as a potential graft material for vestibuloplasty. Gurinsky (2009)[51] reported results of a series of five patients treated with membranes for shallow-to moderate Miller Classes I and II recession defects. At 12 weeks, an increase in newly generated gingival tissue of 3.2mm ± 1.7mm was measured. Coverage was 100% in four out of five patients and 88% in the fifth patient.Kothiwale et al. (2009)[52] clinically and radiographically evaluated and compared the efficacy of demineralized freeze-dried bone allograft and bovine derived xenogeneic bone graft with amniotic membrane in the treatment of human periodontal Grade II buccal furcation defects. Results showed significant pocket depth reductions, clinical attachment level gains, and significant improvement in bone fill and percentage gain with both of the materials. Wallace (2010)[53] evaluated clinically and histologically the efficacy of a new resorbable, immune privileged, self-adhering amniotic membrane for ridge preservation following tooth extraction. Quality of the histologically evident bone formed at 4.5 months was excellent. There was no evidence of resorption of crestal bone height and inflammation, which suggests the potential benefits of using amniotic allograft in guided bone regeneration. Rosen (2011)[54] used a combined approach for correcting both the hard- and soft-tissue deformities around a maxillary canine that included a mineralized bone allograft, recombinant platelet derived growth factor, and a chorion amnion barrier covered by a subepithelial connective tissue graft.The advantages of this particular barrier are that it is extremely thin, measuring 300mm after full hydration, with the major noncollagenous components being laminins, proteoglycans, and fibronectin, further enhancing its tissue friendly nature. Kothari et al. (2012)[55] also concluded that grafts of amniotic membrane are viable and

reliable for covering of the raw surface, prevent secondary contraction after vestibuloplasty, and maintain the postoperative vestibular depth. A clinical trial carried out by Suresh and Gupta (2013)[56], on a 56-year-old male with vertical recession depth of 2mm in upper right canine for root coverage and enhancement of gingival biotype by using chorion membrane along with coronally advanced flap, showed 100% root coverage and the soft-tissue biotype enhancement from thin to thick. H. Singh and H. Singh (2013)[57] presented a case report on bioactive amniotic membrane as a membrane for the treatment of isolated gingival recession. The results showed significant root coverage with uneventful healing. Shetty et al. (2014)[58] compared usage of Platelet-rich Fibrin (PRF) and amniotic membrane in bilaterally occurring multiple Miller Class I recession. 100%root coverage was observed with both of the membranes but the results were stable even after seven months in the amniotic membrane-treated site.

**LIMITATIONS**:

The use of amniotic membranes is technique sensitive Infection transmission with transplantation of amniotic membranes is always an associated risk of hence adequate precautions should be taken and safety criteria should be included in application of these biological membranes.[59] Amniotic membranes are fragile membranes, so they need to be dealt with care.[59] Cryopreserved/ hyper dry membranes are expensive.[59] "zone of altered morphology" (ZAM) includes structural weaknesses and a marked disruption of the connective tissue layers as well as a marked reduction of the thickness and cellularity of the membrane.[60] Due to decreased integrity and increased apoptosis of cells in this region, use of the ZAM is not preferred.

**THE FUTURE OF AMNIOTIC TISSUE**:

The benefits of novel allograft include reduction of surgery time, improving patient outcomes with an affordable price tag. Amnion tissue has many potentials uses across the field of medicine and dentistry. Third generation amniotic membrane has been developed to further optimize and simplify amniotic membrane transplantation for ophthalmic and dental surgery as well.[11] Many characteristics similar to stem cells are present in AECs, but one of the most important properties of stem cells is that they survive freeze-thaw. Hence it could be applied to the transplantation therapy for a wide variety of diseases. Technical

limitations with regards to suturing is present as AM is a thin structure. A new approach might include the use of glues as a substitute for suturing.[61]

**CONCLUSION:**

Despite the few obstacles mentioned above, the future of the Amniontic- chorionic membrane in applications such as Tissue Engineering and regeneration is very exciting. Benefits of having abundance of growth factors, having anti-scarring properties, no morbidity while procuring the membrane and its availability in large amount makes it more material of choice for its use. However, further in vitro and clinical work is needed to determine the physical properties and safety of the Amniontic- chorionic membrane for the uses described in this review.

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# AWARENESS AMONGST THE GYNECOLOGISTS REGARDING THE ASSOCIATION BETWEEN SEX HORMONAL CHANGES AND PERIODONTAL HEALTH/DISEASES: A QUESTIONNAIRE SURVEY

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## ABSTRACT:

Sex hormones play an important role in periodontal health and disease. For example, puberty, menses, pregnancy, menopause, and oral contraceptives use, influence a woman's periodontal health. A survey was conducted among 50 gynecologists who are practicing in private hospitals. In the form of questionnaire, 16 questions were framed to evaluate the awareness among the gynecologists about female sex hormones on periodontal health. 72% of them were aware that sex hormonal changes are correlated with periodontal disease. Findings showed that most gynecologists were aware and concerned about female patient's oral health during various hormonal phases.

## Introduction

The mouth serves as a mirror to general health status and also acts as a portal for the disease to the rest of the body.[1] Oral health during pregnancy has long been a focus of interest. It involves multiple substantial and hormonal changes that have a momentous impact at the time of pregnancy.[2]

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Oral health problems with pregnancy primarily include gingivitis, pregnancy granuloma, and periodontitis.[3-5] Pregnant women with periodontitis may be at a higher risk of preterm birth weight/low birth weight.[6,7] Studies showed 18.2% of all preterm low birth weight (PLBW) cases may be attributable to the periodontal disease.[8] Most of the studies have shown that individuals during pregnancy with severe periodontal diseases have a greater risk to preterm birth and low birth weight.[9] Avoiding oral health during their pregnancy causes many complications. So, gynecologists should create an inimitable opportunity to educate the women throughout their pregnancy period. Assessment of oral health care at the time of pregnancy by gynecologists plays an important role in the entire issue. Gynecologists motivate pregnant women to maintain good oral health and it provides good welfare of mother as well as an opportunity to decrease adverse pregnancy outcomes[10]. So, together with dental and medical practitioners should recognize oral health care as an integral part of the overall prenatal care. Hence, it becomes important to evaluate the knowledge of medical health professionals about periodontitis and its association with adverse pregnancy outcomes.

**Materials and Methods:**

This cross-sectional study was conducted using a self-administered questionnaire among gynecologists of four different cities Godhra, Santrampur, Lunavada and Nadiad. 50 gynecologists were included in the survey. Questionnaires which included 16 questions were distributed to the participants through personal interview and were requested to fill the same. Participants were randomly selected and assigned the questionnaire which contained: (a) Self-perception of participant's professional experience, their type of practice and periodontal health status; (b) assessing knowledge about periodontal disease etiology and adverse influences on pregnancy outcome; (c) participant's knowledge about periodontal health and correlating it with the pregnancy outcomes. Questionnaires included multiple choice questions and yes or no. Results on continuous measurements are presented on the mean±standard deviation (Min-Max) and results on categorical measurements are presented in number (%).

## Statistical analysis:

Statistical analysis was performed using statistical univarient analysis software. Gynecologist responses and opinions regarding their clinical practice

were calculated by qualitative analysis. Both univariant and multivariate analyzes are used according to sex, professional Fisher man exact test and Chi-square test. Standard backward P values were used to compare the multiple variables. The degree of significance was fixed to P = 0.05, and analysis of the results is experience their periodontal health status and correlation of participants

**Results:**

Table 1 explains self-perception of professional experience, regarding given questions among 50 respondents. 50 out of 50 gynecologists answered "YES" regarding the question "Is good oral hygiene necessary for good h e a l t h ?"

| SR NO | QUESTIONS | YES | NO | YES % | NO % |
|---|---|---|---|---|---|
| 1 | Is good oral hygiene necessary for good health? | 50 | 0 | 100 % | 0% |
| 2 | Is there an association between oral disease and general health? | 50 | 0 | 100 % | 0% |
| 3 | During menstruation are there any problems in the teeth /gums? | 11 | 39 | 22% | 78% |
| 4 | Do pregnant women complain of problems in their teeth/ gums more often than other individuals? | 27 | 23 | 54% | 46% |
| 5 | Are pregnant women more susceptible to bleeding from gums? | 24 | 26 | 48% | 52% |
| 6 | Do pregnant women complain of teeth mobility more often than other individuals during the gestational period? | 13 | 37 | 26% | 74% |
| 7 | Do pregnant women often complain of swelling/ any unusual growth in the gums? | 20 | 30 | 40% | 60% |
| 8 | Any additional, oral hygiene maintenance necessary during their pregnancy? | 39 | 11 | 78% | 22% |
| 9 | Can the dental treatment be carried out during pregnancy? | 44 | 6 | 88% | 12% |
| 10 | Is local anesthesia with vasoconstrictors safe in pregnancy? | 43 | 7 | 86% | 14% |
| 11 | Do gum infections during pregnancy result in the preterm low birth weight deliveries? | 34 | 16 | 68% | 32% |

| | | | | | |
|---|---|---|---|---|---|
| 12 | Do pregnant women need additional periodontal health care during their gestations period to prevent adverse pregnancy outcome? | 38 | 12 | 76% | 24% |
| 13 | Advising the patient to delay a visit to the dentist until after pregnancy? | 4 | 46 | 8% | 92% |
| 14 | How much %(percentage) you refer the female patients with puberty, pregnancy, menstruation, menopause and oral contraceptive therapy to the periodontist for dental concern in a month from your routine OPD? | 19 | 31 | 38% | 62% |
| 15 | What do you believe; gingival change (during these various phases) needed treatment? | 33 | 17 | 66% | 34% |
| 16 | Which trimester is the safest for dental treatment? | 2nd | 3rd | 2nd | 3rd |
| | | 30 | 20 | 60% | 40% |

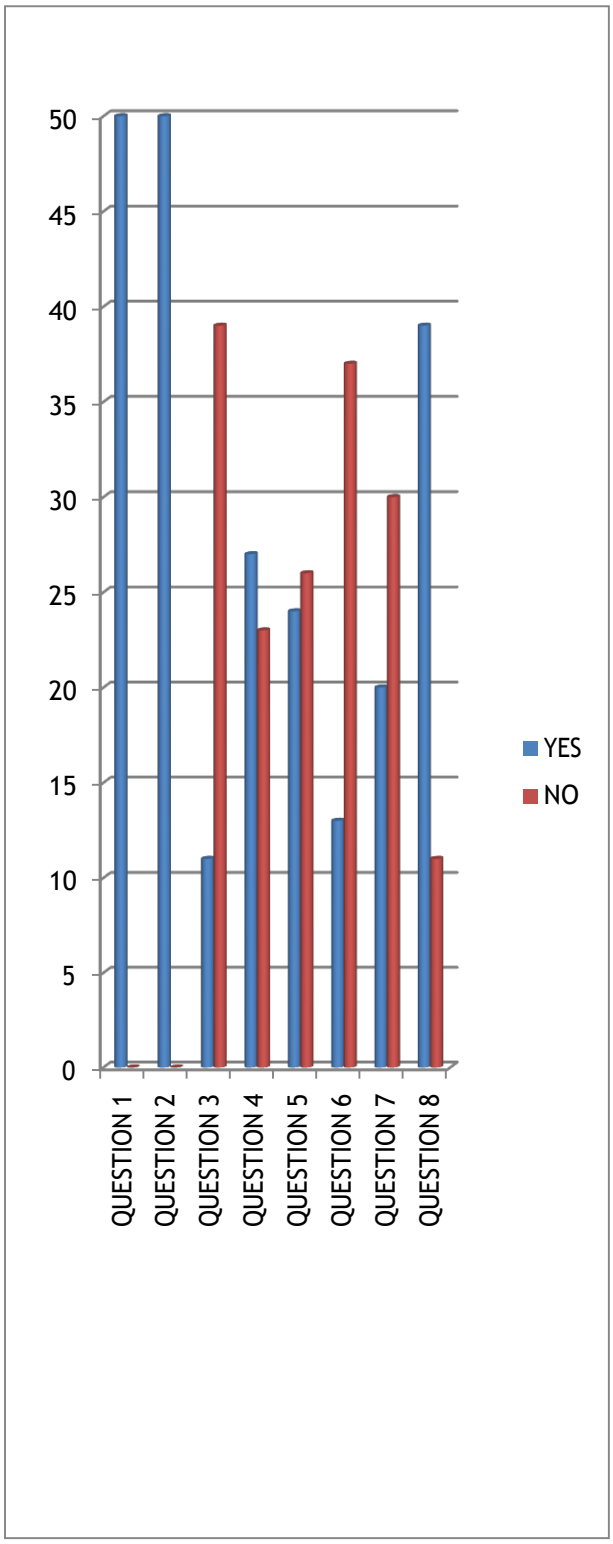
**Table 1: Shows how many gynecologists gave answers ("YES" or "NO") and also shows percentage of 16 answers ("YES" or "NO") of 16 different questions.**

Periodontal awareness among gynecologists was detailed in Table 1. All gynecologists correctly understand that periodontal diseases are related with oral as well as systemic inflammation and infection. 24 participants agreed that, gingival bleeding is the clinical signs of periodontal disease. 13 of the participants opinioned, tooth mobility as a clinical sign of the periodontal diseases. Table 1 also explains the percentage of answers. Along with this 40% of participants believed gingival overgrowth as oral symptoms in pregnant women. In addition, 68% gynecologists' opinioned that, periodontal diseases cause preterm birth in pregnancy $50^{\%}$ of them believed that there is an association between Oral disease and general health. Bar diagram 1, 2 describes the comparison of answers of 16 questions. Fewer gynecologists (11) noticed that there are problems in teeth/gums during menstruation. Interestingly 27 gynecologists' opinioned, pregnant women complained in their teeth/ gums more often than other individuals. 39 of participants estimated that there is a need of additional treatment during pregnancy. Most of the participants (44) believed that dental treatment can be done during pregnancy.

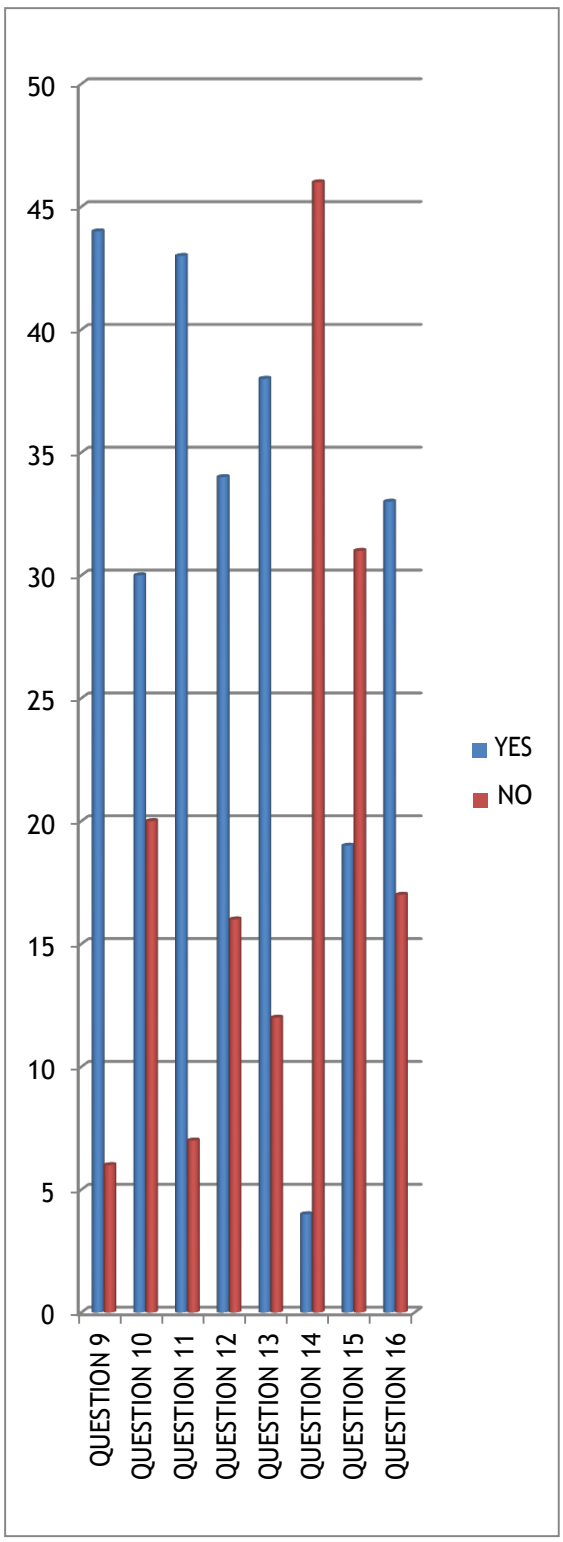
43 of them considered local anesthesia with vasoconstrictors safe in pregnancy. 17 of respondents had never referred the patient for a dental checkup.

The univariant analysis at the time of finding out the influence of pregnancy on periodontal diseases showed that there is

significant difference between participants who are diagnosed and not diagnosed with the periodontal disease at 1° level of significance with 1° of freedom, hence $P < 0.05$. With regard to professional experience, participants showed there is an insignificant difference between less than 10 years and more than 10 years of professional experience at 5% level of significance with 1 degree of freedom, hence $P > 0.05$. Influence of periodontal disease on pregnancy outcomes shows there is significant Difference between, diagnosed with the periodontal disease and non-diagnosed with periodontal disease about the periodontal status at 1% level of significance with 1 degree of freedom with $P < 0.05$. In addition, there is a significant difference between greater than 10 years and less than 10 years of professional experience at 1% level of significance with 1 degree of freedom with $P < 0.05$. Multivariate analysis showed there is a significant difference between the type of practices at 1% level of significance with 2 degrees of freedom ($P < 0.05$). Oral health-related information given to the patient showed a significant difference between diagnosed and non-diagnosed periodontal disease with a 1% level of significance with 1 degree of freedom shows ($P < 0.05$). In addition, with regard to the professional experience greater than 10 years and less than 10 years of professional experience at 5% showed there is significant difference pertaining to the oral health related information was given to the patient with a degree of freedom 1 ($P < 0.05$). The importance of periodontal care during pregnancy showed there is insignificant difference between 1% participants diagnosed with periodontal disease and non-diagnosed with periodontal disease ($P > 0.05$). In another different study, regarding the importance of periodontal care during the pregnancy showed that there is significant difference between private and government hospital practitioner, participants with a different type of practices 2 degrees of freedom ($P < 0.05$)[18].




**Bar diagram 1: Describes the comparison of answers ("YES" or "NO") of 1-8 questions out of 16 questions**




**Bar diagram 2: Describes the comparison of answers ("YES" or "NO") of 9-16 questions out of 16 questions**

## Discussion:

This study indicates an awareness of the association between periodontal diseases and pregnancy outcomes among gynecologists. 50 respondents were chosen for this study from Gujarat state. Among 50 subjects, 100% of them were having knowledge that, good oral hygiene is necessary for good health and there is an association between oral disease and general health. McCann AL in 2001[1] did a study regarding "Maintaining women's oral health" and had a result that 100% of them knew that; there is an interrelation between oral disease and general health. Annan in 2005[3] also did the same study and got 95% results for same. 48% of participants identified gingival bleeding as the clinical signs of periodontal disease in this study. In other study,Tarannum *et al.*[12] concluded that 50% of them were aware of clinical signs. In central North Carolina, Page RC[4] concluded 56% were aware that bleeding gums were the clinical signs in pregnancy. Rai *et al.*[6] showed 51% of them were aware of clinical signs associated with periodontal disease in the general population and pregnant women such as gingival bleeding. Interestingly, they had also noted tooth loss, caries and alveolar bone destruction as clinical signs associated with periodontal disease. This indicates participants were not aware of the pathogenesis of periodontal disease. In the present study, 68% gynecologists opinioned that periodontal diseases cause preterm birth in pregnancy. Rocha *et al.*[13] who is members of Brazilian Federation of Gynecology and Obstetrics, did study on gynecologists, and results showed that 61% of the gynecologists were aware about the influence of periodontal diseases on pregnancy and that it causes preterm birth. This result was consistent with those reported in other studies.[10,14-17] However, according to Tarannum *et al.* less numbers in the study reflect whose awareness or attitude is not easily discernable. Participant's answers to the question might indicate a lack of awareness of the association or it might reflect their disagreement with the association despite being aware of the evidence. This difficulty in distinction is inherent in survey-type studies, so they attempted to frame the question to reflect awareness, i.e., is there an association between periodontal diseases and PLBW infants" rather than attitude, i.e., "Do you believe there is an association between periodontal diseases and PLBW infants," and results were considered more likely to reflect awareness in his study.

This study showed (66%) gynecologists' opinioned that dental treatment is needed in pregnancy. 100% of participants estimated that there is a possible connection between the health

of the teeth, gum, and pregnancy. McCann AL in 2001[1] did a study named "Maintaining women's oral health" and had a result that 58.5% of them were having knowledge that, dental problems should be treated in pregnancy. On the contrary, Page RC concluded in his study that 64% gynecologists do not agree that dental treatment should be carried out during pregnancy because they believe that, it is not safe and can lead to adverse effects during pregnancy[4]. Hormonal changes lead to change in the microflora of an oral cavity. In pregnancy, there are few inflammatory changes like bleeding and swollen gums, plaque accumulation etc. occurs in an oral cavity. In this study, 78% of participants answered positively that, "Any additional, oral hygiene maintenance is necessary during pregnancy?" And 54% of them knew that pregnant women have complained of problems in their teeth/ gums more often than other individuals. Offenbacher S et al.[8] also got the similar results, in their study 78.5% gynecologists knew that additional maintenance is required in pregnancy and 44% participants had knowledge that pregnant women have complained of problems in their teeth/ gums more often than other individuals. But Krejci CB[2] in his study said that during his survey only 15% of gynecologists knew that pregnant women have complained of problems in them teeth/ gums more often than other individuals, because of lack of knowledge. Moreu et al.[9] in his study said that, 72% gynecologists agreed that local anesthesia with vasoconstrictors is safe in pregnancy. In this study, 86% of participants knew that local anesthesia with vasoconstrictors is safe in pregnancy. There is no risk to the fetus during the first trimester; the pregnant mother may experience an increasing level of discomfort. So, it is safe to perform routine dental treatment in the 2nd trimester, but from the third trimester routine dental treatment should be avoided. In this study, 60% of participants said that 2nd trimester is the safe period for dental treatment and 40% of the participants said that dental procedure should be carried out in the only 3rd trimester. In the present study, about 38% of participants suggested female patients to visit the dental clinic when they are at risk but not regularly. These results may indicate a strong need for interdisciplinary communication and coordination to declare the provision of sufficient health care to pregnant females. 62% of respondents never refer the patient for a dental checkup. Cohen *et al.*[11] found that in his study 97.4% of them showed consideration of dental treatment during pregnancy, 55.8% showed consideration when they are at risk. 66% of them refer the patient for dental check. Rocha *et al.*[13]

found that in Brazil, 58% of them systematically refer the patients to dental care. According to Strafford *et al.*,[10] 64% of obstetricians reported that dental care was important to routine prenatal care, only 49% performed oral health evaluations. Only 40% of them were encouraged to seek dental care by health-care professionals during pregnancy. Some of the other studies showed many patients do not seek and are not advised to seek routine dental care as part of their prenatal care.[18, 19] Periodontal knowledge among the Gujarat gynecologists could be considered as predictable. Clinical behavior regarding oral and periodontal health did not correlate with such knowledge. Therefore, training gynecologists on how to provide a visual screening for oral health problems is also recommended. For practicing gynecologists, continuing education courses on periodontal disease and systemic conditions could be developed by the dental community in the Gujarat state. Providing oral health referral sources to gynecologists helps in referring pregnant women to oral health care that might facilitate the process for better oral health care for pregnant women and reduce adverse pregnancy outcomes. Systematic referral to the dentist during pregnancy can cause a decrease incidence of negative pregnancy outcomes, especially in patients with severe periodontal disease.

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# PERIODONTAL DISEASE-SYSTEMIC DISEASE INTER-RELATIONSHIP AWARENESS STUDY

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****Dr. Hiral Purani *Dr. Dhvani Valvai *Dr. Deesha Chhaya

## Abstract:

**Aim:** To determine the awareness among patients about the inter-relationship between periodontal and systemic diseases.

**Material and method:** A survey were conducted among 100 patients aged between 35 to 65 years who visited the Department of Periodontology and Oral Implantology, Faculty of Dental Science, Dharmsinh Desai University, Nadiad. Assessment form comprised of a questionnaire having 12 questions framed to evaluate the awareness among patients about periodontal and systemic diseases inter-relationship.

**Results:** 100 patients were surveyed. About 69% of them were not aware that periodontal disease is correlated with systemic diseases like diabetic mellitus, cardiovascular diseases, hematological disorders, hormonal discrepancies and osteoporosis.

**Conclusion**: The awareness about the inter-relationship of periodontal and systemic diseases among patients is very minimal.

***Key Words:*** *Periodontal disease, Systemic disease, Diabetes mellitus.*

## Introduction

For decades, close attention has been paid by physicians and dentists to their own respective fields, specializing in medicine pertaining to the body and the oral cavity, respectively. However, recent studies have strongly suggested that oral health may be indicative of systemic health.

Currently, this gap between allopathic medicine and dental medicine is quickly closing, due to significant findings supporting the association between periodontal disease and various systemic conditions such as cardiovascular disease,

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type 2 diabetes mellitus, adverse pregnancy outcomes, osteoporosis etc. Significant effort has brought numerous advances in revealing the etiological and pathological links between the periodontal disease and systemic conditions like cardiovascular disease, type 2 diabetes, osteoporosis, adverse pregnancy outcome, hematological disorders etc. Therefore, there is a reason to hope that the strong evidence from these studies may guide researchers towards greatly improved treatment of periodontal infection that would also ameliorate these systemic illnesses. It is important for the general public to be aware of the association between periodontal disease and systemic conditions. Hence, a study was planned to evaluate the awareness of the common people about the inter-relationship of the periodontal disease with systemic disease.

## Material and methods:

The aim of the study was to determine the awareness among patients about the inter-relationship between periodontal and systemic diseases. A cross-sectional survey was conducted among 100 patients of all socioeconomic status visiting the Department of Periodontics and Oral Implantology, Faculty of Dental Science, Dharmsinh Desai University. A simple random sampling was done. All patients aged 35-65 years were included in the survey. The information was collected using a self-explanatory questionnaire. Twelve questions were chosen to assess the patient's health problem and their awareness about inter-relationship between periodontal disease and systemic disease. The nature and purpose of the survey was explained to the patients and written consent was obtained. The questionnaires were given to the patients during their regular visit to the dental hospital. This questionnaire was printed in English as well as a regional language. Patients were asked about their health status whether they have any systemic problems like diabetes, heart problem, blood disorders, hormonal disease, and bone disease. Few questions were asked regarding their awareness, like do they know the oral disease is an indicator of systemic disease or not. Whether they have knowledge that diabetic patients can have gum problems and same way severe gum problems can worsen glycemic control of the patients. Whether they are known to the fact that long-term diabetes can increase the severity of gum disease and if treated shows improvement in periodontal health and that untreated diabetes can lead to worsening of periodontal health and loosening of teeth.

Not only about diabetes, but they were also asked questions about pregnancy, heart problems, bone disorders and hematological disease, like do they know that gum disease is common during pregnancy and regular visit to the dentist is necessary during that period. Are they aware of the fact that gum problems lead to heart problem or whether blood disorders have any impact on gum disease or have they ever noticed any bone disease causing loosening of teeth? Three options – "Yes", "No" or "Don't know" were given and the patients answered based on their knowledge. Then a brief knowledge was given to the patient about the correlation between periodontal disease and systemic diseases like diabetic mellitus, cardiovascular diseases, hematological disorders, hormonal discrepancies and osteoporosis.

## Results:

100 patients were taken up for the study out of which 11% of patients had diabetes mellitus, 27% had heart disease and 6% had hormonal problems and 1% had bone problems(osteoporosis). Following this, a questionnaire was given to the patients to evaluate the awareness regarding the association between periodontal diseases and systemic diseases. Almost 69% patients did not know that periodontal disease is an indicator of systemic disease (Chart - 1). Only 21% were aware that there is a correlation between diabetes mellitus and periodontal disease. 64% of patients did not know anything and 15% believed that there isn't any correlation (Chart - 2). As shown in (Chart – 3) 73% patients did not know that diabetes increases the severity of periodontal disease. Only 9% of patients knew that periodontal problem will worsen diabetes (Chart - 4). Treatment of diabetes cures periodontal disease- this fact was known to 72% of patients only (Chart - 5). About 22% of patients had knowledge of the fact that loosening of teeth can occur because of diabetes (Chart - 6) and 15% believed that diabetes does not cause loosening of teeth. As shown in (Chart - 7), 63% of patients were oblivious to the fact that periodontal disease is common during pregnancy. About 22% of patients felt that it is necessary to have a dental opinion during pregnancy whereas 66% of patients had no knowledge about whether to have a dental opinion or not (Chart - 8). As shown in (Chart – 9), 70% of the patients surveyed told they do not know that cardiovascular disease is related to periodontal disease and 25% of patients had wrong knowledge who answered 'No' when asked about the

relationship between heart problems and gum disease. Unawareness was there in 72% patients about the correlation between hematological disorders and periodontitis (Chart - 10). 71% of patients participated in the survey were ignorant of the relationship between bone disorders and periodontal disease and 9% of patients answered "No" to the same question

(Chart - 11).

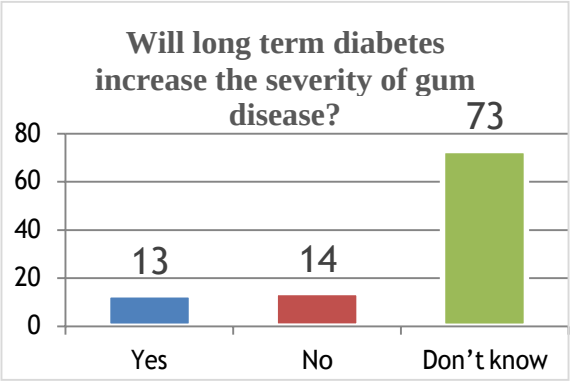


Chart - 3

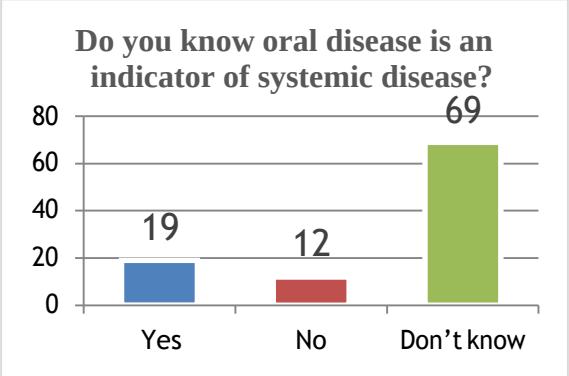


Chart - 1

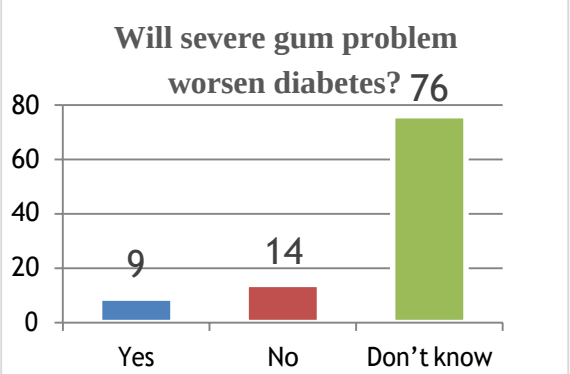


Chart - 4

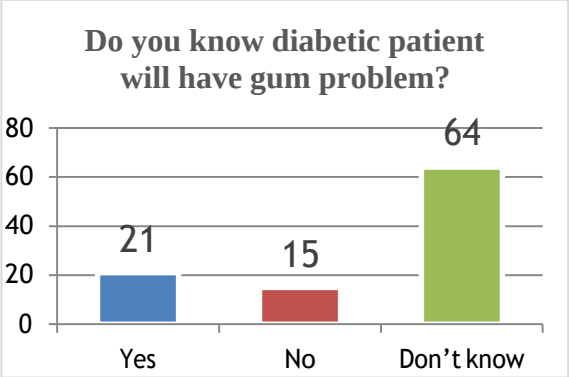


Chart - 2

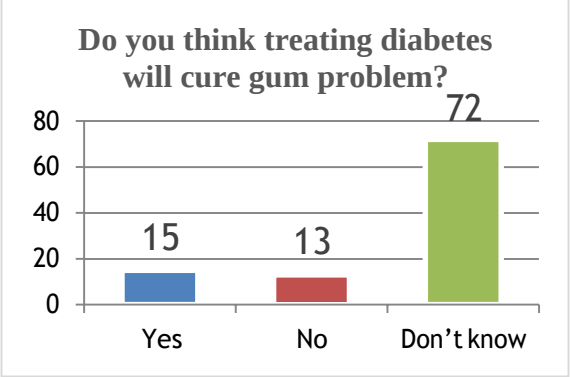


Chart - 5

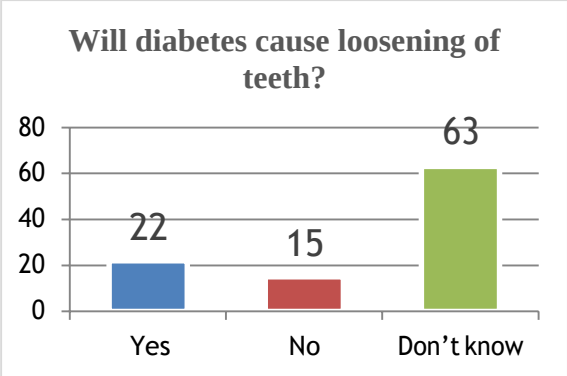


Chart - 6

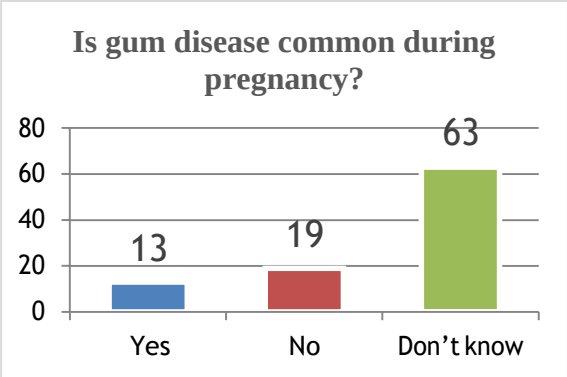


Chart - 7

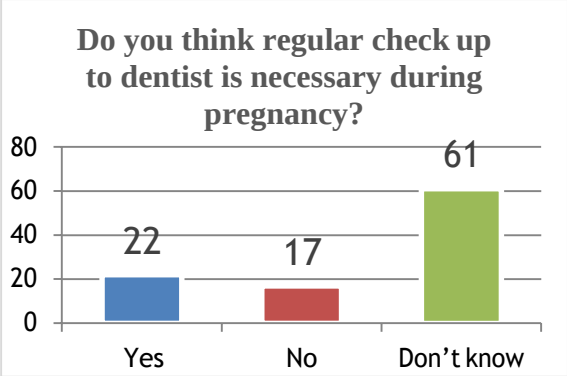


Chart - 8

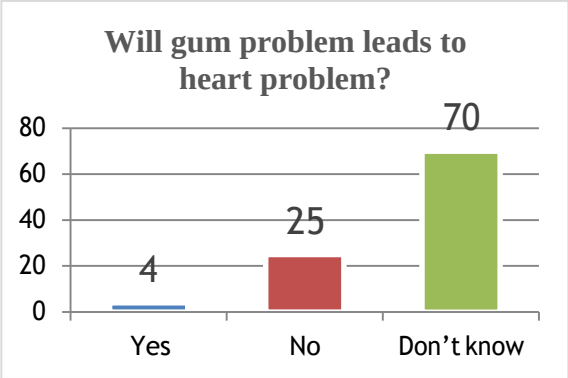


Chart - 9

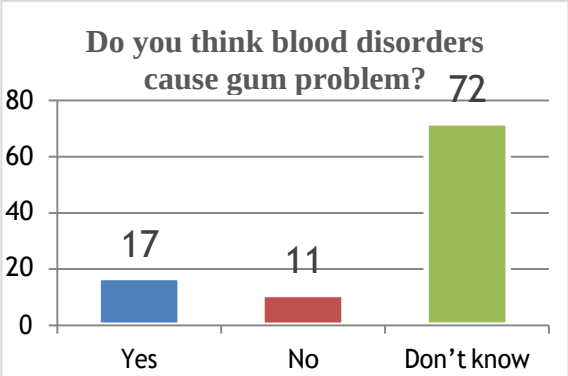


Chart - 10

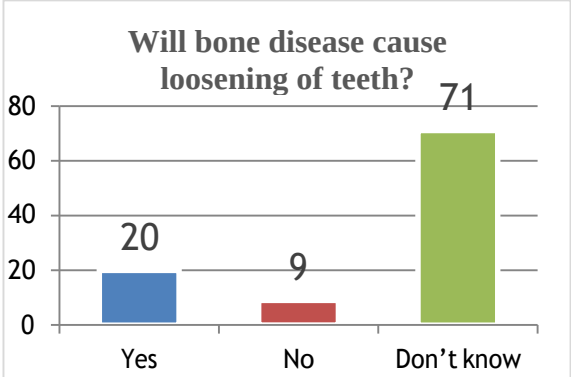


Chart - 11

## Discussion:

Periodontal disease is no longer just about oral health. It is about the entire body. It is an immune inflammatory response to microbial agent resulting from the interplay between periodontal pathogens and host. 500 different microorganisms are capable of colonizing the oral cavity. Once an inflammatory lesion in the periodontium is established, bacteria from the dental plaque can invade into the gingival tissue through the ulcerated sulcular epithelial lining of periodontal pockets and then disseminate into the systemic circulation causing systemic disorders.[1] Conversely, certain systemic disorders and conditions alter host tissues and physiology, which may impair host barrier integrity and host defense to periodontal infection, resulting in a more destructive disease. So, it is important to know the two-way relationship between systemic and periodontal disease. Diabetes mellitus is a metabolic disorder characterized by hyperglycemia due to defective secretion or activity of insulin. As diabetes is a metabolic disorder and periodontal disease is an infectious disease of the oral cavity, the pathophysiological relationship between these two entities is through the ability of both conditions to induce an inflammatory response, because of advanced glycation end products or bacterial accumulation, respectively, which further leads to the production of inflammatory mediators.[2] *Porphyromonas gingivalis* [3], a member of a red complex have the ability to invade deep vascular endothelium associated with the periodontium and can be found within pathological vascular plaques.[4,5] The study by Grossi et al. indicated that the effective control of periodontal infection in diabetic patients could improve the level of glycemic control.[6] Efforts should be directed at preventing periodontitis in patients who are at the risk of diabetes, as well as in those patients with poor metabolic control. Prevention and control of periodontal disease must be considered an integral part of diabetes control.[7,8,9] Taylor et al. reported that severe periodontitis presents six times greater risk of a poor glycemic control during a recall. Bangash et al.[10] conducted a study among diabetic patients and concluded that 64% of patients knew the oral complication of diabetes which is not in accordance with this study. Preterm low birth weight (PLBW), is a birth weight of less than 2500g with a gestational age of lesser than 37 weeks. Buduneli et al. study suggested that periodontal disease had a contributory role in PLBW.[11] In a study by

Zeba Rehman Siddiqui et al.[12] less than 20% of people knew that periodontal disease can be a cause of low birth weight babies which is in accordance with the study done by Nasir et al.[13] which was conducted among the medical interns. In this study, 63% of patients were not aware that periodontal disease is common during pregnancy. Habashneh et al.[14] concluded that awareness on periodontal disease affecting pregnancy outcomes was 36.1% which is less when compared with a study done by Tarannum and Faizuddin[15] which was 54%. Fusobacterium nucleatum, a gram-negative anaerobe ubiquitous to the oral cavity, was isolated from amniotic fluid, placenta, and chorioamnionic membranes of women delivering prematurely.[16] Case-control and prospective studies have shown preliminary evidence of the treatment of periodontal disease as a method for preventing PLBW.[17] Cardiovascular disease is a common cause of death, accounting for 29% of deaths worldwide.[3] In this study, only 4% of patients were aware of the correlation between cardiovascular diseases and periodontal diseases. Etiologically, the chronic presence of periodontal microbes can lead to atherogenesis via two pathways: 1) Direct invasion of the arterial wall[4] and 2) The release of systemic inflammatory mediators in response to infection with atherogenic effects.[18] Investigating this by sampling carotid atheromatous plaques, Cairo et al. detected *T. Forsynthensis* DNA in 79%, *F. Nucleatum* in 63%, *P. Intermedia* in 53%, *P. Gingivalis* in 37%, and *A. Actinomycetemcomitans* in 5% of the samples from carotid atheroma patients.[19] *P.Gingivalis* have demonstrated the ability to interact with the endothelial surface and to induce smooth-cell proliferation, causing damage and impairing the vasomotor functionality of the endothelial cells.[20,21,22] Arpita Gur found only 16% and 12% respondents were aware that the periodontal disease may be the possible risk factor for coronary heart disease and cerebral infarction respectively.[23] Similar results were found by Zeba Rehman Siddiqui et al.[12] in their study. In a study by AS Anandakumar, 46.7% of medical practitioners were not aware that antihypertensive drugs cause gingival enlargement.[24] Periodontal diseases is characterized by the resorption of a bone and the loss of soft tissue attachment of the tooth. Due to the commonality of bone loss between periodontal disease and osteoporosis the outcomes of both are similar. Oral osteopenia and systemic osteopenia share risk factors including age, estrogen deficiency and smoking.[25]

According to the result of Meenakshi et al**,** 75% of patients participated in the survey were not aware of the relationship between bone disorders and periodontal disease.[26] In this study only 20 % of patients had knowledge that bone disease can cause loosening of teeth. Periodontal health is of critical importance in patients with bleeding disorders as inflamed and hyperemic gingival tissues are at increased risk of bleeding.[27] Periodontitis may cause tooth mobility and warrant extraction, which may be a complicated procedure in patients with bleeding disorders. Patients with hematological disorders may neglect their oral health due to fear of bleeding during tooth brushing and flossing, which leads to increased gingivitis, periodontitis and caries. Patients undergoing periodontal treatment may be at increased risk for bleeding. Although the incidence of bleeding disorders is low in the general population, a hemorrhagic episode during or after periodontal procedures can lead to detrimental complications and can place the patient's life at risk.[28] Meenakshi et al**,** found 84% of the study population did not know hematological disorders are correlated with the periodontitis.[26] In this study 72% of the population were unaware of the same.

**Conclusion:**

Periodontal disease is an associated risk factor for various systemic diseases like diabetes, cardiovascular disease, osteoporosis, adverse pregnancy outcomes etc. Many types of researches and studies have been conducted to establish the relationship between periodontal disease and systemic diseases. The awareness about the inter-relationship among patients is very minimal. Awareness should be spread among the public and steps should be taken to prevent the periodontal disease, thereby reducing the prevalence of systemic diseases.

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# SOFT TISSUE MANAGEMENT IN ORAL IMPLANTOLOGY

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****Dr.Nidhi Jathal *****Akanksha Dwivedi

## Abstract

In the modern history of dental implants, the focus was to achieve osseointegration however this has changed over a period of time. A soft tissue seal with structures around the implants may contribute to protect the structural durability, functional harmony and aesthetics of the tissues around the implant. An association exists between bone and soft tissue preservation around implants, and this has a direct influence on aesthetics. The final outcome is the result of a number of important parameters ranging from the periodontal to the prosthetic point of view.

***Key words:*** *Dental implants, peri-implant soft tissue, grafting, guided tissue regeneration, platform switching*

## INTRODUCTION

The goal of modern dentistry is to restore the patient to normal contour, function, aesthetics, speech and health. What makes implant dentistry unique is its ability to achieve this goal regardless of the atrophy disease or injury of the stomatognathic system. The objective of implant therapy has expanded from functional restoration of the missing dentition to include the re-creation of the lost hard and soft tissues. The soft tissue that surrounds the dental implants is termed as the peri-implant mucosa. To the maximum possible extent, the peri-implant soft tissue should have the same characteristic morphology as that of the tissue surrounding the natural tooth mimicking the architecture of the soft tissue around natural teeth.

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It is essential to recreate the volume of the soft tissues which should appear in harmony with the dental restoration. Hence this paper reviews biologic events associated with healing of the soft tissue for the management of soft tissues in implant therapy.

**MINIMALLY INVASIVE FLAP TECHNIQUES:**

Papilla preservation flaps proposed by Sclar in 2003 suggested that when mesial and distal papilla are present, they should be left intact by giving a bevelled peri- crestal incision with facial vertical release incisions short of the muco-gingival junction, joining the crestal incision. This kind of technique increases the surface area for flap coaptation, decreases the dehiscence of wound margins and dramatically improves incision line aesthetics. [1]

The Curvilinear incision advocated by Miller PD Jr in 1988 used the curvilinear incisions which allow a greater volume of mucosal tissues to be incorporated in a flap, improving its overall elasticity. This facilitates passive flap coaptation and coronal advancement over a large volume of hard and soft tissue grafts, without the embarrassment of circulation to the flap margin. It is easily camouflaged and becomes less conspicuous with time compared to a linear incision. [2]

The U-peninsula flap suggested by Miller PD Jr in 1988 advocated the palatal or lingual based U-shaped peninsula flap for access to an aesthetic implant site, when visualisation of the buccal aspect of the alveolar ridge for tissue augmentation is unnecessary. Incisions through the buccal tissues are avoided to minimize scarring and to avoid soft tissue recession at the site by preserving circulation and soft tissue volume. [2]

The use of tissue punch in aesthetic implant therapy is primarily indicated for exposure of a submerged implant when the volume and architecture of the peri-implant soft tissue are already ideal in area critical for prosthetic emergence. This tissue punch is available in a variety of sizes to accommodate various implants. [3]

**SURGICAL TISSUE GRAFTING AND AUGMENTATION TECHNIQUES AROUND IMPLANTS [4]:**

Dhir S and George P in suggested the following surgical tissue grafting and augementation techniques.

1. Apically positioned flap / Vestibuloplasty (APF/V)
2. Free Gingival Graft (FGG)
3. Inter-positional Free Gingival Graft
4. Sub-epithelial Connective Tissue Graft (SCTG)
5. Modified palatal roll technique
6. Vascularised Inter-Positional Periosteal Connective Tissue Flap (VIP-CT)
7. Papilla Regeneration
8. Modification of Soft Tissue Augmentation Techniques
9. Combined techniques

**PROSTHETIC CONSIDERATIONS**

**Implant position:**

According to Kois. J the mesio-distal position should be 1.5–2.0 mm between a tooth and an implant, and 3 mm between adjacent implants; 3.5–4.5 mm between the upper central incisors. The bucco- lingual position should be 2–3 mm inside from the line joining the adjacent gingival margins

and the apico-coronal position: 3 mm apically from the gingival margin of the implant site.[5] Repeated connections and disconnections of healing or implant abutments at different stages of surgery or prosthetic execution are the cause of the trauma of soft tissue attachment, which results in disruption of the bond between the epithelial attachment and the connective tissue, and in bacterial colonization that induces bone resorption, followed, in thin gingival biotypes, by gingival recession which can negatively impact soft tissue stability.[6]This would be particularly important in the restoration of adjacent implants, where clinicians are challenged to conserve optimal papilla anatomy in the inter-implant region.[7]

**SWITCH PLATFORM CONCEP4[4,4]**

Wang et al in 2011 suggested that an implant design with a platform diameter less than that of the implant body, with a tapered wall, and with a convergent or sloping implant shaped module of the platform shoulder, can be considered as the ideal implant design for homogenous occlusal force distribution, prevention of bone loss around the implant collar and crestal bone, and improvement of the gingival aesthetics.[10] Platform switching presents several advantages like supracrestal fibers are above the bone, implant/abutment interface is located away from the bone, increases the horizontal component of the biological width, induces maintenance of the horizontal and vertical height of the mesiodistal papilla, decreases cervical bone resorption to the usual minimum amount of bone loss as far as the first thread of the implant.

**PROVISIONAL AND FINAL RESTORATION:**

The provisional implant restoration plays an essential role in the anterior sector in the preservation or the shaping and formation of peri-implant soft tissue. Clark et al suggested that the definitive restoration is typically delivered following a 4–6-month provisionalization phase[11]. According to Kinsel R, the cement line and preparation, it should be ideally kept flush with the level of the soft tissue margin at surgery, but it may later be extended to lie 0.5–1.0 mm subgingival following implant integration.[12] Wilson J conducted a prospective clinical study and concluded that clinical and endoscopic signs of peri- implant disease are absent in 74% of the test implants after the removal of excess cement.[13]

## CONCLUSION:

Implant dentistry has been established as a predictable treatment modality with high clinical success rates. The replacement of missing teeth is only one part of the treatment. Another important aspect of therapy consists of replacing the lost portion

of the alveolar process and the associated soft tissue. The re-establishment of a normal alveolar contour is a critical step in aesthetic success. The long-term prognosis of the function and the aesthetics of dental implants can be improved by correctly classifying alveolar ridge defects, by adhering to proper techniques for alveolar ridge and soft tissue augmentation, and by ensuring the most appropriate mode of implant placement in individual patients.[14] All these factors contribute to the major success of the implant treatment. However, if soft tissue management is not done appropriately the implant therapy may not give completely successful results.

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# Milling Procedure in Prosthodontics

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## ABSTRACT

In prosthodontics various indirect restorative methods like casting and heat sintering procedures were used widely but they have limitations. To overcome these limitations milling procedure was introduced. It is known as the process of braking down, sizing, separating or classifying aggregate materials. In milling procedure any restoration can be fabricated by subtractive manufacturing. Milling machine are classified into two type namely Horizontal milling machine and Vertical milling machine

***Keywords:*** *Subtractive manufacturing, horizontal milling machine, vertical milling machine, dry milling, wet milling*

## INTRODUCTION

Prosthodontics is one of the oldest dental specialties and has a long history of innovation and adaptability. Various indirect restorations methods like casting and heat sintering procedures were used widely but due to limitations like distortion, surface roughness, irregularities and porosity[1] advancement in the process was a prime requirement. In order to overcome these limitations milling was introduced. In simple words,

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All the milling processes that are to be carried out and all the final dimensions are fed into the computer via the program. The Milling refers to the process of breaking down, separating, sizing, or classifying aggregate material. It has advantages like better accuracy, reduced clinical visits, and marginal integrity.[2] computers thus knows what exactly is to be done and the fabrication of restoration takes place.[3] These restorations can be fabricated by two methods:

1. Subtractive manufacturing
2. Additive manufacturing

**Historical Background:**

The CAD/CAM technology was introduced by Duret in 1971 however unlike today, dental CAD-CAM was not very popular due to a number of factors that included: The cost of the equipment's and the time needed, the precision needed while recording the details of the site of preparation of the restoration, precision in the final milling of the accurate restoration.[10] The CEREC 1 system was the first to be introduced for dental purpose that marked a landmark in the mid 1980's. In 1987 Dr. Andersson designed the Procera system.[3] He attempted fabrication of titanium copings by spark erosion. He introduced CAD/CAM technology for processing composite veneered restorations. The Lava CAD/CAM System was introduced in 2002. It has been used for fabrication of zirconia frameworks in all ceramic restorations.

**Type and components of milling machine:**

Most of the milling machines are constructed of a column and knee structure and they are classified into two main types namely Horizontal Milling Machine and Vertical Milling Machine. The name horizontal or vertical is given to the machine by virtue of its spindle axis. Horizontal machines can be further classified into Plain Horizontal and Universal Milling Machine. The main difference between the two is that the table of a Universal Milling Machine can be set at an angle for helical milling while the table of a Plain Horizontal Milling Machine cannot perform thus.[5] Two types of milling machine are mainly being used

**Horizontal Milling Machine:**

The Horizontal Milling Machine is a very robust and sturdy machine. A variety of cutters are available to remove or shape the material that is normally held in a strong machine vice. This horizontal miller is used

when a vertical miller is less suitable. For instance, if a lot of material has to be removed by the cutters or there is less of a need for accuracy - a horizontal milling machine is chosen.[6]

**Vertical Milling Machine:**

A vertical milling machine which is of similar construction to a horizontal milling machine except that the spindle is mounted in the vertical position.[6]

**Types of Milling Procedure:**

Milling is the final phase of the dental CAD/CAM process. It involves developing a restoration from a CAD model into a physical part that undergoes processing, finishing, and polishing before being inserted into the patient's mouth.[7]

The construction data produced with the CAD software is converted into milling strips for the CAM-processing and finally loaded into the milling device. Processing devices are distinguished by the means of number of milling axes; which are listed thus: -

3-axis devices

4-axis devices

5-axis devices

**3 – Axis milling devices:**

This type of milling device has degrees of movement in the three spatial directions. Thus, the mill path points are uniquely defined by the X -, Y -, and Z- values.[8]

All 3-axis milling devices used in the dental field can turn the component by 180° in all 3 spatial directions, i.e. X, Y, Z, in the course of processing the inner and the outer surfaces of the prosthesis.

Some examples of 3 axis devices are as following:[8]

1. in Lab (Sirona, Dentsply, USA)
2. Lava (3M ESPE, USA)

**4– Axis milling devices:**

In this type of device, in addition to the three spatial axes, the tension bridge for the component can also be turned infinitely variably.[8] As a result, it is possible to adjust bridge fabrications with a large vertical height displacement into the usual mold dimensions. Hence, amount of material as well as the milling time can be reduced. Some examples of 4 axis devices are as following:[8]

1. Zeno (Wieland-Imes, Germany)

**5 – Axis milling devices:**

With a 5-axis milling device there is also, in addition to the three spatial dimensions and the rotatable tension bridge ($4^{th}$ axis), the possibility of rotating the milling spindle ($5^{th}$ axis).[8]

Some examples of 5 axis devices are as following:[8]

1. Everest Engine (KaVo, Germany)
2. HSC Milling Device (etkon, Germany)

However, it should be noted that the increased quality of the restoration results much more from the result of the digitalization, data processing and production process rather than increasing the number of processing axes.

**Dry Milling:**

The comminution of materials in a suitablethe presence of a liquid, either by rods, balls, or pebbles, or autogenously, by the material itself; used if the subsequent process is a. Dry processing is applied mainly with respect to zirconium oxide blanks with a low degree of pre-sintering.[22] Some illustrations of wet milling are as following:

1. Zeno 4030 (Wieland- Imes, Germany)
2. Lava (3M ESPA, USA) and Cercon brain (Dentsply, USA)

**Wet milling:**

Wet milling is also known as Green milling. In this process the milling diamond or carbide cutter is protected by a spray of cool liquid against overheating of the milled material. This kind of processing is necessary for all metals and glass ceramic material in order to avoid damage through heat development. 'Wet' processing is recommended, if zirconium oxide ceramic with a higher degree of pre-sintering is employed for the milling process. A higher degree of pre-sintering results in a reduction of shrinkage factor and enables less sinter distortion.[22]

Some illustrations of wet milling are as following:

1. Everest (KaVo, Germany)
2. Zeno 8060 (Wieland-Imes, Germany)
3. inLab (Sirona, Dentsply, USA)

**Applications, Advantages and Limitations of Millig Procedures:**

Inlays, onlays, veneers, crowns, fixed dental prostheses, implant abutments, and the full spectrum of implant prostheses, when fabricated via milling procedures ensures a restoration with better accuracy, restorative quality, in term improving the life & prognosis of the treatment. The milling procedure was developed to solve three challenges. The first challenge was to ensure adequate strength of the restoration, especially for posterior teeth. The second challenge was to create restorations with a natural appearance. The third challenge was to make tooth restorations easier, faster, and more accurate. In some cases, CAD/CAM technology provides patients with same-day restorations.[10]

**Applications of Milling Procedure:**

Procedure in fixed prosthodontics

In complete denture prostheses

In removable partial denture prostheses

In implant prosthodontics

In fabrication of surgical guides for implant placement:

In maxillofacial prosthodontics

**Advantages of Milling:**[7,11-16]

The use of Milling procedures for dental restorations has numerous advantages over traditional techniques. Speed, High precision and accuracy, Application of new materials, Reduced labor, Cost effectiveness, Quality control, Ease of retrieving the data.

**Limitations of Milling Procedure:**[9,11,17,18]

Time investment to master the technique, initial high cost of CAD/CAM equipment, Difficulty in recording details with some scanners. However, the advantages of milling procedures outweigh these limitations and hence it has emerged as a successful treatment option.

**The Future of Milling:**

Milling devices are expected to become increasingly simple and convenient to use. In anticipation of future advances, the CEREC AC is prepared for voice control and voice output. Improvements in technology should avoid some of the back-and-forth data information between the dentist, the manufacturer, and the dental laboratory. There are some areas of application for which milling is already applied. In some production centers, so-

called ‘laser sintering devices’ are used to produce crown and bridge frames from chrome cobalt alloys. Since the productivity of such devices is very high, dental restorations can be produced very cost-effectively. Basically, geometries are conceivable with this technology that cannot be realized with grinding technology.

**Conclusion:**

The introduction of milling in dentistry and its extraordinary speed of development in the industry affirms that it is being rapidly accepted in the dental profession. It allows application of newer high strength materials with outstanding biocompatibility combined with adequate mechanical strength, provisions for esthetic designs and excellent precision of fit and longevity. However, these advantages must be balanced against the high initial cost of milling machines and the need for additional training. The future evolution of milling procedures in dentistry could be spectacular considering its numerous possibilities. Its application is promising, not only in the field of dental prosthetics, but also in other fields of dentistry. It provides innovative, state-of-the-art dental service, and contributes to the health and the quality of life in aging societies.

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# MINIMALLY INVASIVE POST ENDODONTIC RESTORATIONS

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**Abstract**

Endodontic therapy is routinely used in contemporary dentistry as a treatment modality to avoid the loss of a tooth. Post endodontic treatment, a satisfactory restorative solution is necessary to improve the longevity of a tooth. Restoring endodontically treated teeth with a minimally invasive approach has become more successful lately because of the improvement in the adhesive restorative technologies. Biomimetics or bio emulation makes use of two key concepts: adhesion and tissue preservation. Following this concept helps us to achieve maximum longevity and esthetics while preserving the remaining tooth structure. The tooth – restorative bond is less likely to disrupt when the tooth is restored using the concepts of biomimetics. The materials and the kind of adhesion used helps the restoration to simulate the tooth so ultimately, the tooth and the restoration work in cohesion with each other and chances of failures are reduced. This paper has reflected over the types of minimally invasive post endodontic restorations that help us execute this form of treatment to restore a tooth.

***Key words:*** posts, core, inlays, onlays, biomimetic, minimally invasive, endocrowns

## INTRODUCTION:

There are a variety of materials and techniques advocated for restoring pulpless teeth, and hundreds of studies devoted to this subject have been published in the dental literature.[1] Scientific literature on the post-endodontic restoration is unanimous: the prognosis of root-filled teeth depends not only on the success of the endodontic treatment but also on the amount of remaining dentine tissue, and the nature of final restoration.[2] The recent changes in the methods available for restoring endodontically treated teeth depend on the improvement of the adhesive techniques, composite resin materials, fiber posts, and indirect ceramic materials.[2]

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Biomimetic dentistry uses modern materials to replicate the tooth's biologic and mechanical function.[3] This technique involves using dental adhesives and sometimes fiber reinforcement to reproduce the tooth's natural hard tissues to facilitate a secure bond.[3] As Pascal Magne points out, the concept of modern biomimetics can be summarized into three distinct, but closely linked, categories: Observation of nature, biology, its role, its mechanical behavior, and its optical characteristics; respect of nature in preparing a minimal dental tissue and reproduction of nature using adhesion and modern biomaterials (composites and ceramics).[4]

**NEED FOR MINIMALLY INVASIVE POST ENDODONTIC RESTORATIONS:**

Many classical indications for a crown restoration are nowadays questioned.[5] The largest reduction in tooth stiffness results from additional preparation, especially the loss of marginal ridges; the literature actually reports 14% to 44% and 20% to 63% reduction in tooth stiffness following occlusal and mesio-occluso-distal (MOD) cavity preparations, respectively.[6] Minimally invasive preparations, with maximal tissue conservation, are now considered the gold standard for restoring endodontically treated teeth.[7]

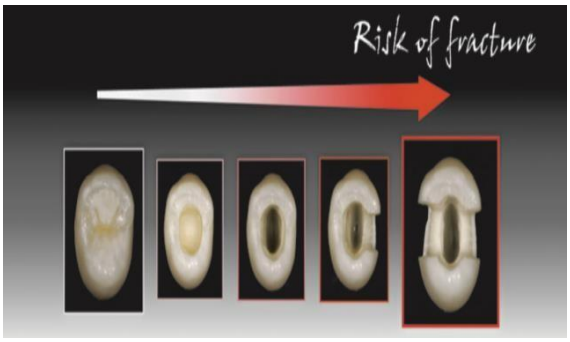


**Illustration 1: The risk of fracture of an endodontically treated tooth is directly related to the quantity of tissues lost and to the specific cavity**

**RADICULAR RESTORATIONS:**

The loss of tooth structure makes endodontically treated teeth more susceptible to fracture or so it is believed. A post facilitates the retention of restorative materials for fabrication of a foundation in both posterior and anterior teeth.[8] Consideration must be given to the variables involved: type of tooth, remaining tooth structure, periodontal support, root and pulp morphology, and occlusion.[8]

**INDICATIONS FOR POST PLACEMENT:**

1. Type of tooth:

Molars:

Posts are rarely required in endodontically treated molars and when required, because of lack of adequate remaining coronal tooth structure, it should generally be placed only in the largest canal.[9]

**Premolars:**

The decision regarding post placement is made based on the remaining coronal tooth structure, the functional requirements of the tooth, and an evaluation of the forces that act on the tooth.[9]

**Incisors:**

Because of the shearing forces that act on them, anterior endodontically treated teeth are restored with posts more often than posterior teeth.[9] The decision to place a post is dictated by the amount of coronal remaining tooth structure after the crown preparation is completed.[9]

2. Amount of remaining tooth structure:

Class I: Describes the access preparation with all 4 axial cavity walls remaining.

Class II : Describes loss of 1 cavity wall, commonly known as the mesio-occlusal (MO) or the disto-occlusal (DO) cavity.

Class III: Represents an MOD cavity with 2 remaining cavity walls.

Class IV: Describes 1 remaining cavity wall, in most cases the buccal or oral wall.

Class V: Describes a decoronated tooth with no cavity wall remaining.[10]

**IMPORTANT PRINCIPLES FOR POSTS[11]**

Retention and resistance, failure mode, preservation of tooth structure, the ferrule effect and retrievability.

**CRITERIA FOR POST PLACEMENT[10]**

Post length:

post length should reach two-thirds of the entire root length. A crown-length/post-length ratio of at least 1:1 should be provided.

Post diameter:

A diameter of one-third of the root diameter is postulated in many reviews. A minimal dentin thickness of 1 mm around the post should be provided.

Post fixation:

Adhesive systems seem to be able to stabilize the tooth. posts were adhesively cemented were significantly more fracture resistant than those using zinc phosphate cement.

Post design:

Parallel-sided posts and those surrounded by large amounts of cement had lower fracture rates than tapered posts or tapered posts with maximal adaptation in the root canal. Tapered posts preserve more tooth structure but tend to have a greater failure rate.

Post & core material:

With respect to the material used, efforts should be made to make sure that the post and the core material should be the same or an analog material should be used.

**TYPES OF POSTS**:

Posts can be classified as

- Active and passive posts
- Parallel and tapered posts
- Prefabricated and custom made posts
- According to material used:
  - Metal posts
  - Zirconia posts
  - Carbon fibre posts

- Glass fibre posts
- Polyethylene fibre posts

**THE POST/RESIN INTERFACE**

In addition to the interface between the resin cement and dentin, the post/resin inter- face is also important. Several surface treatments of the post have been recommended for improving the bonding of resin cements or core materials to fiber posts.[12]

- Silane application
- Air abrasion
- Alternative etching techniques involving hydrogen peroxide or sodium ethoxide.[12]

**CORONAL RESTORATIONS:**

Coronal rehabilitation of endodontically treated teeth is required but choosing the type of restoration depends on a number of factors, most important of which is the amount of the tooth structure remaining. The minimally invasive restoration to elect range from direct composite restorations, veneers, inlays, onlays and endocrowns.

**CLINICAL GUIDELINES:**

Minimal loss of tooth structure:

Such teeth should be treated with only adhesive restoration filling the access cavity and pulpal chamber. The choice of material should be limited to composite resins, in combination with an effective adhesive system, following the total bonding concept.[7]

Upto one half of the coronal tooth structure missing:

Complete occlusal coverage such as an endocrown or indirect tooth-colored overlay is suggested, overlying a bonded composite resin liner-base to create an even cavity geometry and fill undercuts.[7]

More than half of the coronal tooth structure is missing:

A post-and-core restoration is mandatory to ensure tooth-restoration continuum strength and resistance to fracture. A ferrule effect should also be attained. Occlusal anatomy and function are usually restored with a full crown.[7]

Most of the coronal tooth structure is missing:

This represents the least favorable biomechanical situation and cannot be satisfactorily or safely approached in the long term. Extraction and implant therapy can be considered an alternative to the conventional treatment.[7]

**Direct composite restorations**:

This is the least invasive option especially when restoring posterior teeth with conservative access preparation. Developments in the adhesive restorative technologies enable construction of debilitated tooth structure with a more conservative non-invasive approach to rebuild the integrity of the residual tooth structure.

**Illustration 2: Direct composite restoration**

**Veneers:**

Among indirect techniques, ceramic laminate veneers represent a well-documented, effective, and predictable treatment option.[13] Recently composite veneers are also being used to restore the anteriors. The main indication for using veneers include in the anteriors where discoloration cannot be masked with direct restoration.

**Illustration 3: Veneers**

**Posterior indirect adhesive restorations**:

The typologies of cavities that have to be restored in the posterior area are : inlay (a cavity that does not need cuspal coverage), onlay (a cavity with coverage of one or more cusps), overlay (a specific onlay typology with complete cuspal coverage), and veneerlay (an overlay with the involvement of the buccal wall and a preparation combined with a laminate veneer).[14]

**Endocrowns**:

The endocrown is a restorative option for endodontically treated teeth. It consists of a circular butt-joint margin and a central retention cavity inside the pulp chamber and lacks intraradicular anchorage.[7] It is a conservative alternative to full crowns for the treatment of posterior nonvital teeth that require long-term protection and stability.[7]

**Illustration 4: Ceramic overlays**

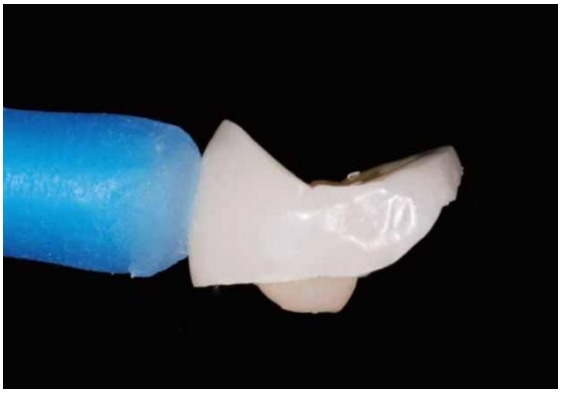

**Illustration 5: Endocrowns**

**CONCLUSION:**

The advances in material science and adhesive dentistry have allowed us to use a more conservative minimally invasive approach to restore endodontically treated teeth. Preservation of tooth structure is of utmost importance for ensuring success of these restorations. Advances in adhesive dentistry have enabled us to use posts as a reinforcement factor rather than a retentive element. Last, but not the least, proper treatment planning while restoring an endodontically treated tooth is the key factor that decides the success or failure of a restoration.

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