Indian Dental Association

ISSN: 09733442

Volume 41

Issue 1

KSDJ KARNATAKA STATE DENTAL JOURNAL

Official Publication of IDA Karnataka State Branch

INDIAN DENTAL ASSOCIATION KARNATAKA BRANCH

CONTENTS

FROM EDITORS DESK

Dear Readers,

Welcome to another enriching edition of our publication, where knowledge meets curiosity and insight sparks inspiration. In this issue, we're excited to feature a thought-provoking exploration into the world of dental implants. Discover how these remarkable advancements in dentistry are reshaping smiles, restoring confidence, and transforming lives. Whether you're considering dental implants or simply intrigued by the intersection of technology and oral health, this feature is sure to captivate your interest.

Additionally, we're thrilled to announce a call for papers for our upcoming issue, focusing on the crucial topic of 'Oral Concerns of Systemic Diseases.' As we delve deeper into the intricate connection between oral health and overall well-being, we invite experts, researchers, and practitioners to contribute their insights, findings, and perspectives on this vital subject.

Join us as we continue to explore the frontiers of knowledge, expand our horizons, and empower our readers with information that matters. Here's to another enlightening journey together.

For any inquiries, submissions, suggestions, please feel free to reach out to us at editorksdj2023@gmail.com

Warm regards,
Editorial Team.

Dr. Mohan Kumar K. P
Hon. Editor

Dr. Patil Disha
Assistant Editor

PRESIDENT'S MESSAGE

Dr. Bharath SV
President

Dear Esteemed Readers,

As the President of the Karnataka State Dental Journal, it is my privilege to extend a warm welcome to all our readers.

Our journal has long served as a platform for the exchange of knowledge, ideas, and innovations in the field of dentistry. It is a testament to the dedication and expertise of our contributors, reviewers, and editorial team that we continue to uphold the highest standards of academic excellence.

In each issue, we strive to present cutting-edge research, insightful reviews, and thought-provoking perspectives that reflect the dynamic landscape of modern dentistry. We are committed to fostering collaboration and dialogue among dental professionals, educators, researchers, and students, both within Karnataka and beyond.

As we embark on this journey together, I encourage you to actively engage with the content of our journal, to share your insights and experiences, and to contribute to the advancement of dental science and practice.

Thank you for your continued support and participation in the Karnataka State Dental Journal. Together, let us continue to elevate the standards of oral healthcare and make a positive impact on the lives of our patients and communities.

Best wishes,
Dr. Bharath SV
President
IDA
Karnataka State Branch

SECRETARY MESSAGE

Dear Colleagues,

Oral rehabilitation, especially the field of implant dentistry, has significantly evolved in the last few decades. The introduction/development of new tools, such as: The immediate function concept, digital planning, standard dental implants with different micro- and macro-designs, zygomatic implants, guided surgery, prosthetic CAD/CAM solutions, regenerative solutions, or standardized maintenance approaches with risk prediction, have allowed us to overcome significant challenges and dramatically improve patients' quality of life. Today, there is a growing body of evidence on the successful long-term outcomes of implant-supported rehabilitation protocols that provides validation for their predictability and safety.

Nevertheless, there is still margin for both exponential and incremental growth in modern implant dentistry research, considering the challenges and potential correlations between the implant geometry, the biomechanical behavior, the biomaterials, the bone quality, the patients' medical condition, and the surgical technique. Thus, research on all of the advances, innovations, and outcomes is of interest in this Special Issue of journal dedicated to implant dentistry.

Hearty congratulations to all the contributors for this edition of journal

Dr. Mahesh Chandra K
Secretary

INDIAN DENTAL ASSOCIATION KARNATAKA STATE BRANCH

OFFICE BEARERS : 2022-2023

President
Dr. Bharath SV

Hon Secretary
Dr Mahesh Chandra K

Treasurer
Dr. Sanjay Kumar. D

Editor in Chief
Dr. Mohan Kumar K.P

Joint Secretary
Dr. A. G. Annaji

Assistant Secretary
Dr. R. Chethan

CDE Chairman
Dr. Revan Kumar Joshi

CDH Chairman
Dr. Venkatesh Babu

President Elect
Dr. Bharath SV

Immd. Past President
Dr. Srinidhi D

Vice Presidents

Dr. Mahendra V. Pimpale
Dr. Dhanu G.
Dr. M. G. S. Prasad
Dr. Aaquib Hashmi

Executive Committee Members

Dr. M. L. V. Prabhuji
Dr. Shuban Alva
Dr. Pratap Kumar Shetty
Dr. Padma Raj Hedge
Dr. Shivu M. E.
Dr. H. R. Arunananda
Dr. Sushanth V. H.
Dr. Ali I. M.
Dr. Sachin Shivanaikar
Dr. Praveen S. Basandi
Dr. Shambulingappa P.

Dr. Umesh Allad Dr. Arshad Hussain
Dr. Vishwanath Patil
Dr. Sharan Shetty
Dr. Pramod Shetty
Dr. Sanath Shetty
Dr. Jitheesh Shetty
Dr. Girish Katti
Dr. Utkarsha Lokesh
Dr. Kirthi Shetty
Dr. Shishir Shetty
Dr. Nithish Shetty

Dr. Sudarshan Kumar R. N.
Dr. Yokesh V. R.
Dr. Raghunand Sindhe J.
Dr. Manjunath Sarangi
Dr. Jeevan Shetty
Dr. Dhayakar K. V.
Dr. Dhulappa Patil
Dr. Raghunath N.
Dr. Sheshadri R.
Dr. Nikita S.
Dr. Manjunath R. K.

Central Council Members

Dr. Rama Murthy T. K.
Dr. Mahesh Chandra K.
Dr. D. Srinidhi
Dr. V. Ranganath
Dr. Narendra Kumar M.
Dr. Annaji A. G.

Dr. Mahendra V. Pimpale
Dr. Shiva Prasad S.
Dr. Charan Kumar Shetty
Dr. Sanjay Kumar D.
Dr. Anirban Chatterjee
Dr. Raghavendra Pidamale

Dr. Ravi M. G.
Dr. Kiran Radder
Dr. Raghavendra Katti
Dr. H. P. Prakash
Dr. Veerendra Kumar S. C.
Dr. Ramachandra Mallan
Dr. Shiva Sharan Shetty

`

IMPLANT IMPRESSIONS – THE ULTIMATE NO BRAINER FOR A SUCCESSFUL PROSTHESIS

Author:

Dr Supriya Nandi
Indian Navy Hospital Ship Dhanvantari , Port Blair , South Andamans
Andaman & Nicobar Islands

Corresponding author:
Dr Supriya Nandi
Indian Navy Hospital Ship Dhanvantari , Port Blair , South Andamans
Andaman & Nicobar Islands
Email: drsupriya431@gmail.com

ABSTRACT

For a successful dental implant therapy, apart from Osseo integration of the implant to the bone, fit of the prosthesis holds an equal weightage. To fabricate a passive fit prosthesis, the impression of the implants needs to be accurately recorded. The precision of the impression made decides the fit of the prosthesis and the connection of the components. There are several types of impressions in implant dentistry like open tray, closed tray, digital etc. it depends upon the thorough knowledge and understanding of the operator to choose the impression material of choice and the technique for an error free prosthesis.

KEYWORDS – implant impressions, prosthesis, passive fit, open tray, closed tray, digital impression, dental implants

INTRODUCTION

Dental Implants are no foreign term to the laymen. Currently Implants have become a common means for replacing missing teeth and restoring back the smile, chewing ability and confidence that the patient has always wanted. Various factors play an important role in the long-term success of an implant. One of the key factors in maintaining longevity is the passive fit of implant prosthesis. A passive fit implant is a Strain- free superstructure that does not provide load to any of the components.

The discrepancies in passive fit of prosthesis may lead to complications such as screw loosening, screw facture, occlusal discrepancies, and increased plaque accumulation, resulting in loss of Osseo integration and implant fracture. [1]The success of a passive fit prosthesis depends upon how accurately have the impressions been made and transferred to receive the copings. Accurately relating an analogue of the implant or implant abutment to the other structures in the dental arch is a prime factor for prosthesis success. Further the accuracy of impression is affected by the selection of impression tray, impression technique and type of impression material, number and angulation of implant. [2]

OBJECTIVES OF AN IMPLANT IMPRESSION

1. Accurately positioning the prosthetic components to the Osseo-integrated implant fixture.
2. Accomplice the superstructure in such a way that Maximum esthetics and emergence profile is achieved.

3. Harmony to be maintained between hard tissue and soft tissue.

The amalgamation of all the following steps combines in making an accurate and hassle-free implant impression.

a. Identification of correct implant components.
b. Selection of custom tray - Can be stock or custom trays.
c. Choosing impression materials - accurate, easy to mix, biocompatible, dimensionally stable.
d. Selecting the screw-driver - hex - either external or internal depending on the implant-abutment system.
e. Healing caps or abutments.
f. Impression copings and abutments.[3]

Implant level impressions[4]

The implant level impression is a universal impression technique allowing for the fabrication of any type of restoration. This impression gives greater flexibility for the selection and modification of an abutment by a laboratory technician.

There are two primary techniques for implant level impressions:

• The indirect (closed tray) technique and
• The direct (open tray) technique.

The direct technique may use:

• Splinted or
• Non-splinted implant impression copings

Abutment Level Implant Impression[5]

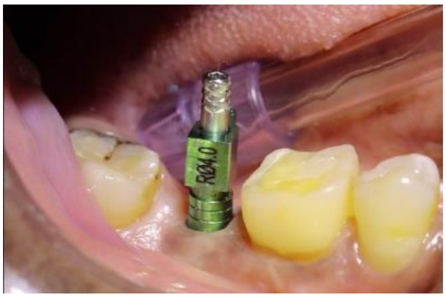
If there is a requirement to replace old implant supported crown, abutment level impression is indicated just like crown and bridge cases

Advantages of Abutment level impressions

i. Simple provisional restoration fabrication
ii. Selecting abutments in the laboratory
iii. For custom-made abutments[6]

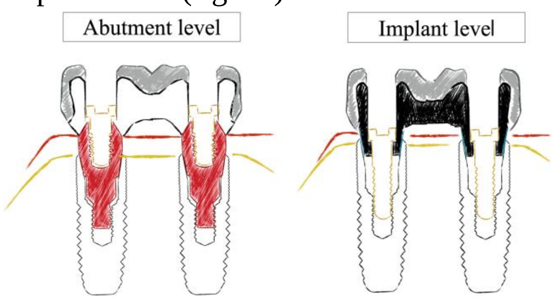
TECHNIQUES FOR IMPLANT IMPRESSION

1. **Fixture level impressions** - The impression coping is connected to the top of the implant fixture (body of the implant). After a fixture-level impression is taken, the abutment can be selected right on the model where the superstructure can also be fabricated. (fig 1)



2. **Abutment level impressions** Abutment level impression is a method of taking an impression by connecting the abutments to the top of the implant fixture (body) and subsequently connecting the impression copings to them. The connected abutment in the oral cavity is not removed in the abutmentlevel

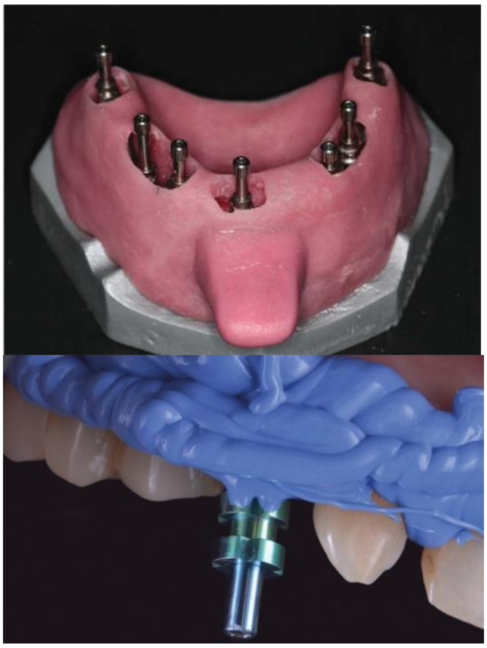
impression. (fig 2)



. (fig 2)

It has been reported that the accuracy of the implant-abutment level impression is higher when the pick-up technique is used as opposed to conventional crown and bridge impression technique[7]. The fixturelevel technique failed to be as good as abutment-level technique in terms accuracy of angle of implants showing mostly linear errors.

3. **Open Tray Technique**–In this method, the impression coping is connected to the fixture in the oral cavity. The tray from which impression is to be made is made a hole along the coping. Material of choice is loaded and after the impression material hardens, the impression is unfastened from coping's screw from the open tray. The impression body, and the impression coping is removed together with the impression body from the oral cavity. (fig 3,4)

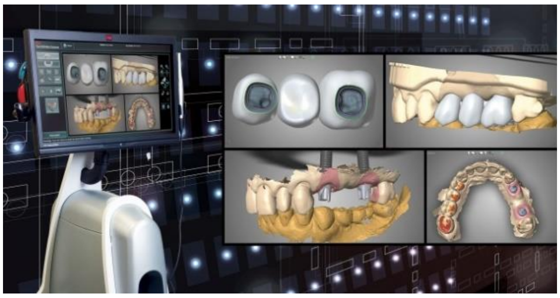


(fig 3,4)

4. **Closed Tray Impression Technique**– Here a Stock tray or a Custom tray is used. A regular impression is made and as the impression material polymerizes the impression is dislodged from the closed tray impression copings. Thereafter impression copings are removed and implant or abutment analogs are attached to the copings. This then goes into the impression body during what is called a transfer process. The combined coping-analog assembly is then inserted into the definitive impression. (fig 5)

5. **Provisional Restoration** - Another method of transferring soft tissue information is incorporating the provisional restoration into the impression. When screw retained restorations are used, the provisional restoration itself can be used as a pick up type impression coping. A soft tissue cast is poured around the exposed provisional after an impression coping is attached; yielding a soft tissue cast which is identical to the soft tissue form intra orally. This allows communication of some vital information to the technician fabricating the definitive restorations[8]. (Fig 6)

6. **Digital impressions** - With the expanding use of digital/computerized impressions, implant systems provide scan bodies that allow for capture of the relationship of the implant connection to adjacent structures more accurately through sensors. This negates or reduces the use of traditional impression materials. In order to take a digital impression of an implant, the first thing you need to do is acquire the proper Intra-oral scan-body. Scan-bodies are specific to the brand of implant. They attach directly to the implant, much like a traditional impression coping, and are present during the digital scan. The foremost common scanning principles utilized by intraoral dental scanners on the market are triangulation, active wave-front sampling, and parallel confocal optical device scanning [9].



(fig 7)

Some tips for making an accurate Implant Impressions

- Use correct size tray as per the arch, preferable to use a customized tray
- Use a Vinyl glove for rubber based impression material as it prevents retardation of setting of the impression material from the interaction of latex gloves
- During open tray technique, make sure to block the impression material from entering the impression posts
- It has been shown that the pickup type impression coping is the more accurate type of impression as errors occur on removal and replacement of the transfer type impression copings, especially in the occluso-gingival direction. [10-13]

Additional Impression Techniques[8]

Lorenzoni et al compared three different impression materials (polyether, polyvinyl siloxane, and hydrocolloid) and transfer caps with the Frialit(R)-2 system and with the indirect technique to improve transfer precision. A three-dimensional (3D) co-ordinate measuring machine determined that that addition-silicone (a-silicone) and polyether are superior materials for implant transfer procedures. Transfer caps “significantly reduced rotation in the XY-plane but did not improve the absolute 3D displacement,” they concluded.

Wee et al have noted that die systems used for multiimplant casts are crucial for obtaining optimum intraoral fit in accord with painstaking prosthodontic procedures accompanying implants. The in vitro study compared “the accuracy of implant casts fabricated from three conceptually different die systems at the solid, sectioned, and repeated stages.” They used a polyether impression material to make 30 direct transfer implant impressions of the master cast. They made 10 experimental implant casts for each of three die systems: double-pour (Pindex), plastic base (DVA), and die tray (KO

Tray). Analysis of measurements led them to recommend a double-pour or plastic base die system when a multi-implant-retained prosthesis requires sectioned dies.

Chee et al. suggest to use an open custom tray which is rigid, to allow access to the retaining screws of pick up impression copings, to use a polyvinyl siloxane impression material with adhesive applied to the custom tray and poly ether as a soft tissue cast material[14]

Studies also show that cast accuracy was not affected by impression material viscosity, using a stiffer impression material around the impression coping or cap did not produce more accurate casts with either the closed tray indirect or direct technique. Cast accuracy was affected by the impression technique. The closed tray/indirect impression technique using screw-on metal impression copings at the implant level yielded more accurate casts than the closed tray/direct impression technique with plastic impression caps used at the abutment level[15]

CONCLUSION

Implant Dentistry is ever evolving with invention of new techniques, procedures and materials. To obtain a perfect fit, a precise impression is a must. As a clinician it should be in our knowledge to select the right type of impression technique and material that best suits the case in order to achieve best fit and avoid errors in prosthesis.

REFERENCES

1. Gayathridevi S.K, Gowda H, Vaishali K, Suma. Impression Techniques in Implants. J Dent OroFacial Res., 2016; 12(2): 11-19.
2. Bohnenkamp, D. M., & Garcia, L. T. (2007). Phonetics and tongue position to improve mandibular denture retention: a clinical report. The Journal of prosthetic dentistry, 98(5), 344-347.
3. Annaldasula, Shweta & Yen, Chein. (2021). A comprehensive review of impression techniques in implant dentistry. International Journal of Dentistry Research. 6. 16-23. 10.31254/dentistry.2021.6106.
4. Revilla-Leon M, Sanchez-Rubio J, Oteo-Calatayud J, Ozcan M. Impression Technique for a CompleteArch Prosthesis with Multiple Implants Using Additive Manufacturing Technologies. J Prosthet Dent, 2017; 117(6): 1-7. 3.
5. Cabral L, Guedes C. Comparative Analysis of 4 Impression Techniques for Implants. Implant Dent, 2007; 16(2): 187-89.
6. Susanna S Brainerd , Dr. Bindu R Nayar. Impression Techniques in Implant Dentistry. e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 17, Issue 11 Ver. 12 (November. 2018), PP 33-44
7. Assuncao WG, GennariFilho H, Zaniquelli O. Evaluation of transfer impressions for osseointegrated implants at various angulations. Implant dentistry. 2004; 13(4):358-66.
8. Chee, W., Jivraj, S. Impression techniques for implant dentistry. *Br Dent J* 201, 429–432 (2006).
9. Alikhasi M, Alsharbaty MH, Moharrami M. Digital implant impression technique accuracy: a systematic review. Implant dentistry. 2017; 26(6):929-35
10. Liou A D, Nicholls J I, Yuodelis R A, Brudvik J S. Accuracy of replacing three tapered transfer impression

copings in two elastomeric impression materials. Int J Prosthodont 1993; 6: 377-383. 5.
11. Assif D, Fenton A, Zarb G, Schmitt A. Comparative accuracy of implant impression procedures. Int J Perio Rest Dent 1992; 12: 112-121.
12. Barrett M G, de Rijk W G, Burgess J O. The accuracy of six impression techniques for osseointegrated implants. J Prosthodont 1993; 2: 75-82.
13. Spector M R, Donovan T E, Nicholls J I. An evaluation of impression techniques for osseointegrated implants. J Prosthet Dent 1990; 63: 444-447.
14. Balouch F et al. Comparison of Dimensional Accuracy between Open-Tray and Closed-Tray Implant Impression Technique in 15° Angled Implants. J Dent Shiraz Univ Med Sci., 2013; 14(3): 96-102
15. Liou A, Nicholls J, Yuodelis R, Brudvik J. Accuracy of Replacing Three Tapered Transfer Impression Copings in Two Elastomeric Impression Materials. Int J Prosthodont, 1993; 6(04): 377-83.

THE EVOLVING LANDSCAPE OF SURFACE TREATMENTS OF DENTAL IMPLANTS– A REVIEW

Authors:

1. Dr. Namitha MV
House Surgeon, Coorg Institute of Dental Sciences, Virajpet, Karnataka

2. Dr. Gaurav
Associate Prof, Dept of Oral Medicine & Radiology
Coorg Institute of Dental Sciences, Virajpet, Karnataka

3. Dr. Basavaraj S Salagundi
Prof & Head, Dept of Prosthodontics & Crown & Bridge
Coorg Institute of Dental Sciences, Virajpet, Karnataka

4. Dr. Vasishta S
Post Graduate student, Dept of Prosthodontics & Crown & Bridge
Coorg Institute of Dental Sciences, Virajpet, Karnataka

Correspo nding Author:

Dr. Gaurav
Associate Prof, Dept of Oral Medicine & Radiology
Coorg Institute of Dental Sciences, Virajpet, Karnataka
Email: drgauravdrsunny@gmail.com

ABSTRACT:

The success of dental implants hinges on various important factors of which a meticulous surface treatment is a pre requisite. The surface of these implants plays a crucial role in the process of osseointegration. Modifying the implant surface through various treatments enhances osseointegration, promotes healing, and reduces the risk of complications. This article delves into various key aspects of surface treatment, elucidating the significance, methods, and outcomes in enhancing the performance of a dental implant.

Keywords: Implant, Surface Treatment, Osseointegration.

INTRODUCTION:

Modern dentistry aims for nothing less than complete restoration: bringing back patients' natural smile, confident bite, comfortable chewing, and clear speech, all while safeguarding their oral health. This mission reaches its full expression in the field of implant dentistry.

When a diseased tooth needs removal, or replacing missing teeth becomes necessary, dental implants shine as the most advanced and impactful solution. They go beyond merely filling a gap; they revolutionize patients' oral wellbeing. Unlike traditional prostheses, implants fuse effortlessly with the jawbone, mirroring the stability and function of natural teeth. This unique bond offers aesthetics as well as restores the function. [1,2]

The success of dental implants hinges on various important factors of which a meticulous surface treatment is a pre requisite. The surface of these implants plays a crucial role in the process of osseointegration. Modifying the implant surface through various treatments enhances osseointegration, promotes healing, and reduces the risk of complications. This article delves into various key aspects of surface treatment, elucidating the significance, methods, and outcomes in enhancing the performance of a dental implant.[3]

IMPORTANCE OF SURFACE TREATMENT:

Dental implants are not mere replacements for missing teeth; they are engineered to seamlessly integrate with the jawbone. Surface treatment plays a pivotal role in this integration, influencing the implant's ability to bond with surrounding tissues [osseointegration]. It improves biocompatibility, minimizing the risk of inflammation or rejection and promoting a harmonious interaction between the implant and the body's tissues. Surface treatments, such as altering surface roughness or applying coatings, enhance the mechanical stability of the implant, ensuring it can withstand functional forces and providing long-term support. Surface treatments like anodic oxidation create protective layers, reducing the risk of corrosion and increasing the lifespan of the implant. It optimizes the implant's surface characteristics to facilitate tissue integration, contributing to improved aesthetic outcomes and functional performance. Effective surface treatment contributes significantly to the overall success of implants, ensuring they remain stable, functional, and aesthetically pleasing over an extended period. [1,2]

CLASSIFICATION OF SURFACE TREATMENT FOR DENTAL IMPLANTS [1]

PHYSICAL (AND SUBTRACTIVE) METHODS OF SURFACE TREATMENT

1. Machined surface
2. Abrasive/sandblasting with grit media
3. Laser Ablation
4. Nanoparticle compaction
5. Plasma Cleaning
6. Porous tantalum trabecular metal

CHEMICAL (AND ADDITIVE) METHODS OF SURFACE TREATMENT

1. Acid etching
2. Alkaline treatment
3. Anodization of the surface
4. Peroxidation
5. Fluoride treatment
6. Vacuum treatment
7. Plasma coatings and surface treatments

BIOLOGICAL/BIOMIMETIC SURFACE TREATMENT METHODS

1. Bioactive coatings
2. Attachment of peptides
3. Attachment of antibiotics
4. Attachment of growth factors
5. Attachments of remodelling factors

PHYSICAL (AND SUBTRACTIVE) METHODS OF SURFACE TREATMENT

Sl.no	Technique	Properties	Procedure	Advantages	Disadvantages
1.	Machined surface [1,2]	The machined implant is turned, milled, or polished. It is minimally rough, with a surface area roughness (Sa) value of 0.3–1.0 lm.9	It is the basic state of dental implants after manufacturing without any additional chemical or mechanical alterations.	● Good initial stability. ● Ease of placement. ● Reduced risk of micro-cracks. ● Reduced risk of bacterial adhesion.	● Lower osseointegration potential. ● The lack of surface roughness might lead to decreased long-term bone integration in some cases. ● Machined surfaces might not be suitable for all patients or all implant placements due to low osseointegration potential.
2.	Sandblasting [3]	Abrasive particles like alumina or sand create microscopic craters and grooves on the implant surface.	The implant surface is thoroughly cleaned and degreased and placed in a sandblasting chamber. Fine particles of Al2O3 is propelled under controlled pressure using air or steam. The abrasive particles impact the implant surface creating microscopic irregularities and increasing surface area.	● Simple and cost-effective. ● Increases surface area significantly. ● Well-established technique.	● Inconsistent surface texture. ● Potential for long-term wear and tear due to rough surface. ● Potential for residual abrasive particles. ● Less increase in surface area compared to sandblasting. ● Potential for long-term reduction in bioactivity due to altered titanium oxide layer.

3.	Laser Ablation [4,5]	High-precision laser beam creates specific patterns or textures on the implant surface at the nanoscale.	Implant surface is thoroughly cleaned to ensure laser beam interaction. A specific laser type, like an Er:YAG laser, is chosen based on desired ablation patterns and properties. The laser beam ablates/removes the TiO_2 layer on the implant surface, creating precise micro and nano scale features like pits, grooves or even complex biomimetic structures. Pulse duration, energy and beam focusing determine depth, size, ad shape of the ablated features allowing for tailored surface modification.	● Highly controlled and precise. ● Allows for tailored surface features based on need. ● Potentially enhances initial bone cell attachment.	● Relatively new technique. ● Less clinical data compared to other methods. ● Potentially higher cost, requires specialized equipment.
4.	Plasma Cleaning [6,7]	Plasma bombardment removes contaminants and increases surface wettability.	Implant is thoroughly cleaned and placed in a vacuum chamber filled with oxygen or argon gas. An electrical field microwave frequency excites the gas molecules creating a highly reactive plasma, composed of ions electrons and free radicles. The energetic plasma particles bombard the implant surface, removing organic contaminants, oxides and impurities through a combination of sputtering (material ejection) and chemical reactions. Depending on the plasma gas, the cleaning process can also activate the surface, increasing its wettability and creating functional	● Improves initial surface properties before other treatments. ● Simple and effective for cleaning.	● Does not directly create surface roughness. ● Limited impact on bone cell attachment. ● Typically used as a preparatory step rather than an independent treatment.

			groups for subsequent modification with coatings or biocompatible molecules. Finally, the chamber is vented and the implant is removed.		
5.	Nanoparticle Compaction [8]	Nanoparticles of titanium, hydroxyapatite, or other biocompatible materials are deposited and compacted onto the implant surface. This creates a dense, nanocrystalline layer with increased surface area and bone-like structure.	The implant surface is thoroughly cleaned. Fine particles of biocompatible materials like hydroxyapatite, $Ca_3(PO_4)_2$ or TiO_2 are suspended in a liquid. The nano particle suspension is applied to the implant surface, and pressure or specific physical process like high energy beams are used to compact the nanoparticlesonto the surface, creating a dense nanofilm layer, which might be further treated with heat or chemical solutions to enhance its stability and bioactivity.	• Enhanced osseointegration • Improved biocompatibility. • Enhanced mechanical properties like wear resistance and implant stability. • Nanoparticles can be functionalized to deliver specific drugs or growth factors to the implant site.	• Precise control and uniform deposition of nanoparticles require specialized equipment and expertise. • More expensive treatment option compared to traditional methods.
6.	Porus tantalum trabecular metal (PTTM) [9,10]	PTTM is typically 80-90% porous, mimicking the spongy structure of natural bone. This allows for bone ingrowth into the implant, promoting a stronger and more stable bond.	The core of the implant is made up of strong and biocompatible material like titanium alloy. A highly porous mesh structure is formed from medical grade tantalum metal through processes like chemical vapour deposition or mechanical forming. Then the tantalum mesh is bonded or affixed to the midsection around the body of the implant. The	• Enhanced osseointegration • The increased surface area promotes blood vessel growth and nutrient exchange, potentially accelerating bone healing around the implant.	• Relatively expensive material compared to traditional surface treatment methods. • Manufacturing and manipulating PTTM can be technically demanding, requiring specialized equipment and expertise. • Brittleness: The porous nature of PTTM can make it more susceptible to fracture

			coronal and apical parts of the implant remain as the originally fabricated titanium alloy, providing screw like threads for secure anchoring in the jaw bone. It can also further undergo micro texturing or coating with hydroxyapatite to further enhance osseointegration.	• PTTM can be applied to various implant materials, including titanium and cobalt-chromium alloys.	compared to solid metal.

CHEMICAL (AND ADDITIVE) METHODS OF SURFACE TREATMENT

Sl. no	Technique	Properties	Procedure	Advantages	Disadvantages
1	Acid etching [11,12]	Mild acid solution dissolves small portions of the titanium oxide layer, creating microscopic irregularities.	Thoroughly cleaned implant is immersed in HCl, H_2SO_4 or HNO_3, often at elevated temperatures. The acid dissolves a thin layer of TiO_2 on the implant surface creating microscopic pits and grooves increasing surface area. Later the implant is exposed to a neutralizing solution to stop etching process and thoroughly rinsed.	• Offers more control than sandblasting. • Smoother surface compared to sandblasting. • Good option for combining with other treatments.	• Less increase in surface area compared to sandblasting. • Potential for long-term reduction in bioactivity due to altered titanium oxide layer.
82.	Alkaline treatment [13]	The alkaline solution creates microscopic pores and irregularities on the implant surface, enhancin g its roughness. This increased surface area promotes bone cell adhesion and blood vessel ingrowth, facilitat ing	Implant surface is thoroughly cleaned and immersed in a controlled solution of strong alkaline solution like NaOH or KOH. The alkaline solution dissolves a thin layer of TiO_2 similar to acid etching but with a slightly different surface topography. It might also induce formation of a nano crystalline layer on the surface. Implant is treated with a neutralizing solution and thoroughly rinsed to remove	• The combined effect of increased surface roughness and wettability potentially leads to improved bone cell attachment and faster osseointegrati on. • Reduced risk	• The long-term clinical data regarding alkaline surface treatment is still limited. • The optimal parameters for alkaline treatment may vary depending on the implant material and desired surface

		osseointegration. The alkaline treatment alters the implant's surface chemistry, making it more hydrophilic.	any residual alkaline material.	of peri-implantitis. • Potential for improved long-term success. • Maintains the original chemical composition of the implant material.	characteristics.
3.	Anodization [1,14]	Creates a titanium oxide layer on the implant surface, improving biocompatibility and osseointegration. Imagine a thin, protective shell that makes the implant more comfortable for bone tissue to interact with.	The implant surface is thoroughly cleaned. The implant acts as the anode in a specialized electrochemical cell containing specific electrolyte solutions like H_3PO_4 acid or HF acid. A controlled voltage is applied between the implant (anode) and a cathode (usually platinum) within the electrolyte solution. Under the applied voltage, titanium oxide forms on the implant surface, and in specific conditions, this oxide layer self-organizes into highly ordered titanium dioxide nanotubes. The voltage, electrolyte composition, and other parameters determine the nanotube diameter, length, and morphology, tailoring the surface characteristics for specific functions. Additional functionalization of the nanotubes with biocompatible molecules or coatings can further enhance biocompatibility, drug delivery, or antibacterial properties.	• Enhances biocompatibility. • Promotes bone cell attachment. • Provides long-term stability.	• May decrease wettability initially. • Requires specific equipment and expertise.

4.	Plasma Immersion Ion Implantation [6,7]	Bombards the implant surface with specific ions (calcium, phosphorus) to mimic bone composition. It's like embedding tiny bone-like building blocks right into the implant's surface.	The implant surface is thoroughly cleaned and placed in a vacuum chamber filled with a specific gas, often nitrogen or titanium vapor. An electrical field or microwave frequency excites the gas molecules, creating a highly ionized plasma composed of ions and electrons. A pulsed high voltage is applied to the chamber, accelerating the plasma ions towards the implant surface. The energetic ions bombard the implant surface, penetrating and embedding themselves within the outer layers. This modifies the surface composition, creating a nitrided (TiN) or oxidized (TiO2) layer depending on the gas used.	● Creates a biomimetic surface promoting strong osseointegration. ● Improves corrosion resistance.	● Relatively new technique with limited long-term data. ● Requires specialized equipment and expertise.
5.	Vacuum treatment [1]	Vacuum treatment utilizes low-pressure environments to increase the surface energy of the implant. This promotes improved adhesion between the implant and subsequent surface modification layers like coatings or bio actives.	Sputter deposition: In this technique, a target material is bombarded with high-energy ions, which sputter atoms off the target. These atoms travel through the vacuum chamber and condense on the implant surface, forming a thin film coating. Arc-PVD: Similar to sputter deposition, but the target material is vaporized using an electric arc instead of ion bombardment. This results in a higher deposition rate and denser film coatings. Electron beam-PVD (E-beam PVD): In this technique, a high-energy electron beam vaporizes the target material, which then condenses on the implant surface. E-beam PVD	● The increased surface energy facilitates better bonding between the implant and its surface modification. ● Clean and controlled surface. ● Tailored surface properties.	● Limited clinical data. ● Often requires specialized equipment and expertise, potentially increasing the cost and technical complexity of the implant manufacturing process. ● Material compatibility concerns.

			offers excellent control over the film thickness and composition.		
6.	Peroxidation [9,10]	Peroxidation can create microscopic irregularities on the implant surface, enhancing its roughness. This increased surface area promotes cell adhesion and blood vessel ingrowth, facilitating osseointegration. It can remove organic contaminants and potentially etch away a thin layer of metal oxides	The implant is thoroughly cleaned and immersed in a hydrogen peroxide solution or exposed to a hydrogen peroxide vapor. The hydrogen peroxide reacts with the titanium surface, creating a titanium dioxide (TiO2) gel layer. The thickness and properties of the TiO2 gel layer can be controlled by varying the concentration and temperature of the hydrogen peroxide solution, as well as the exposure time. The TiO2 gel layer is typically stabilized by heat treatment or other methods to improve its durability. The implant is then rinsed and prepared for further processing or implantation.	• Faster bone cell attachment and improved osseointegration, potentially shortening treatment times and enhancing implant stability. • Reduced bacterial adhesion. • Cleaner surface. • Less aggressive than acid etching.	• Long-term clinical data on peroxidation's effectiveness is limited. • Precise control of peroxidation parameters is crucial to achieve desired surface modifications without damaging the implant material. • Potential for metal ion release.

BIOLOGICAL/BIOMIMETIC SURFACE TREATMENT METHODS

Sl. No	Technique	Properties	Procedure	Advantages	Disadvantages
1.	Bioactive coatings [2,5,12]	Composed of biocompatible materials like hydroxyapatite, bioactive glass or polymers. These materials directly bond with bone tissue forming a strong mechanical and	The implant surface is thoroughly cleaned. Sol-gel: This method involves immersing the implant in a liquid precursor solution that gels and forms a thin film coating upon drying or heating. This method is relatively simple and versatile, allowing for precise control over the coating	• Enhanced rapid osseointegration. • Improved biocompatibility as mimicking natural bone composition minimizes	• Technical complexity. • Potential for delamination due to improper application or insufficient bonding. • Expensive than traditional methods.

		chemical connection.	thickness and composition. The specific coating material used will depend on the desired properties: Hydroxyapatite (HA): This naturally occurring calcium phosphate ceramic mimics the mineral composition of bone, promoting bone cell attachment and growth.[1] Bioactive glasses: These glasses dissolve in the body fluid over time, releasing ions that stimulate bone formation and create a strong bond with the implant surface. Biopolymers: These synthetic or natural polymers can be tailored with specific functionalities, such as promoting cell adhesion or releasing antibacterial agents After the coating is applied, it may require further processing, such as heat treatment or chemical stabilization, to improve its adhesion and durability. The implant is then rinsed and prepared for further processing or implantation.	inflammation and tissue rejection. • Potential for drug delivery.	• Limited material choices.
2.	Attachment of peptides [15,16,3]	Synthetic or natural peptides are attached to implant surface via chemical bonding or adsorption. They target specific receptors on bone cells promoting their	The implant surface is meticulously cleaned. The specific peptide sequence used will depend on the desired outcome. Different peptides can target various biological processes, such as promoting bone cell adhesion, inhibiting bacterial growth, or triggering tissue regeneration.	• Targeted osseointegration. • Improved biocompatibility. • Antibacterial and anti-inflammatory	• Technical complexities like precise peptide selection, immobilization techniques etc • Developing and applying peptide coatings can be

		attachment and growth. They also act as signalling molecules, stimulating bone formation.	There are several methods for attaching peptides to the implant surface, each with its own advantages and limitations. Direct binding: Certain peptides can spontaneously bind to the titanium surface through electrostatic interactions or physical adsorption. This method is simple but may not be as stable or controlled as other approaches. Self-assembled monolayers (SAMs): This technique involves pre-coating the implant surface with a specialized molecule that acts as a linker between the implant and the peptide. The linker molecule can be tailored to achieve specific chemical interactions with the desired peptide sequence. Chemical conjugation: This method involves covalently attaching the peptide to the implant surface using chemical linkers. This provides a more stable bond but requires careful selection of the linker and reaction conditions.	potential. • Controlled drug delivery.	expensive than traditional surface treatments.
3.	Attachment of growth factors [15,17,3]	Growth factors, naturally occurring signalling molecules are immobilized onto the implant surface through various methods like chemical	The implant surface undergoes meticulous cleaning and degreasing to remove any impurities. The specific growth factor(s) chosen depend on the desired outcome. Popular choices include: Bone morphogenetic proteins (BMPs): These potent factors	• Enhanced osseointegration. • Potential for reduced implant size. Faster bone integration is possible	• Technical complexity. • Expensive due to growth factors and specialized procedures. • Overdoses or unintended effects of growth factors

		binding, encapsulation etc. they attract and activate bone forming cells stimulating their proliferation leading to faster bone growth around the implant. Growth factors like BMPs, Platelet derived growth factors are been used.	stimulate bone formation and are key for osseointegration. Fibroblast growth factors (FGFs): They promote blood vessel formation and soft tissue healing around the implant. Platelet-derived growth factor (PDGF): This factor stimulates soft tissue and bone cell growth, contributing to both soft tissue integration and osseointegration. Diverse techniques exist for attaching growth factors to the implant surface: ● Direct binding ● Self-assembled monolayers (SAMs) ● Chemical conjugation: ● Carrier matrices Following growth factor attachment, the implant may undergo further processing like rinsing, drying, or sterilization, depending on the specific method used.	with the use of smaller implants. ● Improved bone quality. ● Potential for tissue regeneration thus improving aesthetics.	can lead to overgrowth of bone, inflammation. ● Limited long term data.
4.	Attachment of antibodies [15,16]	Specific antibodies are immobilised onto the implant surface through physical or chemical methods. They target and bind to specific molecules or cells acting like highly precise "locks" with designated "keys".	Antibodies targeting specific oral pathogens can be immobilized on the implant surface, potentially preventing bacterial adhesion and biofilm formation, the initial steps in peri-implantitis development. Meticulous cleaning and degreasing of the implant. Choosing the right antibody depends on the desired target. Antibodies against specific bacterial species, inflammatory factors, or cell surface	● Targeted action due to their unique specificity, directing their effects towards specific molecules or cells. ● Enhanced osseointegration.	● Technical complexity. ● High cost for developing and utilizing specific antibodies. ● Limited long- term data. ● Off target binding or unexpected interactions with immune systems require careful

			receptors are potential candidates. Several methods are currently being explored for antibody attachment: a) Certain antibodies can directly bind to the titanium surface through physical adsorption or electrostatic interactions b) Pre-coating the implant with specialized linker molecules facilitates controlled attachment of the antibodies. This method offers better stability and allows for tailoring the linkers to specific antibody interactions. c) Covalently bonding the antibodies to the surface using chemical linkers provides the most robust attachment but requires careful selection of compatible linker chemistry and reaction conditions. d) d) Polymers, hydrogels, or other biocompatible materials can encapsulate and release the antibodies over time, providing a sustained local delivery at the implant site. After antibody attachment, the implant may undergo further processing like rinsing, drying, or sterilization, depending on the specific method used.	● Reduced inflammation and infection risk. ● Antibodies could be tailored to individual patient needs.	investigation.
5.	Attachment of remodelling agents [15,18,19]	Remodelling are molecules that specifically influence bone turnover, either stimulating bone formation or	Meticulous cleaning and degreasing ensure optimal binding of the remodelling agents. Remodelling agent selection: A) Bisphosphonates: These	● Enhanced osseointegration. ● Faster healing ● Improved	● Technical complexity. ● Expensive procedure. ● Overdose or unintended effects

		inhibiting bone resorption. Several types of remodelling are being explored like bisphosphonates, parathyroid hormone fragments and synthetic peptides.	molecules inhibit bone resorption by binding to specific sites on bone-resorbing cells. B) Runx2 activators: These agents stimulate bone formation by activating Runx2, a key transcription factor involved in bone cell differentiation. C) BMP inhibitors: While BMPs typically promote bone formation, specific inhibitors could be used to fine-tune bone remodelling around the implant. D) Antimicrobial peptides: These peptides combine bone remodelling properties with antibacterial activity, potentially targeting both bone integration and peri-implantitis prevention. Remodelling agent immobilization is done by ● Direct binding ● Self-Assembled Monolayers (SAMs) ● Chemical conjugation 1. Carrier matrices After agent attachment, the implant may undergo further processing like rinsing, drying, or sterilization, depending on the method used.	bone quality. ● Reduced risk of peri-implantitis.	of some agents can lead to unwanted bone remodelling patterns or systemic side effects. ● Limited and long-term data.

CONCLUSION

As we delve deeper into the science of dental implants, the intricate relationship between surface characteristics and osseointegration becomes increasingly clear. Researchers are vigorously exploring new surface treatments and chemical modifications, understanding how they impact cellular and biological processes at the implant site. While current success rates surpass 90%, significant advancements may lie ahead, especially in improving outcomes for patients with weaker bones or underlying medical conditions.

REFERENCES

1. Miriam Ting, Steven R. Jefferies, Wei Xia, Ha˚kan Engqvist, Jon B. Suzuki Classification and Effects of Implant Surface Modification on the Bone: Human Cell–BasedIn Vitro Studies. J Oral Implantol2017 Feb;43(1):58-83

2. Ducheyne P, Van Raemdonck W, Heughebaert JC, Heughebaert M. Structural analysis of hydroxyapatite coatings on titanium. Biomaterials 1986 March; vol7.

3. Ankur Gupta, M Dhanraj, G Sivagami. Status of surface treatment in endosseous implant.Indian J Dent Res, 21(3), 2010.

4. Francisco J.C. Braga Rodrigo F.C. Marques, Edson de A. Filho, Antonio C. Guastaldi Surface modification of Ti dental implants by Nd: YVO4 laser irradiation. 30 September 2007, Pages 9203-9208

5. panelG. Pető, A. Karacs, Z. Pászti, L. Guczi, T. Divinyi, A. Joób. Surface treatment of screw shaped titanium dental implants by high intensity laser pulses.28 January 2002; 7-13.

6. Vercaigne S, Wolke JG, Naert I, Jansen JA. Bone healing capacity of titanium plasma sprayed and hydroxyapatite coated oral implants.Clin Oral Implants Res; 1998 Aug;9(4):261-71

7. Kangasniemi IM, Verheyen CC, van der Velde EA, de Groot K. In vivo tensile testing of fluorapatite and hydroxylapatite plasma sprayed coatings. J Biomed Mater Res;1994 May;28(5):563-72.

8. Rahimeh Rasouli, Ahmed Barhoum and Hasan Uludag A review of nanostructured surfaces and materials for dental implants: surface coating, patterning and functionalization for improved performance.Biomater Sci; 2018 May 29;6(6):1312-1338.

9. GT Pinter, B Trimmel, M Kivovics, T Huszar, Z Nemet Long-Term Results of Anodic and Thermal Oxidation Surface Modification on Titanium and Tantalum Implants.April 2023.13(4):760

10. Piero Papi, Sara Jamshir, Edoardo Brauner, Stefano Di Carlo, Antonio Ceci, Luca Piccoli, and Giorgio Pompa, Clinical evaluation with 18 months follow-up of new PTTM enhanced dental implants in maxillo-facial post-oncological patients. Ann Stomatol (Roma). 2014 Oct-Dec; 5(4): 136–141.

11. Orsini G, Assenza B, Scarano A, Piattelli M, Piattelli A. Surface analysis of machined versus sandblasted and acid-etched titanium implants. Int J Oral Maxillofac Implants.2000 Nov-Dec;15(6):779-84.

12. Cochran DL, Nummikoski PV, Higginbottom FL, Hermann JS, Makins SR, Buser D. Evaluation of an endosseous titanium implant with sandblasted and acid-etched surface in the canine mandible: Radiographic results. Clin Oral Implants Res 1996 Sep;7(3):240-52.

13. E W Zhang, Y B Wang, K G Shuai, F Gao, Y J Bai, Y Cheng, X L Xiong, Y F Zheng and S C Wei In vitro and in vivo evaluation of

SLA titanium surfaces with further alkali or hydrogen peroxide and heat treatment.Biomedical Materials;4 February 2011;6(2).

14. Kim KH, Ramaswamy N. Electrochemical surface modification of titanium in dentistry. Dent Mater J.2009 Jan;28(1):20-36.

15. Alekh Kurup, Pankaj Dhatrak, Neha Khasnis a Surface modification techniques of titanium and titanium alloys for biomedical dental applications: A review.2021;39(1).;84-90

16. Stefanie Kligman Zhi Ren, Chun-Hsi Chung, Michael Angelo Perillo, Yu-Cheng Chang, Hyun Koo, Zhong Zheng, and Chenshuang Li. The Impact of Dental Implant Surface Modifications on Osseointegration and Biofilm Formation.J Clin Med. 2021 Apr; 10(8)

17. Avila, Gustavo, Misch, Kelly, Galindo-Moreno, Pablo, Wang, Hom-Lay; Implant Surface Treatment Using Biomimetic Agents.Implant Dent;2009 Feb;18(1):17-26

18. Heng Dong, Hui Liu, Na Zhou, Qiang Li, Guangwen Yang, Li Chen, and Yongbin Mou Surface Modified Techniques and Emerging Functional Coating of Dental Implants. 2020;10(11); 1012.

19. Manley MT, Koch R. Clinical results with the hydroxyapatite-coated Omnifit hip stem. Dent Clin North Am; 1992 Jan;36(1):257-62.

PERIODONTAL CONSIDERATIONS IN IMPLANTS- A REVIEW

Authors:

1. Dr Deepa Maralingannavar
   Post Graduate, Department of Periodontology
   Maratha Mandal's Nathajirao G. Halgekar Institute of Dental Sciences and Research Centre, Belagavi.
   Mail id: smdeepam8@gmail.com

2. Dr Sonali Purohit
   Post Graduate, Department of Periodontology
   Maratha Mandal's Nathajirao G. Halgekar Institute of Dental Sciences and Research Centre, Belagavi.
   Mail id: sonalipurohit261@gmail.com

3. Dr Minal Manolkar
   Assistant Professor, Department of Periodontology
   Maratha Mandal's Nathajirao G. Halgekar Institute of Dental Sciences and Research Centre, Belagavi.
   Mail id: minalmanolkar@gmail.com

4. Dr Sachin Shivanaikar
   Professor, Department of Periodontology
   Maratha Mandal's Nathajirao G. Halgekar Institute of Dental Sciences and Research Centre, Belagavi.
   Mail id: drsachinshivanaikar@yahoo.co.in

5. Dr Bhanu Teja E
   Post Graduate ,Department of Periodontology
   Maratha Mandal's Nathajirao G. Halgekar Institute of Dental Sciences and Research Centre, Belagavi.
   Mail id: teja42007@gmail. Com

ABSTRACT:

The success of dental implant therapy is intricately linked to the health and stability of the surrounding periodontal tissues. This review article comprehensively examines the critical periodontal considerations essential for the long-term success of dental implants. It explores the multifaceted relationship between peri-implant tissues and periodontal health, encompassing factors such as soft tissue management, bone morphology.The review delves into the importance of adequate keratinized tissue around implants to maintain optimal soft tissue health and stability. Moreover, the review provides insights into the management of peri-implant diseases, outlining various therapeutic modalities and preventive strategies aimed at preserving peri-implant health and minimizing.

Keywords: Implant, Periodontal Considerations, Peri-implant.

1. INTRODUCTION

Implant Dentistry has been the fastest growing treatment modality in dentistry for the past 20 years.Dental implants have been shown to successfully replace missing teeth while providing all restorative functional needs. Techniques and materials have been developed over the years to facilitate a high degree of clinical success. Nonetheless, the ultimate long-term success of implants is largely relied upon the interface between implants and their surrounding tissues, both soft and hard tissues.

Periodontology, Oralsurgery, restorative dentistry and prosthodontics all play their essential roles in the placement and maintenance of oral implants, but the principles of periodontal therapy probably play the most important role in influencing the final success of treatment.

Successful rehabilitation of osseointegrated implants is largely dependent on patient selection and preservation of meticulous surgical and prosthodontic protocols. One of the factors for implant success and or failure could be the ability of mucosa to provide an adequate seal between the oral environment and the implant,mucosa to provide an adequate seal between the oral environment and the implant, with its superstructure piercing the mucosa. It has been claimed that absence of a seal leads to inflammation of the marginal connective tissue with subsequent loss of the implant. Basic differences between tooth and implant are given in Table 1 and Figure 1.

The osseointegrationatthe hard tissue interface has been well established in most implant systems. However, the importance of the soft tissue interface, which forms the barrier or biological seal, has been increasingly recognized as afundamental factor to implant success.The implant–soft tissue interface is referring to the soft tissue in contact with mainly the implant abutment surface.

Indeed, this review sheds light on the paramount importance of periodontal soft and hard tissue in ensuring the success of dental implants. By recognizing the pivotal roles ofboth soft and hard tissues, clinicians can enhance the predictability and longevity of implant treatments, ultimately benefiting patients by optimizing functional and aesthetic outcomes.

Feature.	**Implant**	**Tooth.**
	Hard tissue	
Histology	Bone implant contact.	Periodontal ligament
Interference awareness	Osseo perception	1^0 - Periodontal ligament shock absorption 2^0 - Osseous movement
Lateral force	Crestal bone	Apical one third of root surface
Apical movement	3-5 um	25-100 um
Lateral movement	10-50 um	56-108 um
	Soft Tissue	
Epithelial	Peri Implant Epithelium hemidesmosome attachment to Ti	Junctional epithelium hemidesmosome attachment to Enamel or Cementum surface
Periodontal ligament.	Parallel	Perpendicular.
Biologic width	JE = 1.88mm CT = 1.05 mm	JE = 1.14 mm CT = 0.77 mm

TABLE 1: Hard and soft tissue difference around the tooth and implant.JE- Junctional Epithelium, CT- Connective tissue

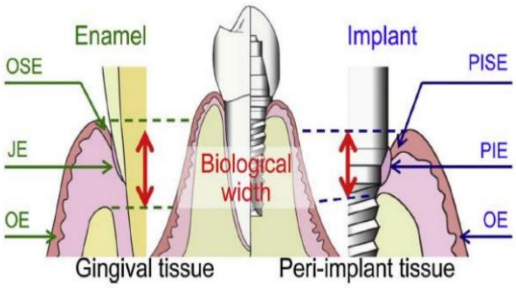


Figure 1: Hard and soft tissue difference around the tooth and implant
OSE-Oral Sulcular Epithelium,JE-Junctional epithelium,OE-Oral epithelium, PISE-Peri implant Sulcular epithelium, PIE- Peri implant epithelium

2. SOFT TISSUE INTERFACE

2.1 JUNCTIONAL EPITHELIUM:

Junctional Epithelium (JE) is a crucial biological adaptation which connects the soft gingival tissues to both natural teeth and implants.[1] Apart from creating a barrier between the oral environments and underlying gingival tissues, it serves as a specialized epithelium[2]tailored for the dynamic maintenance of the connection between soft gingival tissues and the hard structure of teeth or implants. Positioned at the base of the gingival crevice/sulcus, the JE binds to the tooth or implant surface via hemi-desmosomes. Even during routine clinical procedures like periodontal probing and nonsurgical debridement, the dynamic nature of the JE to teeth is evident through rapid reattachment.[3]Notably, periodontal surgery can remove the JE, but primary closure following ideal surgical technique facilitates its rapid reattachment, demonstrating its unique biologic adaptation. Discussions on dental implants reveal no biologic difference in the JE's response between natural teeth and implants.[4,5] The dynamic nature of the JE to the sides of teeth is showcased through routine oral hygiene, includinguse of dental floss, without causing permanent damage.[6] Hygiene concerns around implants have prompted the development of special instruments, but standard instrumentation proves equally effective without interfering with the JE's dynamic reattachment.[7] Ensuring a clean, uncontaminated surface allows the JE to perform its specialized biologic function of binding attached gingival mucoperiosteum to the side of teeth or implants. Recent workshops emphasize the importance of consistent preventive care activities for implants, to those recommended for natural teeth, both in dental offices and at home.[8-10]

2.2 ATTACHED GINGIVA:

The significance of attached gingiva has been a focal point in clinical investigations regarding the "mucogingival problem," particularly in its ability, relative to oral mucosa, to form a new Junctional Epithelium (JEA) after surgical removal of the gingival attachment apparatus. This consideration played a crucial role in early comparisons between excisional techniques like gingivectomy and incisional techniques such as the modified Widman flap.[4] Presently, we understandthat attached gingiva/mucoperiosteum can promptly differentiate to establish a new JEA, whereas oral mucosa doesn't exhibit a similar biological activity.[11] Although discussions on JE regeneration primarilyrefer oral epithelium, distinctions in epithelial nature and biology exist between attached gingiva mucoperiosteum and oral mucosa.[11]

A parallel discussion is emerging on the necessity of attached gingiva/mucoperiosteum in areas where implants are positioned. Two sets of observations complicate reaching a straightforward conclusion regarding the relative importance of attached gingiva versus oral mucosa around implant sites. Denudation procedures reveal that denuded alveolar bone can be covered by new attached gingiva,(12,13)and instances like pulp polyps demonstrate the presence of epithelial cells capable of seeding new growth in the oral environment.(14)The regenerative capacity of new attached gingiva adds complexity to the discussion around implants. Extensive investigations are required to rule out alternative explanations. However, it is certain that having attached gingiva available for primary closure offers significant advantages, including more predictable post-surgical anatomy and a quicker, inherently stable healing process through healing by primary intention when forming a new JEA around a tooth.

2.3 COLLAGEN FIBER ATTACHMENT TO NATURAL TEETH:

Structured collagen fiber attachment to natural teeth has been a focal point in dental research, particularly in the success of osseointegration at the bone-implant interface. However, it is essential to recognize that implants lack gingival fiber attachment, and the term "loss of attachment" does not apply to implants due to the absence of fibrous attachment.(15)Unlike natural teeth, implants lack supracrestal collagen fibers and periodontal ligament fibers within alveolar bone, leading to a different cellular activity around implants. (16)In the esthetic zone, implants may pose clinical challenges due to the absence of organized periodontal fibers in the suprabony soft tissues, impacting the reconstruction of missing anterior teeth.

The significance of organized supracrestal periodontal fibers becomes evident in shaping the healthy marginal gingiva. The absence of such fibers inserting into dental implants presents challenges in achieving long-term esthetic outcomes in anterior tooth reconstruction with implants. Mucogingival problems, characterized by localized progressive loss of attachment, emphasize the importance of resilient periodontal fibrous attachment of attached gingiva mucoperiosteum in protecting the alveolar crest margin. (17)The collagen fiber bundles within the attached gingiva mucoperiosteum play a biologic role in maintaining the alveolar crest bone. The question arises whether decades of clinical research on mucogingival problems around natural teeth need replication for dental implants to conclusively determine the benefits of adequate attached gingiva, especially in areas prone to lateral forces such as sites with frenum attachments or shallow vestibular areas.

2.4 GINGIVAL CREVICE/SULCUS FLUID:

Gingival crevice/suclusfluid play a crucial role in understanding the Junctional Epithelium Attachment's (JEA) biologic adaptation. Although the JEA is designed to bind to the tooth or implant, it does not create a complete seal at the junction of hard and soft tissue structures. The JEA exhibits permeability in both directions, allowing substances to enter host tissues from the gingival crevice (18)and facilitating the flow of tissue fluid and host cells into the external environment of the gingival crevice. (19)The biologic properties of the JEA, such as fluid and host cell permeability, remain generally consistent around both teeth and implants.

In both health and disease, gingival/crevicular/sulcular fluid flows through the JEA. The volume of gingival fluid increases with heightened inflammation, carrying biologic markers of inflammation. [20,21]Even in gingival health, polymorphonuclear leukocytes (PMN), lymphocytes, macrophages, and plasma cells are present within the JEA and adjacent mucosal connective tissues, indicating a constant influx of foreign antigens into underlying connective tissues. [22,23]The presence of these cells beneath the JEA, even in healthy tissues, reflects the innate and adaptive immune systems' normal response to the influx of foreign antigens.[18]

In conditions like periodontitis and peri-implantitis, PMNs exit through the JEA into the external crevice environment around the tooth or implant. [24]Both conditions are associated with significant numbers of PMNs, plasma cells, and macrophages within the connective tissue adjacent to the JEA. The extension of the subepithelial cellular infiltrate directly onto implants in peri-implantitis, along with an increased proportion of PMNs within the infiltrate, [25]may suggest increased activation of the innate immune system in peri-implantitis compared to periodontitis.

2.5 BIOLOGIC WIDTH:

The crucial aspect of implant placement revolves around the concept of biological width, denoting the distance between the peri-implant mucosa margin and the underlying bone crest. This dimension serves as a protective barrier against potential bacterial infection and prevents the entrapment of food debris at the implant/soft tissue interface. Numerous studies highlight that the biological width surrounding dental implants comprises sulcular and Junctional epithelium, accompanied by an underlying connective tissue zone.

It is noteworthy that differences exist between the biological width around a tooth and an implant. In teeth, the biological width is situated supracrestal, while in implants; it is subcrestal when the platform aligns with the crest level. The width is typically greater around implants (3 mm compared to 2 mm in teeth). Histologically, the peri-implant tissue exhibits more collagen fibers oriented parallel to the surface, resembling scar tissue with reduced adhesion. In contrast, around teeth, supracrestal fibers flow perpendicularly and are inserted into the radicular cement and alveolar bone.

Moreover, the peri-implant tissue is less vascularized, receiving blood primarily from terminal branches of the periosteum. In teeth, additional contribution comes from branches originating from the periodontal ligament. This vascular distinction may impact the peri implant tissue's response to bacterial invasion negatively. A recent hypothesis suggests the existence of a relationship between bone and overlying soft tissue around implants, proposing that alterations in this relationship could contribute to early crest bone loss. However, some authors speculate that the biological width or seal might expand by around 1 mm following implant loading, potentially linked to crestal bone resorption.[26]

2.6 MICROBIOLOGY AROUND THE IMPLANTS

Peri-implant diseases, emerging post successful osseointegration of intra-bone implants, arise from an imbalance between bacterial activity and host response. These diseases manifest as either localized inflammation termed peri-implant mucositis or progress to peri-implantitis, leading to bone loss. [27] Microorganisms play a pivotal role in both periodontal and peri-implant diseases, emphasizing the importance of microbiological parameters in diagnosis and monitoring. Studies indicate significant similarities between periodontitis and peri-implantitis in clinical presentation and pathogens involved. [28]Gram-positive cocci dominate at disease onset, followed by an increase in gram-negative anaerobes with plaque accumulation. Pathogens such as Porphyromonas gingivalis, Treponema denticola, Tannerella forsythia, and Aggregatibacter actinomycetemcomitans are commonly found in peri-implant lesions. Early colonization of periodontopathogens is observed around implants, leading to the formation of complex subgingival microbiota. Anaerobic bacteria, including classical periodontopathogens, show proportional increases in both periodontitis and peri-implant diseases. Other pathogens like Prevotella intermedia and Capnocytophaga are implicated in these diseases. Peri-implantitis implants harbor a complex microbiota, including conventional periodontopathogens. Moreover, species like Pseudomonas aeruginosa and Candida albicans are frequently detected around implants. Notably, Staphylococcus aureus and Streptococcus epidermidis are prevalent. Specific bacterial species are associated with peri-implantitis, highlighting microbial differences between healthy and diseased sites. For instance, P. gingivalis, P. intermedia, and A. actinomycetemcomitans are prevalent in peri-implantitis implants. This underscores the role of microbial dysbiosis in the pathogenesis of peri-implant diseases.[29]

3. HARD TISSUE INTERFACE

Implant is held in the bone through osseointegration process. The discovery of osseointegration around Ti implant was an incidental finding when Dr. Branemark, an orthopedic surgeon, studied the flow of blood in rabbit bone in 1952. It was surprising, when he could not remove the Ti screw from the bone of rabbit legs. The Ti was fused into the bone. That was the time the term “osseointegration” was introduced.

Osseointegration or osteointegration refers to a direct bone-to-metal interface without interposition of non-bone tissue. Osseointegration is defined as "a direct structural and functional connection between ordered, living bone and the surface of a load-carrying implant". [30]

The process of bone healing around implant follows the intramembranous osteogenesis process. It first starts as woven bone formation, followed by the parallelfibered and lamellar bone structure. The first new bone formed could happen as early as 1 week after implant placement and the bone remodeling process usually starts in between 6 and 12 weeks, and it continues throughout life.

Clinically, with the remodeling process, it is accepted to have 1–1.5 mm crestal bone loss during the first year after implantation and thereafter 3 mm and >4 mm bone loss, respectively, asa part of normal bone remodeling process, instead of pathological changes.

Two phenomena have been used to describe the bone morphogenesis around the implant, that is, distance osteogenesis and contact osteogenesis (Osborn and Newesely, 1980). The distance osteogenesis is referred to the new bone formed approaching on the implant surface from a distance. In contrast, the contact osteogenesis involves the initiation of bone formation on apposition directly onto the implant surface itself.

Various factors affecting osseointegration are given in Table 2

Table 2 :Factors affecting Osseointegration

- **Bone quality and quantity**
- Implant shape
- Implant surface macro-structure
- Implant micro-structure (roughness)
- Material biocompatibility
- Surgical techniques
- Heat generation during the implant placement surgery
- **Implant primary (initial) stability**
- Implant loading

3.1 PRIMARY STABILITY OF IMPLANT

Primary stability is the absence of mobility in the bone bed after implant placement**.** There is a strong correlation between bone density and dental implant stability. Dental implant stability is positively associated with cortical bone thickness. Bone quality is not the only factor, however; stability is also influenced by surgical technique, implant surface morphology, implant diameter, bone compaction techniques, and cortical anchor for implant placement. Wide implant diameters that increase the contact area between the treated bone and the implant surface will increase primary stability.

3.2 BONE DENSITY AND QUALITY

The significance of bone density and its association with implant dentistry has existed for more than two decades. Several classifications regarding bone density have been recommended.The internal structure of bone is described in terms of quality or density, which reflects a number of biomechanical properties, such as strength and modulus of elasticity.The density of available bone in an edentulous site is a determining factor in treatment planning, implant design, surgical approach, healing time, and initial progressive bone loading during prosthetic reconstruction

3.3 CLASSIFICATIONS OF BONE DENSITY

An appreciation of bone density and its relation to oral implantology has existed for almost 50 years.

Linkow and Chercheve 1970, classified bone density into three categories[32]

Category	Description
Class I bone structure	Evenly spaced trabeculae with small cancellated spaces.
Class II bone structure	Slightly larger cancellated spaces with less uniformity of the osseous pattern.
Class III bone structure	Large, marrow-filled spaces exist between bone trabeculae.

In 1985 Lekholm and Zarblisted four bone qualities found in the anterior regions of the jawbone.[32]

- Quality 1 was composed of homogeneous compact bone.
- Quality 2 had a thick layer of compact bone surrounding a core of dense trabecular bone.

- Quality 3 had a thin layer of cortical bone surrounding dense trabecular bone of favorable strength.
- Quality 4 had a thin layer of cortical bone surrounding a core of low-density trabecular bone.

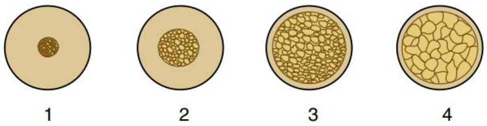


Fig. 2 - Lekholm and Zarb bone qualities

In 1988 Mischproposed four bone density groups independent of the regions of the jaws based on macroscopic cortical and trabecular bone characteristics.

The regions of the jaws with similar densities were often consistent. Suggested treatment plans, implant design, surgical protocol, healing, and progressive loading time spans have been described for each bone density type.[32]

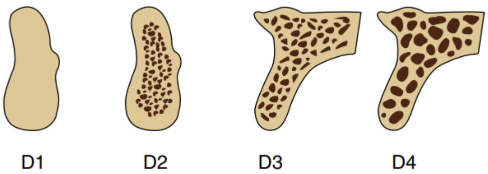


Fig 3 – Misch Classification of bone density

4. INFECTIONS AROUND THE IMPLANT AND THEIR PROPOSED MANAGEMENT

Biological complications associated with dental implants primarily relate to infection in the soft and hard tissues around implants, known as peri-implant mucositis and peri-implantitis, respectively.Peri-implant mucositis describes the presence of mucosal inflammation in the absence of bone loss and the prevalence is around 28% after 2 year implant loading, while peri-implantitis includes inflammation and loss of supporting bone around an implant in function,5% to 10% of overall prevalence has been reported.

The ailing implants had been defined as problems limited to the peri-implant mucosa and not involving the supporting bone, more recently, as biological complications.

The clinical features of peri-implantitis include: radiographic evidence of vertical destruction of the crestal bone, not dependent on implants mobility, formation of a peri-implant pocket in association with radiographic bone loss, bleeding after gentle probing, suppuration might also be present, mucosal swelling and redness, pain is not a typical feature of peri-implantitis.Peri-implantitis can lead to ailing implant, Failing implant and failed implant.

The goals of non-surgical and surgical therapies are to re-establish healthy peri-implant soft and hard tissues. **Table 3** listed current available diagnostic criteria for implant failures as well as their proposed treatment. Occlusal therapy is indicated if occlusal overload is one of etiologic factors for peri-implant bone loss. Antiseptic non-surgical therapy (e.g. antibiotics) is suggested by some authors for treating deep pockets more than 5 mm.surgical procedures such as regenerativeapproaches have been tried and shown promising outcomes after surface is being detoxified. Air powder abrasions as well as acid (e.g. citric or tetracycline) had been shown to be effective in detoxifying contaminated implant surfaces.[33]

Condition	Proposed Treatment
Ailing implant	Non-surgical treatment: Mechanical debridement, Antibiotic: systemically

	or locally
Failing implant	**Vertical defect:** < 2 mm: GBR, Osteoplasty-convert to horizontal defect > 2 mm but <1/2 Implant height: GBR, Autogenous bone wedge grafting >1/2 Implant height. Implant removal **Horizontal defect:** <1/2 Implant height: APF: Osteoplasty; GBR <1/2 Implant height. Implant removal
Failed implant	Implant removal

Table 3: Infections around the implant and their proposed treatment

5. IMPLANTS IN PERIODONTITIS PATIENTS

The responses of hard and soft tissues to plaque formation around dental implants are similar to those around teeth. A cause-and-effect relationship between plaque formation on dental implants and peri-implant mucositis has been demonstrated. A clear understanding of the influence, on peri-implant health, of an individual's susceptibility to periodontitis is necessary for successful implant-treatment planning.

Nevins & Langer described surviving implants in a group of patients with 'recalcitrant periodontitis' – defined as continued periodontal bone loss despite active management. Implant survival was high (> 97%) with only seven implants lost.In contrast, Koldsland et al. investigated risk indicators for peri-implantitis, finding that 'history of periodontitis' was the most conclusive associated variable and this provide evidence that patients with a history of periodontitis are at greater risk of having implant loss and peri-implantitis.A long-term follow-up (≥ 9 years) study of 218 private practice patients in Sweden showed that a history of severe periodontitis was associated with a higher implant failure rate. Those patients with severe bone loss (≥ 30%) in their residual dentition before implant therapy had significantly higher rates of implant failure than did those with less loss of preexisting bone.[34]

5.1 SUPPORTIVE PERIODONTAL THERAPY FOR PATIENTS WITH A HISTORY OF PERIODONTITIS

Supportive peri-implant therapy is essential in the prevention and management of peri-implant diseases in patients with a history of periodontitis.Long-term studies showed that a lack of supportive peri-implant therapy correlated with a greater incidence of peri-implant bone loss, in all patients over 10 years. Patients those with a history of periodontitis, defined as teeth with > 30% bone loss, were at 4.7-times greater risk of having peri-implantitis, after adjusting for smoking status. Hence, patients with a history of periodontitis, even if they are 'treated' and considered periodontally healthy at the outset of implant treatment, may benefit from a greater emphasis on self-performed plaque control and more frequent supportive peri-implant therapy recall visits.[35]

CONCLUSION

In conclusion, the review underscores the critical importance of periodontal considerations in the realm of dental implants. Through an in-depth exploration of various factors such as soft tissue management, bone morphology, and peri-implant disease prevention, it becomes evident that the success and longevity of dental implants are intricately intertwined with the health and stability of surrounding periodontal tissues.By understanding the complex interplay between implant dentistry and periodontal health, clinicians can implement evidence-based strategies to optimize patient outcomes and ensure the long-term stability and function of dental implants. From the meticulous placement of implants to the management of peri-implant diseases, attention to periodontal principles is paramount in achieving predictable and esthetic results.

In essence, a comprehensive understanding of periodontal considerations not only enriches the practice of implant dentistry but also serves as a cornerstone for achieving optimal oral health and quality of life for patients undergoing implant treatment.

REFERENCES

1. Schroeder HE, Listgarten MA. The gingival tissues: the architecture of periodontal protection. Periodontology 2000. 1997 Feb;13(1):91-120.

2. Eggert FM, Germain JP, Cohen B. The gingival epithelium of rodent molars with limited eruption.Cells Tissues Organs. 1980 Jul 9;107(3):297-306.

3Fowler C, Garrett S, Crigger M, Egelberg J. Histologic probe position in treated and untreated human periodontal tissues.Journal of Clinical Periodontology. 1982 Oct;9(5):373-85.

4. Ramfjord SP. Present status of the modified Widman flap procedure.

5. Masaoka T, Hashimoto S, Kinumatsu T, Muramatsu T, Jung HS, Yamada S, Shimono M. Immunolocalization of laminin and integrin in regenerating junctional epithelium of mice after gingivectomy. Journal of periodontal research. 2009 Aug;44(4):489-95.

6. Waerhaug J. Healing of the dento-epithelial junction following the use of dental floss.Journal of Clinical Periodontology. 1981 Feb;8(2):144-50.

7. Bertoldi C, Lusuardi D, Battarra F, Sassatelli P, Spinato S, Zaffe D. The maintenance of inserted titanium implants: in-vitro evaluation of exposed surfaces cleaned with three different instruments. Clinical oral implants research. 2017 Jan;28(1):57-63.

8. Jepsen S, Berglundh T, Genco R, Aass AM, Demirel K, Derks J, Figuero E, Giovannoli JL, Goldstein M, Lambert F, Ortiz-Vigon A. Primary prevention of peri-implantitis: Managing peri-implant mucositis. Journal of clinical periodontology. 2015 Apr;42:S152-7.

9. Bidra AS, Daubert DM, Garcia LT, Kosinski TF, Nenn CA, Olsen JA, Platt JA, Wingrove SS, Chandler ND, Curtis DA. Clinical practice guidelines for recall and maintenance of patients with tooth-borne and implant-borne dental restorations.The Journal of the American Dental Association. 2016 Jan 1;147(1):67-74.

10. Clark D, Levin L. Dental implant management and maintenance: How to improve long-term implant success?.Quintessence International. 2016 May 1;47(5).

11Karring T, Östergaard E, Löe H. Conservation of tissue specifically after heterotopic transplantation of gingiva and alveolar mucosa.Journal of Periodontal Research. 1971 Aug;6(4):282-93.

12. Prichard JF. Present state of the interdental denudation procedure. Journal of Periodontology. 1977 Sep;48(9):566-9.

13James WC, McFall Jr WT, Burkes EJ. Placement of Free Gingival Grafts on Denuded Alveolar Bone—Part II: Microscopic Observations. Journal of Periodontology. 1978 Jun;49(6):291-300.

14. Southam JC, Hodson JJ. The growth of epithelium, melanocytes, and Langerhans cells on human and experimental dental pulp polyps. Oral Surgery, Oral Medicine, Oral Pathology. 1974 Apr 1;37(4):546-55.

15.Glavind L, Löe H. Errors in the clinical assessment of periodontal destruction. Journal of periodontal Research. 1967 Jun;2(3):180-4.

16. Berglundh T, Lindhe J, Ericsson I, Marinello CP, Liljenberg B, Thornsen P. The soft tissue barrier at implants and teeth. Clinical oral implants research. 1991 Apr;2(2):81-90.

17. Hof M, Pommer B, Ambros H, Jesch P, Vogl S, Zechner W. Does timing of implant placement affect implant therapy outcome in the aesthetic zone? A clinical, radiological, aesthetic, and patient-based evaluation. Clinical Implant Dentistry and Related Research. 2015 Dec;17(6):1188-99..

18. Romanowski AW, Squier CA, Lesch CA. Permeability of rodent junctional epithelium to exogenous protein.Journal of Periodontal Research. 1988 Mar;23(2):81-6.

19. Golub LM, Iacono VJ, Nicoll G, Ramamurthy N, Kaslick RS. The response of human sulcular leucocytes to a chemotactic challenge: a new in vivo assay. Journal of Periodontal Research. 1981 Apr;16(2):171-9.

20. Griffiths GS.Formation, collection and significance of gingival crevice fluid.Periodontology 2000. 2003 Feb;31(1):32-42.

21. Ramseier CA, Eick S, Brönnimann C, Buser D, Brägger U, Salvi GE. Host-derived biomarkers at teeth and implants in partially edentulous patients.A 10-year retrospective study. Clinical oral implants research. 2016 Feb;27(2):211-7.

22. Tanaka T. Transport pathway and uptake of microperoxidase in the junctional epithelium of healthy rat gingiva.Journal of Periodontal Research. 1984 Jan;19(1):26-39.

23.Lindhe J, Liljenberg B, Listgarten M. Some microbiological and histopathological features of periodontal disease in man.Journal of periodontology. 1980 May;51(5):264-9.

24.Berglundh T, Zitzmann NU, Donati M. Are peri-implantitis lesions different from periodontitis lesions?.Journal of clinical periodontology. 2011 Mar;38:188-202..

25Carcuac O, Berglundh T. Composition of human peri-implantitis and periodontitis lesions.Journal of dental research. 2014 Nov;93(11):1083-8.

26. Bröker MS, Diago MP, Diago MP. Factors that influence the position of the peri-implant soft tissues: a review. Medicina oral, patología oral y cirugíabucal.Ed. inglesa. 2009;14(9):13.

27. Lindhe J, Meyle J, Group D of the European Workshop on Periodontology. Peri-implant diseases: consensus report of the sixth European workshop on periodontology. Journal of clinical periodontology. 2008 Sep;35:282-5.

28. Heitz-Mayfield L, Lang NP. Comparative biology of chronic and aggressive periodontitis vs. peri-implantitis.Periodontology 2000. 2010 Jun 1;53:167-81.

29. Sabancı A, Eltas A. Peri-Implant Tissue Microbiology: A Review.

30. Branemark PI. Osseointegration and its experimental background.The Journal of prosthetic dentistry. 1983 Sep 1;50(3):399-410.

31.Gupta A, Jain D, Gehi S. Immediate Extraction and Implant Placement in Compromised Situation: A Case Report..

32. Marquezan M, Osório A, Sant'Anna E, Souza MM, Maia L. Does bone mineral density influence the primary stability of dental implants? A systematic review. Clinical oral implants research. 2012 Jul;23(7):767-74.

33. Tsao YP, Wang HL.Periodontal considerations in implant therapy. Int Chin J Dent. 2003;3:13-30.

34. Smith MM, Knight ET, Al-Harthi L, Leichter JW. Chronic periodontitis and implant dentistry. Periodontology 2000. 2017 Jun;74(1):63-73.

35. Roos-JansåkerAM, Lindahl C, Renvert H, Renvert S. Nine-to fourteen-year follow-up of implant treatment. Part II: presence of peri-implant lesions. Journal of clinical periodontology. 2006 Apr;33(4):290-5

COMPLICATIONS OF DENTAL IMPLANTS.

Author:
Dr. Yuthicka Sirohi
Consultant oral Pathologist

Corresponding Author:
Dr. Yuthicka Sirohi
Consultant oral Pathologist
Email: yuthickasirohi@gmail.com

ABSTRACT:

The fixed implant-supported prostheses are fully recognized as the best treatment option for the replacement of single or multiple missing teeth. However, the survival rates actually refer to the prosthesis that continued its clinical service during definite follow-up period and it does not imply that implants are free of complications. This article will review the complications associated with dental implants.It is necessary to have knowledge regarding the complication as it is the operator to be blamed in case of implant failure.

Keywords: Implant, Complications, Failures

INTRODUCTION

Dental implants are the treatment of choice for replacement of a missing tooth as they restore the function of a tooth to nearly normal. The basis for dental implants is osseointegration, where osteoblasts grow and directly integrate with the titanium surface of the implants surgically placed inside the alveolar bone.Good survival rates of up to 10 years have been reported for both single-unit[1,2] and multiple-unit[3,4,5] implant-supported FPDs. The fixed implant-supported prostheses are fully recognized as the best treatment option for the replacement of single or multiple missing teeth. However, the survival rates actually refer to the prosthesis that continued its clinical service during definite follow-up period and it does not imply that implants are free of complications. A detailed knowledge regarding the complications and failures is important for the clinician as proper management of these complications holds the key to the success of the implants. This article will review the complications associated with dental implants.It is necessary to have knowledge regarding the complication as it is the operator to be blamed in case of implant failure.

TYPES OF COMPLICATIONS

These complications of implant placement can be divided into irreversible and reversible, depending upon whether the implant itself can be salvaged or not.

The irreversible complication can be termed as ‘failure’ and is associated with sensitivity and pain upon loading. Vertical or horizontal movements suggest a fibrous encapsulation around the implant, which is seen in the radiograph as a peri-implant radiolucency. As a matter of fact, bone loss down to 1/3 of the implant fixture length may also be considered “failed[6]. Although rotational movement at an early stage of healing may provide insufficient evidence for de-osseointegration as the bone density and mineralization increase over time.

Reversible complications refer to the increased risk of failure but are of temporary significance and are amenable to timely management . Clinical parameters often used in the literature include radiographically observed progressive marginal bone loss exceeding 1.5 mm in the first year and 0.2 mm in the subsequent years [7]. The clinical parameters such as bleeding on probing, sulcus bleeding index, pocket probing depth, mucosal recession, probing attachment levels, crevicular fluid analysis, and microbial composition are indicators of the underlying problem with the implant. However, differences in probing force, hyperplastic state of the gingiva, and different histologic structures of the peri-implant periodontium from that of the natural teeth can result in under or overestimation of the true underlying problems. Therefore, a proper intraoral radiographic bitewing view is the most accurate method to detect the perifixtural bone loss compared to any of these clinical parameters. These reversible complications are further subdivided into - intraoperative complications, early/late postoperatively, and during prosthetic reconstruction and/or after functional loading(surgical, prosthetic/technique, and esthetic/soft tissue associated complications).

INTRAOPERATIVE COMPLICATIONS

A history of surgical trauma in the site during tooth extraction or osteotomy can cause early implant failure. This is due to failure of osseointegration. The critical temperature at which bone necrosis may occur has been reported as 47°C for 1 minute beyond which fat cells may replace bone, leading to an unfavorable condition for osseointegration.

Stability of an implant is a crucial factor in osseointegration. It is directly dependent on primary stability, it is extremely important to accurately measure the primary stability. A wider diameter or longer implant is suggested to re-embrace the stability within anatomic boundaries. However, if this is not possible, the implant is to be removed and its placement delayed until the recipient site is surgically augmented. If an improper implant positioning occurs intraoperatively, the implant is relatively easy to torque out manually. This process may create a gap between the implant and the bone if the same diameter implant is used. The critical gap reported for ensured bone formation ranged from 0.35 to 1.25 mm[8].

Excessive hemorrhage may occur from an osteotomy preparation in the mandible, frequently involving 3 major arteries supplying the mandible, including inferior alveolar, facial, and lingual artery.Subsequently ruptured artery may lose blood. Blood loss >500 ml may result in hypotension,and even life-threatening airway obstruction may occur if not treated at an early stage. To avoid this never pack gauze lingually because there is no hard tissue in the floor of mouth to apply pressure against.

Sinus perforations have been related to the extent of the angle formed by the mediolateral walls of the sinus displayed on computerized tomography.The angles <30°, 31°–60°, and >61° resulted in 37.5%, 28.6%, and 0%, respectively, of sinus perforation. In case of a sinus perforation, seal the window with collagen membrane.

Fracture of the mandible is a severe complication with endosteal implants, especially placed in a severely resorbed mandible with <7 mm of bone height and 6 mm of width. Treatment of the fractured mandible is difficult, attributing to a depressed vitality of bone from a higher proportion of dense cortical bone with diminished central blood supply and its dependence upon the periosteal blood supply.

Nerve trauma results from damages to inferior alveolar, mental, incisive, or lingual nerve during osteotomy preparation or flap incisions. This effect may range from paresthesia to a complete loss of sensation. In such cases, implants must be removed, or shorter implants must be placed to relieve the pressure over the injured nerve. A minor injury usually heals spontaneously within days or months. However, prolonged pressure from neuritis may lead to permanent degeneration of the affected nerve.

EARLY POST OPERATIVE COMPLICATIONS

Screw loosening Overloading of the implants usually causes loosening or fracture of the implant component. The screw loosening or fracture prevailst more with the prosthetic screws as opposed to the abutment screws[9]. Implants restored with single crowns have shown more screw loosening as compared to multiple implants with multiple restored units,[10] and mandibular molar implant restorations are more affected by screw loosening as compared to the maxillary ones. In another study, the incidences of loosening of the abutment screw or the abutment were found to be 59.6% in a follow-up of 15 years.[11] To reduce the incidence of screw loosening, it is advised to maximize the joint clamping forces while curtailing joint separating forces. Joint separating forces include excursive contacts, cantilevered contacts, interproximal contacts, off-axis centric contacts, and nonpassive frameworks.

Implant fracture is one of the leading causes of early implant failure. There can be two reasons - biomechanical overloading and peri-implant vertical bone loss. The risk of implant fracture increases when the vertical bone loss is severe enough to concur with the apical limit of the screw.Implant fractures are also attributable to flaws in the designs and manufacturing of implant itself.Unnoticed and recurrent screw loosening is a risk factor for dental implant fracture, which indicates change in the prosthesis design.[12] When a screw is loose, it is more disposed to excessive sideward load. Fracture of the implant abutment screw can be a huge setback as the remaining fragment inside the implant jeopardizes the efficient functioning of the implant.Implants with a smaller diameter of 4 and 3.75 mm are inclined to fractures more easily than those with the greater diameter. It has been reported that an implant having a diameter of 5 mm is three times stronger than the one with the diameter of 3.75 mm, while an implant of 6 mm diameter is 6 times stronger than a 3.75 mm implant.[13]

Fracture of veneering porcelain is usually seen with single implant restorations. It can be reduced by following the clinical recommendations, that is, by reducing the occlusal table, preventing heavy occlusal contacts, keeping shallow cuspal heights, and by providing adequate thickness of the overlying ceramic.

The problem of fracture of framework is more commonly seen in partially edentulous jaws, because the implant-abutment interface and abutment retention screw are exposed to higher lateral bending loads, tipping, and elongation as compared to bilaterally splinted implants in a completely edentulous jaw.The length of the cast bar or framework span is directly proportional to the construction-related distortion,which could get worsened by nonparallel placement of dental implants. The corrective methods will usually lead to a misfit so it is imperative to improve the original/initial fit of the cast frameworks. Factors that influence the accuracy of the initial fit of the framework include the impression material, impression technique, and positional stability[64,65] of the transfer posts.[14]

DELAYED COMPLICATIONS

Peri-implant disease is an inflammatory pathological change that takes place in the soft and hard tissues surrounding an osseointegrated implant. When an implant is successfully osseointegrated, the peri-implant disease that occurs is the consequence of disparity between the host defense and increasing bacterial load. It usually takes about 5 years for the peri-implant disease to progress and exhibit clinical signs and symptoms.The incidence of peri-implantitis and implant loss could be greater if the studies with longer follow-up periods are evaluated. Rigid supra-crestal/sub-crestal structure and reduced biologic resistance against environmental insults from having a “biologic seal” rather than a true “biologic width” and lacking a periodontal ligament complex render implants more susceptible to bone loss from microbial challenges and occlusal disharmony. The peri-implant disease is also related to unequal occlusal load distribution, which leads loosening of the superstructure, infection of the surrounding area, eventually culminating into the inflammatory process.Predisposing systemic conditions include uncontrolled diabetes mellitus, osteoporosis, smoking, long-standing treatment with steroids, uncontrolled periodontitis, radiation therapy, and chemotherapeutics.[15,16]

While, the implants are the best treatment modality to replace missing teeth and restore function, it is vital to recognise the above mentioned complications during early stages for the better outcomes. Prevention of complications is the best strategy and careful use of imaging tools, a diagnostic wax-up, use of surgical template, and a good understanding of the surgical anatomy and principles will go a long way in success of implant.

REFERENCES

1. Jung RE, Pjetursson BE, Glauser R, Zembic A, Zwahlen M, Lang NP. A systematic review of the 5-year survival and complication rates of implant-supported single crowns. Clin Oral Implants Res. 2008;19:119–30.

2. Jung RE, Zembic A, Pjetursson BE, Zwahlen M, Thoma DS. Systematic review of the survival rate and the incidence of biological, technical, and aesthetic complications of single crowns on implants reported in longitudinal studies with a mean follow-up of 5 years. *Clin Oral Implants Res.* 2012;23(Suppl 6):2–21.

3. Pjetursson BE, Tan K, Lang NP, Brägger U, Egger M, Zwahlen M. A systematic review of the survival and complication rates of fixed partial dentures (FPDs) after an observation period of at least 5 years. *Clin Oral Implants Res.* 2004;15:625–42.

4. Pjetursson BE, Brägger U, Lang NP, Zwahlen M. Comparison of survival and complication rates of tooth-supported fixed dental prostheses (FDPs) and implant-supported FDPs and single crowns (SCs) *Clin Oral Implants Res.* 2007;18(Suppl 3):97–113.

5. Henry PJ, Laney WR, Jemt T, Harris D, Krogh PH, Polizzi G, et al. Osseointegrated implants for single-tooth replacement: A prospective 5-year multicenter study. *Int J Oral Maxillofac Implants.* 1996;11:450–5.

6. Lekholm U, Van Steenberghe D, Herrmann I, et al. Osseointegrated implants in the treatment of partially edentulous jaws: A prospective 5-year multicenter study. Int J Oral Maxillofac Implants. 1994;9:627–635.

7. Albrektsson T, Isidor F. Consensus report of session IV. In: Lang NP, Karring T, eds. Proceedings of the 1st European Workshop on Periodontology. London, UK: Quintessence; 1994:365–369.

8. Carlsson L, Rostlund T, et al. Implant fixation improved by close fit. Cylindrical implant-bone interface studied in rabbits. Acta Orthop Scand. 1988;59:272–275.

9. Goodacre CJ, Bernal G, Rungcharassaeng K, Kan JY. Clinical complications with implants and implant prostheses. *J Prosthet Dent.* 2003;90:121–32.

10. Balshi TJ, Hernandez RE, Pryszlak MC, Rangert B. A comparative study of one implant versus two replacing a single molar. *Int J Oral Maxillofac Implants.* 1996;11:372–8.

11. Jemt T. Single implants in the anterior maxilla after 15 years of follow-up: Comparison with central implants in the edentulous maxilla. *Int J Prosthodont.* 2008;21:400–8.

12.Sánchez-Pérez A, Moya-Villaescusa MJ, Jornet-Garcia A, Gomez S. Etiology, risk factors and management of implant fractures. *Med Oral Patol Oral Cir Bucal.* 2010;15:e504–8.

13. Proceedings of the 4th international symposium on implant dentistry: Focus on esthetics; January 27-29, 1994; San Diego, California. Abstracts. J Prosthet Dent 1994;72:623-34.

14. Thoupos GA, Zouras CS, Winkler S, Roussos VG. Connecting implant framework segments. *Implant Dent.* 1995;4:97–9.

15.. Lang NP, Wilson TG, Corbet EF. Biological complications with dental implants: Their prevention, diagnosis and treatment. *Clin Oral Implants Res.* 2000;11(Suppl 1):146–55. [PubMed] [Google Scholar]

16. Georgiev T. Kamen Nogalchev Local complications occurring during dental implantation. *J IMAB: Annual Proceeding (Scientific Papers)* 2010;16:35–7. [Google Scholar]

CRITICAL APPRAISAL OF DENTAL IMPLANTS IN PEDIATRIC PATIENTS: A LITERATURE REVIEW

Author:
Dr.Patil Disha,
Reader, Department Of Pediatric and Preventive Dentistry,
College Of Dental Sciences, Davangere

Corresponding author:
Dr.Patil Disha,
Reader, Department Of Pediatric and Preventive Dentistry,
College Of Dental Sciences, Davangere
Email- dishapatil26@gmail.com

ABSTRACT

Typically, the use of implants for tooth replacement is limited to individuals who have completed their craniofacial growth. This review seeks to conduct a thorough analysis of the current literature regarding dental implants in pediatric patients, delving into aspects such as effectiveness, safety, and the challenges inherent in their utilization. Through an examination of pivotal studies and recent advancements, the aim is to provide valuable perspectives on the dynamic field of pediatric implant dentistry.

Key words: Children, Dental implants, Development

INTRODUCTION:

Children and adolescents commonly experience edentulous spaces. Instances include partial or total tooth loss due to conditions like Ectodermal Dysplasia and Down's Syndrome, cases of oligodontia resulting from early losses due to severe caries lesions, as well as situations arising from advanced periodontal disease or trauma.[1]

There has been hesitancy in utilizing implant therapy for such children and adolescents due to incomplete jaw growth.

However, it's worth noting that youngsters in this age group could be well-suited candidates for tooth replacement procedures that involve implants.

For example, in cases of trauma in children, the most commonly lost teeth are the incisors. The loss of which leads to rapid resorption of alveolar bone, leaving only a thin crestal bony lamella after healing. If the dentist waits until jaw growth completion, an inadequate bone mass at the site could make implant placement impractical. Furthermore, insufficient bone may significantly compromise the aesthetic outcome achievable with traditional bridgework later on. Opting for an implant will also eliminate the need to prepare neighboring teeth for bridgework. Moreover, using an implant to replace the missing tooth avoids the almost inevitable mucosal inflammation associated with temporary acrylic-based partial dentures.[3]

However, a primary complication observed in the utilization of traditional dental implants in immature individuals is the reported vertical discrepancy of the implant crown with the ultimate occlusal plane. This issue gives rise to numerous aesthetic complications, as ankylosis imposes limitations on tracking sagittal growth.[2]

PLACEMENT OF IMPLANTS:

Mishra et al. [4] provided recommendations for the quadrant-wise placement of implants in their review.

According to them, the maxillary anterior quadrant is a crucial consideration due to the potential for traumatic tooth loss and frequent congenital tooth absence. The vertical growth of the maxilla surpasses other dimensions in this quadrant, making premature implant placement problematic. This can lead to the repetitive need for lengthening the transmucosal implant connection, resulting in poor implant-to-prosthesis ratios and the possibility of load magnification.

Similarly, the maxillary posterior quadrant is influenced by the same growth factors as the anterior region, with an additional factor being transverse maxillary growth at the midpalatal suture. Therefore, it is recommended to delay the placement of osseointegrated dental implants in the maxillary anterior and posterior quadrant until the age of 15 years in females and 17 years in males.

In contrast, the mandibular anterior quadrant is considered the optimal site for osseointegrated implant placement before skeletal maturation. This quadrant presents fewer growth variables, as the closure of the mandibular symphyseal suture occurs during the first two years of life. Prostheses supported by dental implants in the anterior mandible should have a retrievable design to accommodate an average increase in dental height of 5–6 mm, as well as anteroposterior growth.

And lastly due to the ongoing growth and development of the posterior mandible in both transverse and anteroposterior dimensions, it is recommended to defer the placement of osseointegrated implants in the posterior mandibular quadrant until skeletal maturation.

IMPLANT TIMING:

The safest time to place implants seems to be during the lower portion of the declining adolescent growth curve at or near adulthood that can be determined by cephalographic radiographs, serial measure of stature, or handwrist radiographs.[5] A reliable method involves taking serial cephalometric radiographs with a 6-month interval, along with superimposed orthodontic tracings. If there are no observable changes within a one-year timeframe, it can be assumed that growth is complete.[6]

REVIEW:

Bjork[7] utilized titanium pins measuring 1.5 mm in height, implanted in the mandibles of partially endodontic children with an average age of 14.5 years, for longitudinal cephalometric studies and reported that the majority of implants remained stable, whereas pins positioned in the path of erupting teeth or near a bone surface undergoing resorption experienced displacement. Almost all pins situated in resorptive areas were lost and required replacement. In contrast, pins placed in areas of appositional bone growth gradually became embedded.

In another investigation conducted by Kearns et al.,[8] the viability of endosseous implants in growing children was examined, with a focus on assessing the position and stability of implants throughout the growth period. The study included six children experiencing partial anodontia, within age range: 5–17 years. 19 implants in the maxillary and 22 in the mandibular region were placed in these patients. Following an average follow-up period of 7.8 years, prostheses required remodeling to accommodate facial growth. Despite the growth, the implants remained stable and did not exhibit any movement, indicating that transverse growth did not impact the implant position.

In a study by Johansson et al.,[9] a single-tooth implant was inserted in a boy at the age of 12.3 years, and the follow-up extended beyond 4.5 years. Throughout the observation period, the implant remained stationary and did not shift in conjunction with the adjacent teeth, despite the ongoing growth of the maxilla.

However, long-term follow-up of patients receiving single tooth implants in the maxillary region is required to know about the potential risks involved and ways to deal with it.

In 2008 Bergendal et al.,[10] conducted a study assessing 33 dental implants in 26 children, all under 16 years of age, with ectodermal dysplasia (ED) and anodontia in the lower jaw. The findings revealed the loss of 20 implants within a 2-year follow-up period, primarily attributed to inadequate osseointegration. The authors concluded that the placement of dental implants should be avoided in children below the age of 16.

In another prospective clinical trial conducted by Guckes et al.,[11] the impact of endosseous dental implants on the mandible of children with ectodermal dysplasia (ED) was investigated. The study included 23 adolescents aged 12–17 years and 12 preadolescents aged 7–11 years, with a total of 225 implants placed. The results indicated that 22 implants failed, resulting in a success rate of 91.3% (88% in the preadolescent group and 90% in the adolescent group). The findings suggested that osseointegrated implants in children with ED appear to be a viable treatment option. Notably, the mandible continued to grow in a normal pattern, and the implants remained in a stable position within the bone of the mandible.

Chrcanovic[12] conducted a systematic review to evaluate the clinical outcomes and survival rates of oral implants in individuals with ectodermal dysplasia (ED), drawing from previously published case reports and studies. Their final analysis incorporated data from 90 publications, encompassing 228 patients who received 1472 implants. The age range varied from 2 to 56 years, with a mean age of 20 years, and 321 implants were placed in children aged 2–17 years. A failure rate of 6.1% was observed over a mean follow-up period of 61 months. The authors concluded that dental implants in ED patients, particularly in children, exhibited a notably high survival rate.

Several other case reports and case series in the literature have also documented successful outcomes with implant placement in patients with ectodermal dysplasia (ED).[13,14]

Due to the absence of a standard protocol or unanimous agreement among researchers on the procedures and indications for placing conventional or mini-implants in ectodermal dysplasia (ED) patients, it is essential to evaluate all risks and benefits.

Alberga et al.,[15] conducted a retrospective study examining the clinical and esthetic results of dental implant therapy in cleft conditions in 17 patients, averaging 11 years of age in whom 21 implants were inserted and prosthetic rehabilitation followed after a 3-month period. The study reported the failure of only one implant during the 72-month follow-up. The researchers concluded that the patients exhibited excellent implant survival, maintained healthy peri-implant soft tissues, and expressed high satisfaction with the outcomes.

Concerning patients with alveolar clefts, numerous studies have explored dental implant therapy in children who have completed their growth and require bone grafting. However, the existing evidence is limited and insufficient due to the scarcity of prospective clinical studies on dental implants in growing individuals with clefts.[16]

Interestingly, Motoyoshi et al.,[17] documented improved success rates in orthodontic patients with mini implants when loading was initiated at least three months after the initial implant placement.

CONCLUSION:

To flow with the current, there has been an increasing trend in implant application in children. Given the positive success rates observed in a limited number of studies on implant usage in growing patients, thorough planning is crucial for rehabilitative procedures in young children, where immediate, functional, and stable replacement of lost teeth is imperative. Determining the ideal time for implant insertion requires consideration of factors such as skeletal growth status, degree of hypodontia, extent of associated psychological stress, existing dentition status, and the dental compliance of the pediatric patient. Should the treatment planning objectives lean towards utilizing implants before skeletal maturation, it is imperative to educate the child's parents about the advantages and potential complications associated with their use.

To draw conclusion from the current literature, Implant placement should be deferred until skeletal growth is either completed or nearly completed in typical adolescents. However, for individuals with oligodontia or anodontia, earlier intervention might be recommended, particularly in the mandible.

Nevertheless, comprehensive and long-term clinical studies are essential to draw robust conclusions, particularly regarding the suitable age for dental implant placement and the precautions necessary during prosthetic rehabilitation over the follow-up period.

REFERENCES:

1. Ana Paula Soares Fernandes; Márcio Antônio Battistella². Dental Implants in Pediatric Dentistry: A Literature Review. Brazilian Journal of Implantology and Health Sciences, 2022;2(2), 1–12. https://doi.org/10.36557/2674-8169.2020v2n2p1-12
2. J. Jofré, A. Werner.Use of mini implants to replace a missing tooth in a growing patient: a six-year follow up case report. European Journal of Paediatric Dentistry 2015; 16(4): 284-86.
3. Ledermann P. Osseointegrated dental implants as alternative therapy to bridge construction or orthodontics in young patients: seven years of clinical experience. Pediatric Dentistry. 1993; 15(5): 327-333.
4. Mishra, *et al.*: Dental implants in growing children. Journal of indian society of pedodontics and preventive dentistry. 2013; 31(1):3-9
5. Oesterle LJ. Implant considerations in the growing child. In: Higuchi KW, ed. Orthodontic Applications of Osseointegrated Implants. Chicago, Ill: Quintessence; 2000:133–159.

6. Brahmin JS. Dental Implants in Children. Oral Maxillofacial Surg Clin N Am 2005;17:375-81.
7. Bjork A. Variations in the growth pattern of the human mandible: Longitudinal radiographic study by the implant method. J Dent Res 1963;42:400-11
8. Kearns G, Sharma A, Perrott D, Schmidt B, Kaban L, Vargervik K. Placement of endosseous implants in children and adolescents with hereditary ectodermal dysplasia. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1999;88:5-10
9. Johansson G, Palmquist S, Svenson B. Effects of early placement of a single tooth implants. A case report. Clin Oral Implants Res 1994;5:48-51.
10. Bergendal B, Ekman A, Nilsson P. Implant failure in young children with ectodermal dysplasia: A retrospective evaluation of use and outcome of dental implant treatment in children in Sweden. Int J Oral Maxillofac Implants 2008;23:520-4.
11. Guckes AD, Brahim JS, McCarthy GR, Rudy SF, Cooper LF. Using endosseous dental implants for patient with ectodermal dysplasia. J Am Dent Assoc 1991;122:59-62.
12. Chrcanovic BR. Dental implants in patients with ectodermal dysplasia: A systematic review. J Craniomaxillofac Surg 2018;46:1211-7.
13. Sfeir E, Nassif N, Moukarzel C. Use of mini dental implants in ectodermal dysplasia children: Follow-up of three cases. Eur J Paediatr Dent 2014;15:207-12.
14. Mello BZ, Silva TC, Rios D, Machado MA, Valarelli FP, Oliveira TM. Mini-implants: Alternative for oral rehabilitation of a child with ectodermal dysplasia. Braz Dent J 2015;26:75-8
15. Alberga JM, Stellingsma K, Meijer HJA, Oostenbrink HA, Vissink A, Raghoebar GM. Dental implant placement in alveolar cleft patients: A retrospective comparative study on clinical and aesthetic outcomes. Int J Oral Maxillofac Surg 2020;49:952-9
16. Jansma J, Raghoebar GM, Batenburg RH, Stellingsma C, van Oort RP. Bone grafting of cleft lip and palate patients for placement of endosseous implants. Cleft Palate Craniofac J 1999;36:67-72
17. Motoyoshi M, Hirabayashi M, Uemura M, Shimizu N. Recommended placement torque when tightening an orthodontic mini-implant. Clin Oral Implants Res 2006;17:109-14.

AUTOIMMUNE DISEASE AND PERIODONTAL DISEASE -THE POSSIBLE CONNECTION

Authors:

1. **Dr Deepa N Shetty**
   Senior Lecturer, The Oxford Dental College, Bangalore
2. **Dr Anirban Chatterjee**
   Vice Dean, Prof &Head, Maitri Dental college, Durg , Chattisgarh

Corresponding author:
Dr Deepa N Shetty
Senior Lecturer, The Oxford Dental College, Bangalore
Email: deepanshetty@gmail.com

ABSTRACT

Periodontitis is an inflammatory disease that is characterized by loss of the periodontal ligament and alveolar bone. The understanding of pathogenesis of periodontal disease has now made it clear that it is host microbial interaction. Physical, environmental and social host stresses can also affect and alter periodontal disease expression.This review attempts to throw light on the possible connection between autoimmune disease and periodontal disease

Keywords: Peridontitis, Autoimmune, Periodontal disease.

INTRODUCTION

Periodontitis is an inflammatory disease that is characterized by loss of the periodontal ligament and alveolar bone. The understanding of pathogenesis of periodontal disease has now made it clear that it is host microbial interaction. Physical, environmental and social host stresses can also affect and alter periodontal disease expression.[1] Similarly oral infection also was considered as a source of infection at distant sites.[2]

In recent times a strong relationship between periodontal health or disease and systemic health or disease has been identified. Many studies have shown systemic disease to be affected by periodontal disease and vice versa.[3-7]In this review we attempt to throw light on the possible connection between autoimmune disease and periodontal disease

AUTOIMMUNE DISEASE

Autoimmune diseases though relatively uncommon, but their effects onmortality and morbidity are severe.Almost 5% of the world population develops an AD. Of this 5% approximately 78% are women.[8] Concept of autoimmunity is when immune tolerance to self-antigens is disrupted due to which the immune system fails to recognize self-cells and destructs it considering it to be foreign.

The most frequent forms of autoimmune disease are: rheumatoid arthritis, Hashimoto's thyroiditis , inflammatory bowel disease , type I diabetes , systemic lupus erythematosus and Sjögren's syndrome

AUTOIMMUNITY -PATHOGENESIS FOR PERIODONTAL DISEASE

In 1965, Brandtzaeg and Kraus were the first to postulate the autoimmune basis in the pathogenesis of periodontal disease.[9]

The majority of reports show the detection of antibodies to host components, in particular, collagen[10] although antibodies to DNA[11] and aggregated IgG [12,]have also been reported.

possible causes of the autoimmunity[13]

1. Enhanced presentation of self antigens.
2. Altered T helper or T suppressor cell function.
3. Polyclonal activation of cells which have the ability, for reasons which may not be clear, to produce autoantibodies.
4. Idiosyncrasies of the antigen idiotype network.
5. bacterial or viral cross reactivity with self-antigens leading to production of cross reactive antibodies;
6. Genetic predisposing factors.

MEHANISM OF LINK BETWEEN PERIODONTAL DISEASE AND OTHER AUTOIMMUNE DISEASE

The possible link between periodontal disease and autoimmune disease can be explained by following reasons

1. **Citrullination of proteins:**Porphyromonasgingivalis produces the calcium-dependent enzyme, peptidyl-arginine deiminase, which promotes the citrullination of human proteins, by converting peptidyl-arginine sequences to peptidyl-citrulline sequences, this modification protein has been associated with many disease.[14,15]In autoimmune disease like rheumatoid arthritis antibodies are seen and specific autoantibodies are directed against these citrullinated proteins, these autoantibodies are associated to loss of self tolerance mechanism.[16,17] Thus these antibodies are responsible for inflammatory reaction followed by tissue destruction.
2. **Heat shock Proteins-** Pathogenic microorganisms in periodontal disease have shown to induce overexpression of heat shock proteins like HSP60. [18]In progression of periodontal disease HSPs increase pro-inflammatory cytokines production. Persistent stimulus for expression of this heat shock protein, can cause self-immune response, which may lead to onset of autoimmune diseases.[19]
3. **Anti-Neutrophil Cytoplasmic Antibodies (ANCA)**The high antigenic load contribute by the periodontal pathogens leads to hyperactivity of B cells which is responsible for generationofanti-neutrophil cytoplasmic antibodies (ANCA) seen in both rheumatoid arthritis and systemic lupus erythematosus.[20]
4. **Toll Like Receptors:** TLRs mediate the immune responses induced by Lipopolysaccharides LPS released by periodontal pathogens**.**TLRs may have an important role to play in rheumatoid arthritis and SLE.[21,22]
5. **Genetic Susceptiblity[23-26]:** Many studies reported association between histocompatibility complex antigens and certain autoimmune diseases, for example, rheumatoid arthritis with HLA-DRw4, systemic lupus erythematosus in association with HLA-DR3 and HLA-B8.HLA phenotype and susceptibility to

periodontal disease are mainly associated with HLA class I antigen distribution

CONCLUSION:

Periodontal disease itself has a possible autoimmune pathogenesis and can influence the progression of other autoimmune disease as explained by the various mechanism discussed in this article. This relationship with autoimmune disease and periodontal disease should be further probed, with the help of research studies designed to understand the extent and effect of this connection.

REFERENCES

1. Offenbacher S. Periodontal diseases: pathogenesis. Ann Periodontol 1996: 1: 821-878.
2. Hunter W. Oral sepsis as a cause of disease. Br Med J 1900: 1: 215–216.
3. Beck JD, Garcia RG, Heiss G, Volconos P, Offenbacher S. Periodontal disease and cardiovascular disease. J Periodontol 1996: 67(suppl): 1123–1137.
4. Beck JD, Offenbacher S, Williams RC, Gibbs P, Garcia R. Periodontitis: a risk factor for coronary heart disease? Ann Periodontol 1998: 3: 127–141.
5. DeStefano F, Anda LF, Kahn HS, Williamson DF, Rasell CM. Dental disease and risk of coronary heart disease and mortality. BMJ 1993: 306: 688–69
6. Grossi SG, Genco RJ. Periodontal disease and diabetes mellitus: a two-way relationship. Ann Periodontol 1998: 3: 51– 61.
7. Offenbacher S, Beck JD, Lieff S, Slade G. Role of periodontitis in systemic health: Spontaneous preterm birth. J Dent Ed 1998: 62: 852–858.
8. Fairweather DL, Frisancho-Kiss S, Rose NR. Sex differences in autoimmune disease from a pathological perspective. Am J Pathol 2008;173:600e9.
9. Brandtzaeg P, Kraus Fw. Autoimmunity And Periodontal Disease. OdontolTidskr. 1965 Jun 30;73:281-393. PMID: 14317731.
10. Ftis A, Singh G, Dolby AE. Antibody to collagen type I in periodontal disease. J Periodontol. 1986 Nov;57(11):693-8.
11. Clagett JA, Page RC. Insoluble immune complexes and chronic periodontal disease in man and dog. Arch Oral Biol 1978;23:153-65
12. Brandtzaeg P. Tolo K. Immunoglobulinin systems of the gingiva. In: Lehner T. ed. The borderland between caries and periodontal disease, London: Academic Press. 1977. p 145 84
13. O. Anusaksathien; A. E. Dolby (1991). *Autoimmunity in periodontal disease. 20(3), 101–107.*
14. Quirke AM, Lugli EB, Wegner N, Hamilton BC, Charles P, Chowdhury M, et al. Heightened immune response to autocitrullinatedPorphyromonasgingivalispeptidylarginine deiminase: A potential mechanism for breaching immunologic tolerance in rheumatoid arthritis. Ann Rheum Dis 2014;73:263-9
15. György B, Tóth E, Tarcsa E, Falus A, Buzás EI. Citrullination: A posttranslational modification in health and disease. Int J Biochem Cell Biol 2006;38:1662-77
16. Trouw LA, Rispens T, Toes REM. Beyond citrullination: Other post-translational protein modifications in rheumatoid arthritis. Nat Rev Rheumatol 2017;13:331-9.
17. Muller S, Radic M. Citrullinated autoantigens: From diagnostic markers to pathogenetic mechanisms. Clin Rev Allergy Immunol 2015;49:232-9.
18. Choi J, Lee SY, Kim K, Choi BK. Identification of immunoreactive epitopes of the

Porphyromonasgingivalis heat shock protein in periodontitis and atherosclerosis. J Periodontal Res 2011;46:240-5

19. Ueki K, Tabeta K, Yoshie H, Yamazaki K. Self-heat shock protein 60 induces tumour necrosis factor-alpha in monocyte-derived macrophage: Possible role in chronic inflammatory periodontal disease. Clin Exp Immunol 2002;127:72-7.
20. Konstantinov KN, Ulff-Møller CJ, Tzamaloukas AH. Infections and antineutrophil cytoplasmic antibodies: Triggering mechanisms. Autoimmun Rev 2015;14:201-3.
21. Marques CP, Maor Y, de Andrade MS, Rodrigues VP, Benatti BB. Possible evidence of systemic lupus erythematosus and periodontal disease association mediated by toll-like receptors 2 and 4. Clin Exp Immunol 2016;183:187-92.
22. Tripathy A, Khanna S, Padhan P, Smita S, Raghav S, Gupta B, et al. Direct recognition of LPS drive TLR4 expressing CD8+ T cell activation in patients with rheumatoid arthritis. Sci Rep 2017;7:933.
23. J. Reinholdt, I. Bay, and A. Svejgaard, “Role of HLA antigen in periodontal diseased,” Journal of Dental Research, vol. 56, no. 10, pp. 1261–1263, 1977.
24. J. A. Encinas and V. K. Kuchroo, “Mapping and identification of autoimmunity genes,” Current Opinion in Immunology, vol. 12, no. 6, pp. 691–697, 2000.
25. J. Klien and A. Sato, “The HLA system,” New England Journal of Medicine, vol. 43, pp. 782–786, 2000.
26. H. Wigzell, “Positive autoimmunity,” in Autoimmunity, Genetic, Immunologic, Virologic and Clinical Asp

COMPARATIVE EVALUATION OF ANTIMICROBIAL POTENTIAL OF TRIPHALA, NEEM LEAF EXTRACT, GREEN TEA AND 2.5% SODIUM HYPOCHLORITE AGAINST ENTEROCOCCUS FAECALIS AND CANDIDA ALBICANS IN PRIMARY TEETH - AN IN VITRO STUDY

AUTHORS:

1. Dr. Shivani Bellal

Professor, Department of pedodontics and preventive dentistry, Bapuji Dental College and Hospital, Davangere

2. Dr. Mama R Nair

Post Graduate student, Department of pedodontics and preventive dentistry, Bapuji Dental College and Hospital, Davangere

3. Dr. Illa Srinivasan

Head of the department, Department of pedodontics and preventive dentistry, MR Ambedkar Dental College and Hospital, Bangalore.

4. Dr. Jyothsna V Setty

Professor, Department of pedodontics and preventive dentistry, Sri Sidhartha Dental College and Hospital, Tumkur

5. Dr. Roopa Babannavar

Professor, Department of endodontics and conservative dentistry, Bapuji Dental College and Hospital, Davangere

6. Dr. Channesh Patel GS

Reader, Department of endodontics and conservative dentistry, College of Dental Science, Davangere.

7. Dr. Supriya PR

Lecturer, Department of pedodontics and preventive dentistry, Bapuji Dental College and Hospital, Davangere.

CORRESPONDING AUTHORS:

DR. Shivani Bellal.

Professor, Department of pedodontics and preventive dentistry, Bapuji dental college and hospital.

ABSTRACT

The greatest cause of endodontic and periapical pathosis is microbial infection of the dental pulp. The use of intra canal irrigating solutions is essential to ensure microbial elimination. The present in vitro study sought to assess and compare antimicrobial potential of Triphala, Neem leaf extract, Green tea and 2.5% Sodium hypochlorite against E. faecalis and C. albicans in primary teeth.

METHODOLOGY: The study utilized 140 extracted human single rooted primary teeth. The samples were decoronated, instrumented and sterilized. Teeth samples were divided into two groups and were infected with E.faecalis and C.albicans respectively for 48 hours. The two groups were further divided randomly into 4 subgroups each according to the irrigants used and kept in contact with the respective irrigant for 5 minutes. All the samples were incubated in Brain heart infusion (BHI) broth and Sabourauds dextrose broth (SD) for 96 hours. All the samples were subjected to turbidity check and colony count to determine the growth of microorganisms. Statistical analysis was done using Kruskal wallis test and Mann-Whitney test.

RESULTS: All the samples treated showed presence of turbidity. Higher mean E.faecalis and C.albicans growth (CFU/ml x10^2) was recorded in Triphala group followed by Green Tea, Neem Leaf Extract and NaOCl respectively. The difference among the groups was found to be statistically significant (P<0.001).

CONCLUSION: All the tested irrigants showed significant antimicrobial efficacy. The order of antimicrobial efficacy was 2.5%NaOCl > Neem leaf extract > Green tea > Triphala.

KEY WORDS: Sodium hypochlorite, Triphala, Green tea, Enterococcus faecalis, Candida albicans, antimicrobial potential, Primary teeth.

INTRODUCTION

Endodontic long-term success relates to three aspects of treatment, known as 'endodontic triad' composed of instrumentation, disinfection and obturation, which are interwoven. The intricacy of root canal anatomy makes it impossible for the instrumentation of the canals to reach all of the fine aspects of the anatomy. Irrigation of the canal system thus permits removal of residual tissue in the canal anatomy that cannot be reached by instrumentation[1]. Studies analyzing microorganisms within the root canals of teeth with periapical lesion have found that E.faecalis and C.albicans are the most common species in root-filled teeth evincing recalcitrant periradicular lesions and as a consequence, role in causation of endodontic treatment failure has been suggested.[2]

Several chemicals and therapeutic agents are used to disinfect the root canal system. Sodium hypochlorite has been the most widely used irrigant for several decades but it has several undesirable characteristics. In the root canal treatment of deciduous teeth, NaOCl can damage permanent tooth follicles, peripheral tissues and oral mucosa[3]. These reasons have prompted researchers to look for other alternatives.

Herbal products such as Propolis, Morinda citrifolia, Arctium lappa, Triphala, Green tea polyphenols (GTP), German chamomile, tea tree oil, Neem, Aloe vera etc have been reported to exert antimicrobial, anti-inflammatory and antioxidant properties.[4]

Triphala is an Indian ayurvedic herbal formulation consisting of dried and powdered fruits of three medicinal plants Terminalia bellerica, Terminalia chebula, and Emblica officinalis. Its antioxidant, anti-inflammatory, and radical scavenging activity may have an added advantage over the traditional root canal irrigants[5]. Triphala is rich in citric acid, which may aid in removal of smear layer thereby acting as chelating agent and also found to be alternative to sodium hypochlorite for root canal irrigation[6].

Neem (Azadirachta indica) has broad spectrum of therapeutic properties like antibacterial, antifungal, antiviral, antioxidant, anti-inflammatory, antipyretic, analgesic and immunostimulant activity. Furthermore, it also has an anti-adherence activity by altering bacterial adhesion and their ability to colonize. Its biocompatibility to human periodontal ligament fibroblasts is an important factor favouring its clinical application[5]. In various studies Neem leaf extract has shown effectiveness against E.faecalis making it a potential agent for root canal irrigation as an alternative to sodium hypochlorite[6].

Green tea polyphenols is a traditional drink of Japan and China prepared from the young shoots of Tea plant, Camellia Sinensis. GTPs have demonstrated antioxidant, anti-inflammatory and antimicrobial properties in numerous in vivo, in vitro studies. Its anti-oxidative properties can be attributed to the ability of the polyphenols contained in the leaves of Camellia Sinensis, especially the gallocatechins, to inactive free radicals. Green tea contains flavonoids that inhibit the growth and activity of the bacteria and also found to be a good chelating agent[4].

However, there is lack of sufficient documentation or data regarding the antibacterial activity of these products when used as irrigating solutions in endodontics. Hence the aim of the present study was to assess and compare the antimicrobial efficacy of Triphala, Neem leaf extract, Green tea and 2.5% NaOCl against Enterococcus faecalis and Candida Albicans especially in primary teeth.

MATERIALS AND METHODOLOGY

MICROORGANISMS TESTED

E. faecalis (ATCC 29212)
C. albicans (ATCC 18804)
Pure cultures of *E. faecalis* (ATCC 29212) and C.albicans (ATCC 18804) were suspended in 5.0 ml of brain heart infusion broth and Sabourauds dextrose broth respectively. The cell suspension was adjusted spectrophotometrically to match the turbidity of $1x10^8$ CFU/mL (equivalent to 0.5 McFarland standards).

PREPARATION OF IRRIGANT SOLUTIONS

- **Preparation of Triphala and Green tea solution :** Triphala and GT powders were made into a solution by dissolving them in 10% dimethyl sulfoxide (DMSO).[7]
- **Preparation of Neem leaf extract :**

Mature fresh Azadirachta indica leaves were washed in sterilized distilled water and weighed in a sterile disposable cup. 100gms of fresh neem leaves were added to 50ml of absolute ethanol. Mixture was macerated for 1-2 mins. Extract was filtered through muslin cloth for coarse residue. Extraction process was repeated again using coarse residue and 25ml ethanol. Both the extracts were pooled together and filtered through fast filter paper. Alcohol part was removed from the extract on water bath till the volume was about 25ml. Extract was ready and stored at 4°C until used for the assay.[8]

METHODOLOGY:

One hundred and forty extracted human single rooted primary teeth were collected and stored in 10% formalin. Each tooth was decoronated and instrumented 0.5 mm short of apex with a 35k - file, maintaining 7 mm of working length. 1 ml NaOCl was used for cleaning and shaping.1 ml EDTA was used to remove the smear layer. All the roots were autoclaved and divided into two groups (group 1 and group 2). Each group contained 70 samples. Five autoclaved samples from each group were transferred to sterile broth to serve as negative controls. Remaining root canal samples in group 1 were inoculated with 1µl of Enterococcus faecalis suspension and group 2 samples were inoculated with 1µl of Candida albicans suspension using a sterile micropipette. All the samples were incubated at 37°c for 48 hrs. Five infected samples from each group were kept as positive control for E.faecalis and Candida albicans respectively. The infection of samples was confirmed by sampling the culture of E.faecalis on Mac Conkeys agar and Candida albicans culture on Sabouraud's dextrose agar. Each group is further divided into 4 experimental sub groups according to the irrigant used. Each sub group contained 15 samples.
Group 1a/2a- irrigated with 5 ml Triphala
Group 1b/2b- irrigated with 5 ml Neem leaf extract
Group 1c/2c- irrigated with 5 ml Green tea
Group 1d/2d- irrigated with 5 ml 2.5%NaOCl.

All the samples were then washed with distilled water to prevent carryover of irrigants, transferred into tubes containing 2ml of BHI broth and SD broth and aseptically cultured in an incubator at 37°c for 96 hrs. After 96hrs the tubes were examined for the presence of turbidity. Numbers of positive and negative samples were recorded. Then the microbial count was detected, colony count was performed and tabulated. The data was subjected to statistical analysis. Kruskal-Wallis test and Mann-Whitney test were used for statistical analysis.

RESULTS

Analysis of E.faecalis growth in the groups:

Table:1 Mean and standard deviation values of E.faecalis growth according to irrigants used.

Group	Mean	S	SE of Mean	95% CI for Mean		Min	Max	P-Value
				Lower Bound	Upper Bound			
NaOCL	4.20	1.01	0.26	3.64	4.76	3	6	<0.001*
Triphala	14.13	1.25	0.32	13.44	14.82	12	16	
Neem Leaf Extract	6.07	0.80	0.21	5.62	6.51	5	7	
Green Tea	8.80	1.01	0.26	8.24	9.36	7	10	

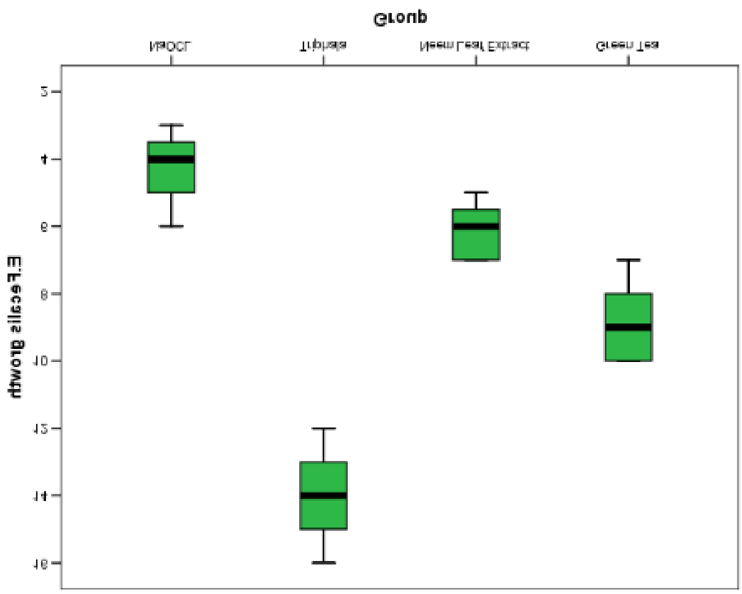
*denotes significant difference

Table 2: Multiple group comparisons for E.faecalis growth.

(I) Group	(J) Group	Mean Difference (I-J)	P-Value	95% CI for Mean Diff	
				Lower Bound	Upper Bound
NaOCL	Triphala	-9.933	<0.001*	-10.963	-8.904
	Neem Leaf Extract	-1.867	<0.001*	-2.896	-0.837
	Green Tea	-4.600	<0.001*	-5.629	-3.571
Triphala	Neem Leaf Extract	8.067	<0.001*	7.037	9.096
	Green Tea	5.333	<0.001*	4.304	6.363
Neem Leaf Extract	Green Tea	-2.733	<0.001*	-3.763	-1.704

*denotes significant difference

GRAPH 1: Box-Plot of E.Fecalis growth in the tested groups:



Analysis of Candida growth in the groups:

Table:3 Mean and standard deviation values of C.albicans growth according to irrigants used.

Group	Mean	SD	SE of Mean	95% CI for mean		Min	Max	P-Value
				Lower Bound	Upper Bound			
NaOCL	3.53	0.52	0.13	3.25	3.82	3	4	<0.001*
Triphala	13.60	1.24	0.32	12.91	14.29	12	16	
Neem Leaf Extract	5.33	1.18	0.30	4.68	5.98	3	7	
Green Tea	8.27	1.03	0.27	7.69	8.84	7	10	

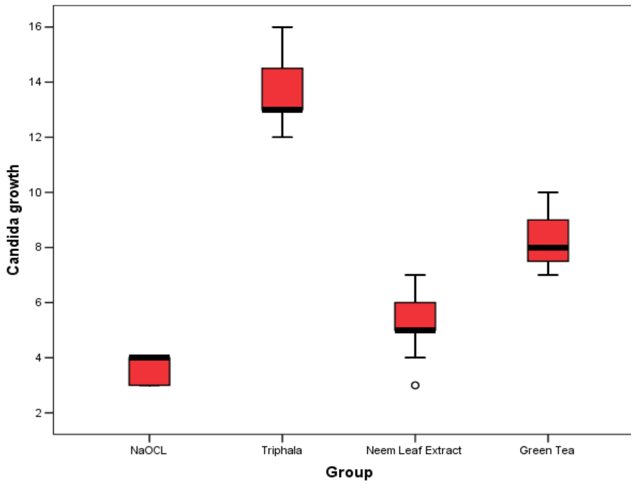
*denotes significant difference

Table 4: Multiple group comparisons for candida growth.

(I) Group	(J) Group	Mean Difference (I-J)	P-Value	95% CI for Mean Diff	
				Lower Bound	Upper Bound
NaOCL	Triphala	-10.067	<0.001*	-11.097	-9.036
	Neem Leaf Extract	-1.800	<0.001*	-2.830	-0.770
	Green Tea	-4.733	<0.001*	-5.764	-3.703
Triphala	Neem Leaf Extract	8.267	<0.001*	7.236	9.297
	Green Tea	5.333	<0.001*	4.303	6.364
Neem Leaf Extract	Green Tea	-2.933	<0.001*	-3.964	-1.903

*denotes significant difference

GRAPH 2: Box-Plot of Candida Growth in the groups:



For E.feacalis:

Higher mean E.feacalis growth (CFU/ml x10^2) in Triphala group followed by Green tea, Neem leaf extract and 2.5% NaOCl respectively. The difference in E.feacalis growth among the groups was found to be statistically significant (P<0.001) as shown in table 1. Graphical representation of the same is shown in graph 1.

Multiple comparisons between the groups using Mann-Whitney test showed that the difference in mean E.faecalis growth was statistically significant between NaOCl & Triphala (P<0.001), NaOCl & Neem leaf extract (P<0.001), NaOCl & Green Tea (P<0.001), Triphala & Neem Leaf Extract (P<0.001), Triphala & Green Tea (P<0.001) as well as between Neem Leaf Extract & Green Tea (P<0.001).

For C.albicans:

Higher mean candida growth (CFU/ml x10^2) in Triphala group followed by Green tea, Neem leaf extract and NaOCl respectively. The difference in candida growth among the groups was found to be statistically significant (P<0.001) as shown in table 3. Graphical representation of the same is shown in graph 2.

The difference in mean candida growth was statistically significant between NaOCl & Triphala (P<0.001), NaOCl & Neem leaf extract (P<0.001), NaOCl & Green tea (P<0.001), Triphala & Neem leaf extract (P<0.001), Triphala & Green tea (P<0.001) as well as between Neem leaf extract & Green tea (P<0.001).

DISCUSSION:

The greatest cause of endodontic and periapical pathosis is microbial infection of the dental pulp. The presence of microorganisms negatively influences the outcome of root canal treatment. Therefore, the use of irrigation solution is essential to ensure microbial elimination. Sodium hypochlorite is currently the most widely used root canal irrigant.[9] It is a broad spectrum antimicrobial agent that has proven to be effective against bacteria, bacteriophages, spores, yeasts, and viruses.[10] However, its potential toxicity and biocompatibility problems associated with the use of concentrated NaOCl have led to the use of substances with known antimicrobial properties, less toxicity and higher safety.

There has been growing interest in the use of herbal products for therapeutic application. Accordingly various studies have been carried out with different plant products.

There possible activity as antimicrobial agents has been of particular interest. The major advantages of using herbal alternatives are easy availability, low toxicity and lack of microbial resistance which would appear prudent to replace conventional root canal irrigant, sodium hypochlorite.

Bystrom and Sundquist reported that 0.5%NaOCl was more effective than saline as an irrigant confirming the antimicrobial properties of that substance.[10] Siqueira et al. found no difference in the antibacterial effect of 1%, 2.5%, and 5.2% NaOCl. They suggested that copious irrigation with NaOCl may maintain a chlorine reserve that is sufficient to eliminate bacterial cells and compensate for the effect of concentration. Although less concentrated solutions have shown antimicrobial effectiveness, higher concentrations of NaOCl present faster and greater bactericidal effect. However higher the concentration greater its cytotoxic effect.[11]

In the present study 2.5% NaOCl has shown maximum antimicrobial effect against E.faecalis and C.albicans resulting in microbial collections close to zero or minimum growth. These results are in accordance with studies conducted by Radcliffe et al and Vienna et al, who found that 2.5% NaOCl inhibited the growth of all tested microorganisms in 5 and 10 min. [12,13]

In our study Neem leaf extract showed maximum antimicrobial effect against E.feacalis and C.albicans following NaOCl. In a study conducted by Nayak Arathi et al also found that ethanolic extract of Neem leaf showed significant antibacterial activity against E.faecalis and C.albicans.[14] Therefore ethanolic extract of Neem leaf was used in the present study. Ethanolic extract Neem leaf contains saponins, tannins, glycosides, flavonoids, alkaloids, reducing sugars and terpenes.[15] These compounds could be responsible for its activity against E.faecalis. In the present study antioxidant and antimicrobial properties makes it a potential agent for root canal irrigation as an alternative to sodium hypochlorite.

In agreement with our results Bohora and co-workers in their study concluded that the Neem leaf extract has significant antimicrobial effect against E.faecalis derived from infected root canal samples.[8] In a study conducted by Pulipparambil et al, Azadirachta Indica extract exhibited significant antimicrobial effect against E.faecalis colonization similar to NaOCl.[16]

In another study conducted by Dutta and Kundabala, Neem leaf extract showed maximum growth inhibition of C.albicans and E.faecalis similar to 2.5% NaOCl.[17] Results of the present study support the above findings.

In an in vitro study conducted by Tyagi et al, 5% sodium hypochlorite has shown maximum antimicrobial effect against C.albicans compared to Neem leaf extract with statistical significance between the groups though the concentration of NaOCl used was more compared to that used in the present study.[18] Similar findings were observed in the present study where 2.5% NaOCl was found to be more effective than Neem leaf extract with a statistical significance between the two groups. However, these results are not in accordance to those reported by Rosaline et al[19] and Dubey et al.[20] Their studies showed significant superior antimicrobial efficacy of Neem compared to NaOCl.

In a study conducted by Vinoth kumar et al, Neem leaf extract showed similar efficacy to 5.25% NaOCl in reducing E.faecalis and C.albicans without a significant difference between two groups.[21] In our study 2.5%NaOCl was found to be more effective compared to Neem leaf extract.

In the present investigation Green tea and Triphala exhibited significant antimicrobial efficacy but were inferior to NaOCl and Neem. Green tea exhibited significantly better antimicrobial effect compared to Triphala. In studies conducted by Prabhakar et al [22] and Pujar et al [7] Sodium hypochlorite has shown maximum antibacterial activity against E.faecalis biofilm formed in tooth substrate and among the herbal irrigants tested. Although Triphala and Green tea polyphenols exhibited similar antibacterial sensitivity, Triphala showed more potency on E.faecalis biofilm. In the present study NaOCl showed significantly higher antibacterial effect against E.fecalis compared to herbal irrigants. These findings are in accordance with the findings in above mentioned studies. [22,23] However in the present study Green tea exhibited significantly greater antibacterial effect compared to Triphala in contrast to above mentioned studies.[22,23] The antimicrobial action of GT might be attributed to its flavonoid content by inhibition of bacterial enzyme gyrase by binding to Adenosine triphosphate B sub unit.[6]

Triphala and GTPs are proven to be safe, containing active constituents that have beneficial physiologic effect apart from its curative property such as antioxidant, anti inflammatory, and radical scavenging activity and may have an added advantage over the traditional root canal irrigants.[7] Dimethyl sulfoxide (DMSO) is used as a solvent for Triphala and GTP, although they are readily soluble in water. DMSO is a clean, safe, highly polar, aprotic solvent that helps in bringing out the pure properties of all the components of the herb being dissolved.[24]

The findings of present study corroborate some previous in vitro studies although few others showed varying results. The inconsistencies in the results could be due to the differences in methodology and variation in the strains tested. Also the time of exposure could be decisive in the efficacy of the substance.

Further studies should test the susceptibility of antimicrobial substances against the mixed biofilms because most odontogenic infections are polymicrobial in nature.

CONCLUSION:

Based on the results of the present study it can be concluded that all the tested irrigants showed significant antimicrobial efficacy. The order of efficacy of different groups was as follows: 2.5%NaOCl > Neem > Green tea > Triphala. Among the herbal irrigants tested Neem leaf extract has maximum antimicrobial effect. Neem has shown promising results when used as irrigant.

CONFLICT OF INTEREST:

The authors declare no conflict of interest

ACKNOWLEGEMENT:

None

REFERENCES

1. Kurtzuan GM. Improving endodontic success through use of endovac irigation system. Endodontic practice. 2009;17-20.
2. El karim, Kennedy J, Hussey D. The antimicrobial effects of root canal irrigation and medication. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2007;103(4):561-69.
3. Oncag et al. Comparison of antibacterial and toxic effects of various root canal irrigants. Int Endo J. 2003;36:423-432.
4. Pujar M, Makandar S. Herbal usage in endodontics - a review. Int J Of Contemp Dent. 2011; 2(1):34-7.
5. Neelakantan P, Jagannathan N, Nazar N. Ethnopharmacological approach in Endodontic Treatment: A Focused Review. Int J Drug Dev & Re, 2011;3(4):68-77.
6. Kamat S, Rajeev k, Saraf P. Role of herbs in endodontics: an update Endodontology 2011; 23(1):96-100.
7. Pujar M, Patil C, Kadam A. Comparison of antimicrobial efficacy of Triphala, (GTP) Green tea polyphenols and 3% of sodium hypochlorite on Enterococcus faecalis biofilms formed on tooth substrate: in vitro. J Endod. 2011; 3(2): 23-30.
8. Bohora A, Vibha H, Kokate S. Comparison of the antimicrobial efficiency of neem leaf extract and 2% sodium hypochlorite against E.faecalis, C.albicans and mixed culture - an In vitro study. Endodontology. 2010; 22(1): 8-12
9. Costa EMMB, Evangelista APA, Medeiros ACD, Dametto FR, Carvalho RA. Invitro evaluation of the root canal cleaning ability of plant extracts and their antimicrobial action. Braz Oral Res. 2012; 26(3): 215-21
10. Bystrom A, Sundqvist G. Bacteriologic evaluation of the effect of 0.5 per cent sodium hypochlorite in endodontic therapy. Oral Surg Oral Med and Oral Pathol. 1983;55: 307-12.
11. Siqueira JF Jr, Rocas IN, Favieri A, Lima KC. Chemomechanical reduction of the

bacterial population in the root canal after instrumentation and irrigation with 1%, 2.5%, and 5.25% sodium hypochlorite. J Endod. 2000;26:331-34.
12. Radcliffe CE, Potouridou L, Qureshi R et al. Antimicrobial activity of varying concentrations of sodium hypochlorite on the endodontic microorganisms Actinomyces israelii, A. naeslundii, Candida albicans and Enterococcus faecalis. Int Endod J. 2004; 37: 438–46.
13. Vianna ME, Gomes BP, Berber (VB, Zaia AA, Ferraz CC, de Souza-Filho FJ. In vitro evaluation of the antimicrobial activity of chlorhexidine and sodium hypochlorite. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2004; 97:79–84.
14. Aarati N, Ranganath N, Soumya BG, Kishore B, Kudalkar M. Evaluation of antibacterial and anticandidial efficacy of aqueous and alcoholic extract of neem (azadirachta indica) - An in vitro study. IJRAP. 2011; 2(1):230-35.
15. Timothy SY, Goji SY, Abdussalam B, Mava Y, Galadima IH. Antibacterial and phytochemical screening of the ethanolic leaf extract of Azadirachta indica. IGAPT. 2011; 2:194-99.
16. Pulipparambil A, Narayana SS, Meyyappan, Prabhu AS, Gurucharan, Kulandaivelu A. Antibacterial efficacy of crude extract of azadirachta indica on Enterococcus faecalis: a comparative invitro study. Indian J Multidiscip Dent. 2013; 3(1):
17. Dutta A, Kundabala M. Antimicrobial efficacy of endodontic irrigants from Azadirachta indica: An in vitro study. Acta Odontol scand 2013; 71(6): 1594-598.
18. Tyagi SP, Sinha DJ, Garg P, Singh UP, Mishra CC, Nagpal R. Comparison of antimicrobial efficacy of propolis, Morinda citrifolia, Azadirachta indica (Neem) and 5% sodium hypochlorite on Candida albicans biofi lm formed on tooth substrate: An in-vitro study. J Conserv Dent. 2013;16:532-35.
19. Rosaline H, Kandaswamy D, Gogulnath D, Rubin MI. Influence of various herbal irrigants as a final rinse on the adherence of Enterococcus faecalis by fluorescence confocal laser scanning microscope. J Conserv Dent. 2013;16(4): 352–55.
20. Dubey S, Chaodary TM, Gupta P. Comparative study of the antimicrobial efficiency of Neem leaf extract, Sodium hypochlorite and Biopure MTAD - An in vitro study. Indian J Dent Adv. 2012; 4(1): 740-43.
21. Vinothkumar TS, Rubin MI, Balaji L, Kandaswamy D. In vitro evaluation of five different herbal extracts as an antimicrobial endodontic irrigant using real time quantitative polymerase chain reaction. J Conserv Dent. 2013; 16(2): 167-70.
22. Prabhakar J, Sethikumar M, Priya MS, Mahalakshmi K. Evaluation of antimicrobial efficacy of herbal alternatives (triphala and green tea polyphenols), MTAD, and sodium hypochlorite against Enterococcus faecalis biofilm formed on tooth substrate: An In vitro study. J Endod. 2010; 36 (1):83-6.
23. Nara A, Dhanu, Chandra P, Anandakrishna L, Dhananjaya. Comparative evaluation of antimicrobial efficacy of MTAD, 3% NaOCL and propolis against E.faecalis. Int. J. Clin. Pediatr. Dent. 2010; 3(1): 21-5.
24. De La Torre JC. Biological actions and medical applications of dimethyl sulfoxide. Ann NY Acad Sci. 1983; 411:1–403.