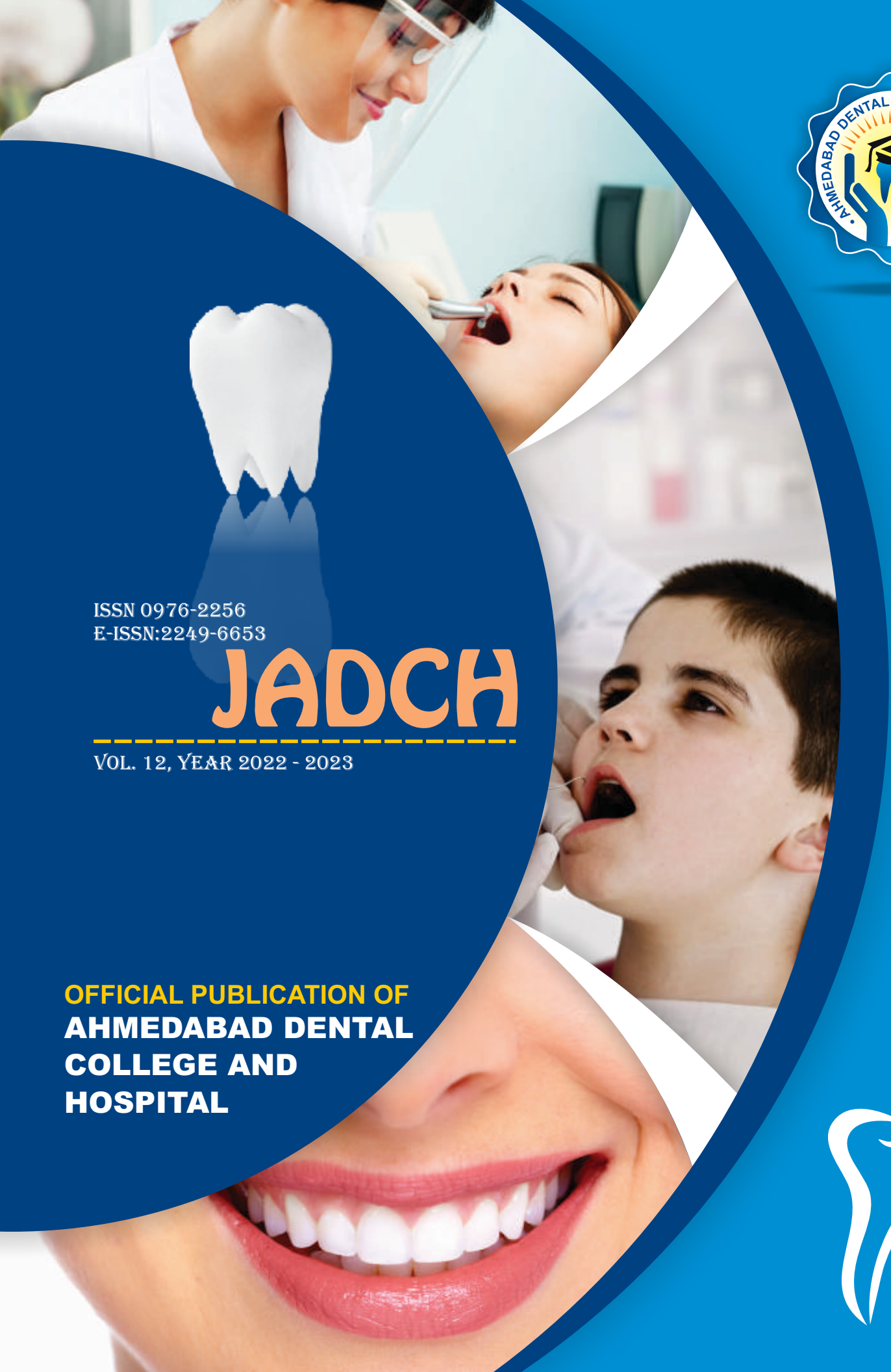

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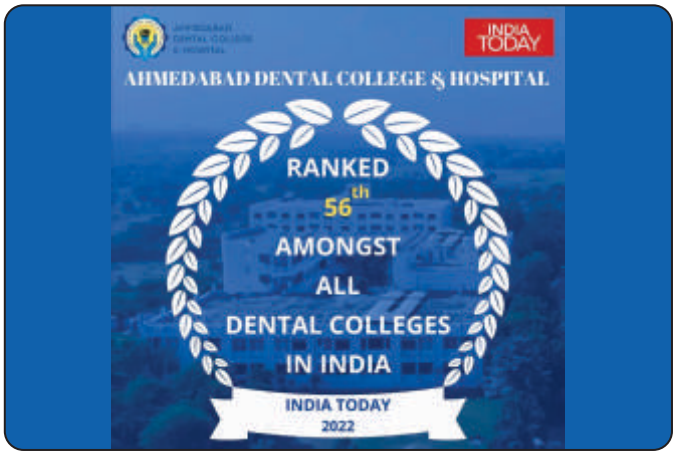

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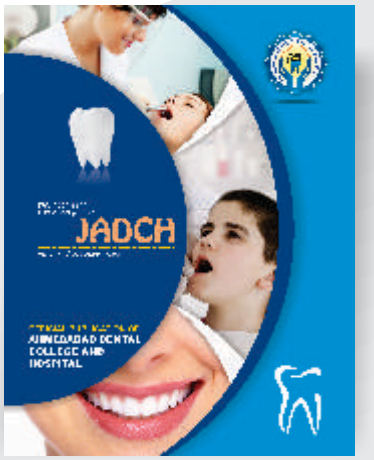

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PREFERENCES AMONG CHILDREN FOR DIFFERENT CARTOONS, COLORS, DENTAL CHAIR AND DENTIST ATTIRE AND ITS ROLE IN DESIGNING PAEDIATRIC DENTAL CLINIC- AN OBSERVATIONAL STUDY

Original Article

Shaivi Tripathi[*], Pratik Kamani[**], Ganesh M.[***], Manpreet Kaur[****], Sharon Paul[*****], Shivangi Kamtekar[******]

ABSTRACT

Background: Dentistry for children is not difficult but different from that for adults. In the modern era of advancement where everything is advancing, the design for paediatric dental clinic shouldn't be lacking behind. **Aim:** To provide best dental experience to children along with addition of technology, the present observational study was conducted to know the recent trending interests for cartoons, colors, dental chair and dentist attire designs among children.

Materials and Methods: A personal interview was carried out in which among 100 children were shown different Placards in the form of collage after obtaining consent from their parents. Children aged between 4 and 9 years participated in this interview.

Results: Based on the response, it was observed that most of the children preferred Doraemon Cartoon, Pink and Orange Colors, Simple Dental Chair and White dentist Attire.

Conclusion: This can be utilized in creating a child friendly clinic which develops friendly relationship between the child and pediatric dentist and enhances a positive attitude towards dentistry from childhood.

Key words: Cartoon, Color, Dental Chair.

INTRODUCTION

"The Foundation of Practicing dentistry for children is the ability to guide them through their dental experience". The experience of a child during the formative years can go a long way in formulating the individual personality as an adult. One of the multitudes of experiences is the visit to the dentist who, unfortunately, is often caricatured as a pain imparting tooth-puller in a child's mind.[1] Dental anxiety and fear of dental treatment in children are recognized in many countries as a public health dilemma.[2] The term dental fear and dental anxiety are often used synonymously[3] and are considered to be the main reason for behavior management problems and avoidance of dental care.[4] The changing expectations of children can encourage pediatric dentists to develop a more child-friendly atmosphere in their clinics. Environmental elements that produce positive feelings can reduce anxiety.[5] In fact, the attractiveness of the physical environment in the dental operatory has been shown to be significantly associated with higher perceived quality and satisfaction, higher reported positive interaction with staff and reduction in patient anxiety. Instead of adults choosing the dental environment for children, it is beneficial to accept preferences and choices of children as to what they enjoy as patients. Therefore, this study was carried out to determine cartoon, color, dental chair and dentist attire preferences among children and its importance in designing Paediatric Dental Clinic.

AIM AND OBJECTIVE

To determine the cartoon, color, dental chair and dentist attire preferences among children and its Importance in designing Paediatric Dental Clinic.

INCLUSION CRITERIA

All the healthy children aged 4-9 years, coming for the first time waiting in the recreation area of the outpatient department in Department of Paediatric and Preventive Dentistry, Ahmedabad Dental College & Hospital were included in the study.

EXCLUSION CRITERIA

The Children with the past dental experience or with any Physical, Mental or emotional condition

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that could affect child's ability to understand & follow instructions were excluded from the study.

MATERIALS & METHOD

The present study included 100 children aged 4-9 years, randomly selected from the recreation area of the outpatient department in Department of Paediatric and Preventive Dentistry, Ahmedabad Dental College & Hospital, Ahmedabad, Gujarat, India. Ethical clearance from Institutional ethical committee was obtained, and also written informed consent of the parents/guardians. All the children's assented to participate in the study.

The Children and their Parents/guardians were first given instructions about the interview procedure in common room by examiner.

The examiner then interviewed each child separately in the presence of parent who was only allowed to observe silently so as to avoid any bias.

The children were shown four different Placards containing varying colors in form of balloons, types of dental chair, different dental chair & various trending cartoons in the form of collage respectively.

The children were then asked to choose about their most preferred cartoon, color, dental chair and dental attire in each placard. Since it was a categorical data, the response noted was tabulated and calculated in form of frequency and percentage (%).

Fig. 1 Cartoon Placard

Fig. 2 Color Placard

Fig. 3 Dental Chair Placard

Fig. 4 Dentist Attire Placard

RESULTS

Total 100 children of the age range 4-9 years participated in the study. Data obtained was calculated in the form of frequency and percentage (%).

On comparison of cartoons, doraemon was the most preferred cartoon (32%) among children followed by chota bheem (28%), Oggy and the Cockroaches (17%), Tom & Jerry (15%), Mickey & Minnie Mouse (6%), and Minion (2%).

When asked about color preferences, children preferred Pink and Orange color (33%) the most followed by Blue (19%), Green (8%), Yellow (4%), White (3%).

Among the Dental Chair Preferences, 53% children opted for Simple Dental Chair and 47% of the children preferred Pediatric Dental Chair.

For Dentist Attire, 50% of the children selected white type of attire while purple attire was chosen by 39% of children. Printed attire (11%) was least preferred among children.

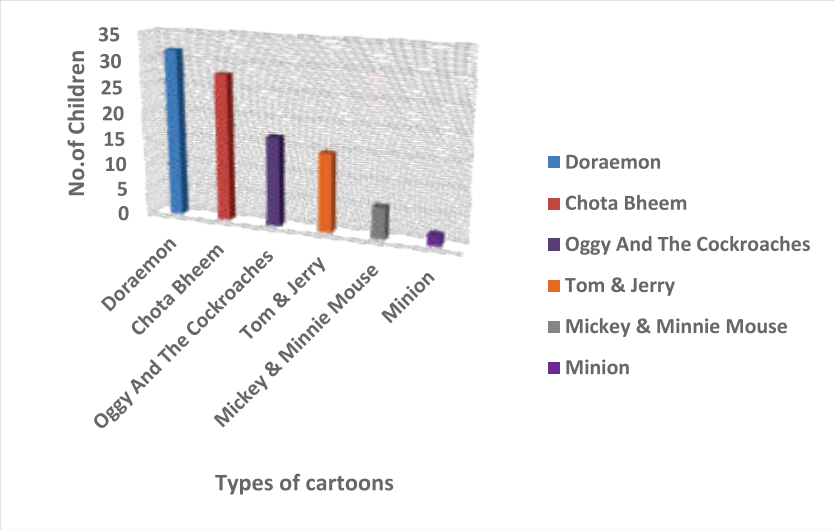

Fig. 5 : - Cartoon Preferences among children

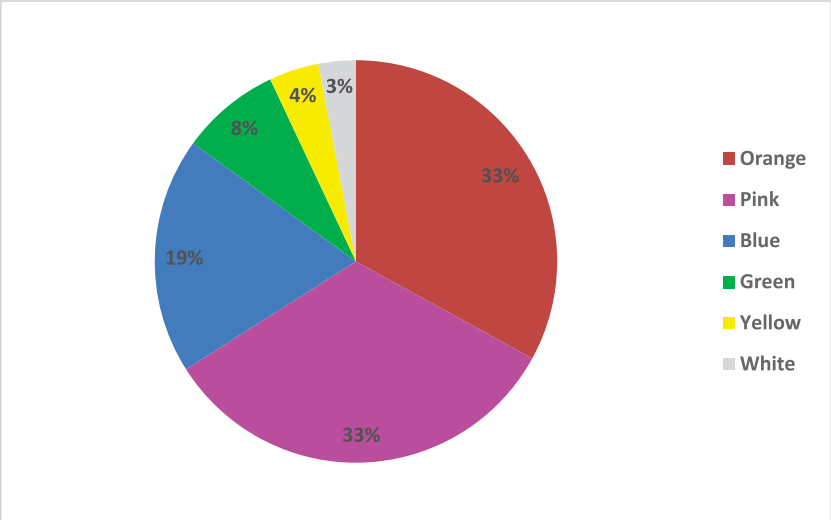

Fig. 6 - Color Preferences among children

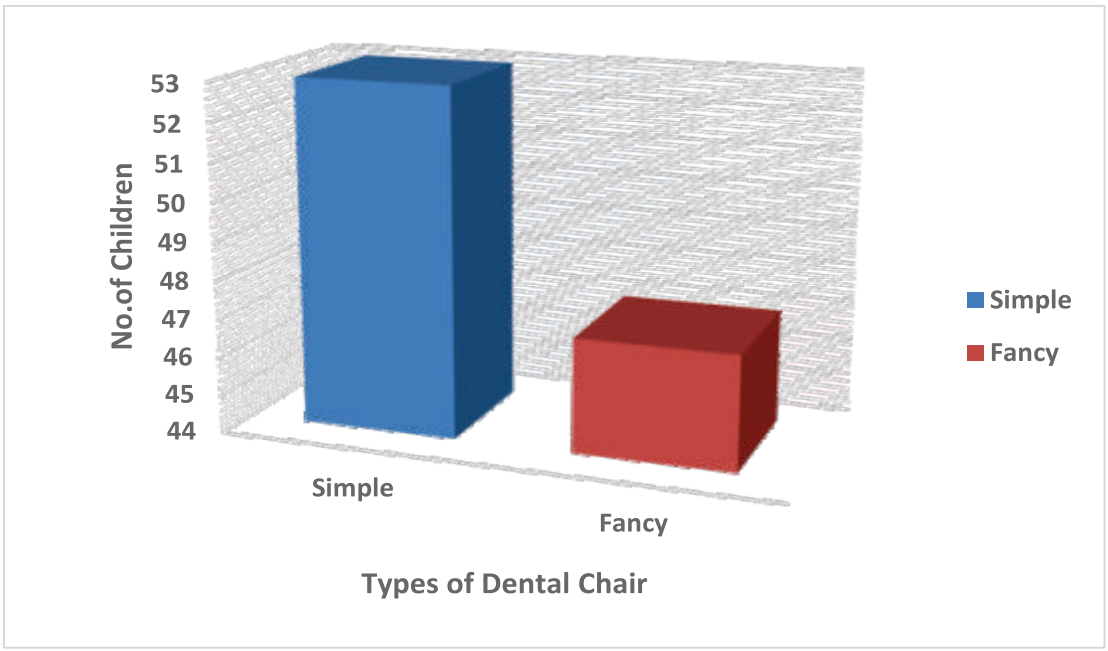

Fig. 7 - Dental Chair Preferences among children

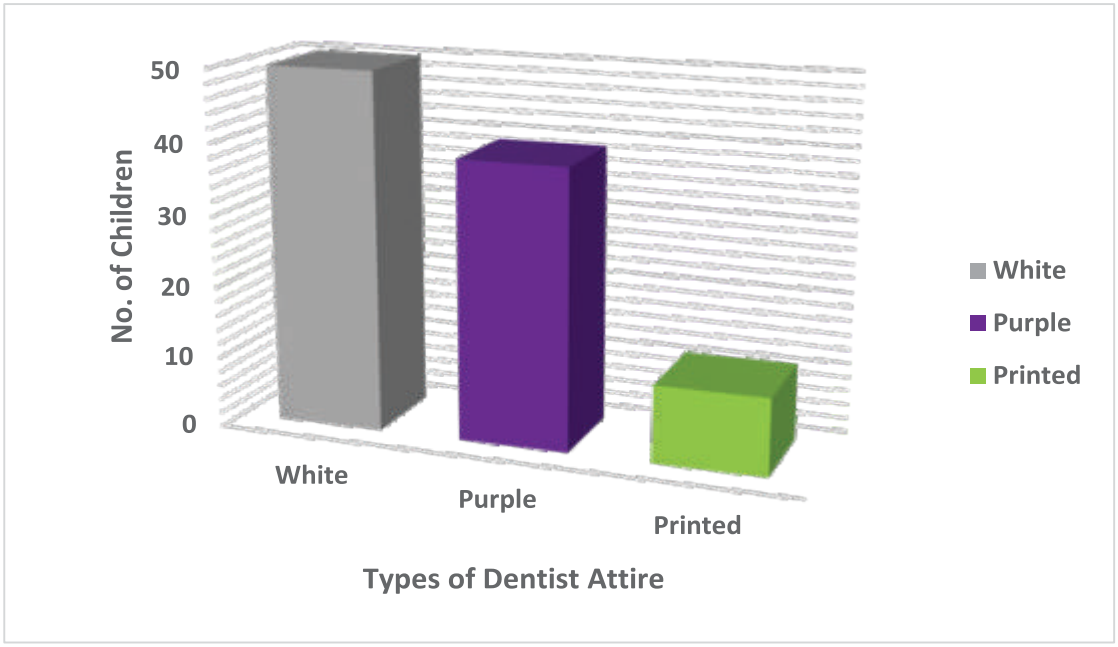

Fig. 8 - Dentist Attire Preferences among children

DISCUSSION

The present study was conducted to determine the preferences of children towards cartoons, colors, dental chair and pediatric dentist attire and to determine its importance in designing pediatric dental clinic.

Cartoons can help children get an early start on learning. The positive influence of cartoons on children can be seen especially in the case of educational cartoons that teach shapes, numbers, and colors. Such cartoons can teach basic things to children in a fun and interactive way, thus making learning an enjoyable activity. The moving, talking pictures and colorful visuals make learning interesting for children. Watching cartoons can help develop your child's cognitive skills. It can help develop logic and reasoning ability, visual and auditory processing, and sustained and selective attention of a child. Cartoons can expose your children to different languages, thus helping children in developing their linguistic abilities. Watching cartoons help increase children's imagination and creativity. Watching cartoons is a great way to teach your kids about local customs, traditions, history, and mythology. For example, watching animated versions of the Ramayana or Mahabharata can teach kids about Indian mythology. Watching cartoons about Aesop's Fables or Panchatantra can teach children about good morals, kindness, and compassion. Children often idolize their favourite cartoon character and mimic them or aspire to be like them.[6]

In the present study, children when given the choices were aware about the trending cartoon characters. The most preferred cartoon among the six characters given was doraemon and the least preferred was minion, the reason might be that the children might not have known or heard about older cartoons or characters which are less shown on television. After doraemon, chota bheem was chosen over the rest of the cartoons as it is one of most trending Indian Cartoon over recent times. Children often believe that Oggy and the Cockroaches and Tom & Jerry often hit each other or cause each other to fall from heights, often without any real consequences and hence they were less preferred.

There was lack of similar studies conducted regarding cartoon preferences among children.

Color is a salient feature in a child's life. Color is one of the most instantaneous method of conveying messages and meanings. Color stimulates and works synergistically with all of the senses, symbolizes abstract concepts and thoughts, expresses fantasy or wish fulfillment, recalls another time or place and produces an aesthetic or emotional response.[7] Color has been studied from philosophical, biological, anthropological and psychological perspectives over the course of time.[8] Children were able to categorize colors according to several dimensions, most basic being whether or not a color perceived had a positive or negative effect on their emotions or whether or not they found the colors to be agreeable or not agreeable. In addition, they could link colors and emotions.[9] The discovery of the correlation between color and emotions and their effect on performance and productivity has recently been adopted in the work settings. Most of the exiting research on environmental design has been focused for healthy adults and those findings cannot be extrapolated for children.

Color therapist **June McLeod**[10] who worked with a nursery childcare organization, reported that the proper use of color can have extremely positive effects on the children including improved emotional development, increase sharing and co-operation, decreased noise levels, easier organization of thoughts, reduced tension and aggression, easier and more peaceful sleep in babies, and the creation of a calmer, happier and more relaxed environment.

Hemphill[11] also found that bright colors elicited positive emotions, while dark colors elicited negative emotions. **Cimbalo et al**[12] found that children used yellow, blue, green and orange to color happy scenes and red, black and brown for sad scenes. **Park**[5] investigated the color preference for pediatric patient rooms among the inpatients, out patients and healthy children. Regardless of gender effects, healthy children and pediatric patients preferred blue and green the most and white the least.

In the present study, six easily identifiable colors were included- Orange, Pink, Blue, Green, Yellow, White. Pink and Orange was the most preferred

and white was the least preferred among children indicating the independent choices of children regardless of any association of emotion or anxiety to the colors shown. Similarly, **Annamary K**[13] stated that colors like blue and pink, have been found to instill a positive dental attitude in children while colors like black and red could develop a negative outlook in their mind

There is lack in understanding as to how children change their color preferences regardless of the health situation or environment.

The 1990s ushered in technologic advances affecting the forefront of dentistry. This technology was the harbinger of a change in dentistry from a need-driven to a want-driven profession. Improvements have been made to dental chairs throughout the 19 th and 20 th centuries to encourage patient and operator's comfort.[14] Dental chair can greatly impact children's psychology as well as posture and positioning of the dentist.

In the present study, simple dental chair was chosen over by the majority of the children. The reasons for their preference might be that they might not be aware of the different types of dental chair and their functionality particularly talking of the pediatric dental chair which is nowadays designed in a very child friendly way to attract the children in the dental environment and make them feel comfortable. Thus, it can be stated that the reason for the preference of the fancy chair by the children was just the customized look it had.

Professional appearance of a pediatrician is an important element affecting the perception of competence of the doctor among patients and their parents/guardians, thus influencing their compliance.[15] In order to make positive changes and adjustments that would make a pediatric dentist look more acceptable for the child, importance must be given to what form of attire will be more preferential. Psychologists/sociologists highlight the importance of appearance and its effect upon first impressions and interpersonal relationships.[16]

In the current study, 50% of children preferred their dentist to wear white coat. The reasons behind their preference towards white coat includes, color, symbol of healing, looks professional, increase their confidence level and interestingly, they believe and trust that doctors or dentist will wear white coat. This result is in agreement with the study done by **Alsarheed et al.** [17]who had stated that white coat was considered as a symbol of healing. The reasons for their dislike include, fear of bodily injury, contamination of white coat, stains, or dirt's will be easily seen. The 39% and 11% of children who preferred colored scrubs and printed scrubs listed reasons for their preference such as, child friendly attire, bright color, attractive, looks simple and not threatening. In various other studies[18,19,20], informal attire has been the least favourite choice by patients. Apart from this, **McCarthy et al.**[21] found that children are not afraid of a doctor in a white uniform. **Ravikumar D** [22] stated that based on children's age, it has observed that children in young age group prefer a regular outfit, middle aged preferred white coat and older children prefer a surgical coat.

CONCLUSION

Children's preferences can help in creating a child friendly clinic which develops friendly relationship between the child and pediatric dentist and enhances a positive attitude towards dentistry from childhood. A colorful wall with cartoon background, filled with toys, in a scented atmosphere, with rhymes played in the background and the presence of parents, are the most preferred dental clinic atmosphere for children aged 6–10 years. Findings from studies in specific contexts should be interpreted carefully, as the application of these findings is not prescriptive for all situations. Since this was an observational study, further research considerations using cross-cultural studies with larger samples may provide valuable information for pediatric dentists in designing Paediatric Dental Clinic.

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AN IN VITRO COMPARISON OF ANTIMICROBIAL EFFICACY OF 5% AND 10% ALOE VERA GEL TO 5.25% SODIUM HYPOCHLORITE AND THEIR EFFECTIVENESS IN DECONTAMINATING GUTTA PERCHA CONES.

Original Article

[*]Shah Zeel, [**]Vaishnav Rahi [***]Sanghavi Zarna, [****]Chokshi Shraddha, [*****]Joshi Pooja, [******]Bavaria Setu

Abstract

Aim: The aim of the present study was to evaluate the antimicrobial efficacy of 5% and 10% *aloe vera gel* with 5.25% sodium hypochlorite and compare the effectiveness in decontaminating gutta-percha cones.
Materials and Method: Freshly collected aloe vera pulp was dried in an oven at 80^{0}C for 48 hours and then powdered, out of which 5% and 10% of Aloe vera gel was made by dissolving it in ethanol. Antimicrobial efficacy was checked for both the concentrations of Aloe vera gel and 5.25% sodium hypochlorite using agar well diffusion method against *E. coli, E. faecalis and Staph. aureus* which are three common gutta percha contaminants. To check the decontamination efficacy, the DiaDent gutta percha points was used. They were decontaminated for 1 minute using two different concentrations of aloe vera gel and 5.25% NaOCl and then they were placed in thioglycolate broth for the development of turbidity. The statistical analysis was carried out using chi square test at 5% level of significance.
Results: The antimicrobial efficacy was assessed by the presence of zones of inhibition. Statistical analysis showed no significant difference in antimicrobial efficacy of 10% aloe vera and 5.25% NaOCl and also 10% aloe vera and 5.25% NaOCl are equally effective in decontaminating gutta percha cones and exhibited better effectiveness than 5% aloe vera.

Conclusion: It can be concluded that 10% Aloe vera gel can be used effectively for decontaminating GP cones within a short duration

Key words: Aloe vera; sodium hypochlorite; decontamination; gutta percha cones.

Introduction:

The primary objective of endodontic therapy is to eliminate or reduce the number of microorganisms for success of endodontic treatment.[1]

Commercially supplied gutta percha cones are not usually sterilized or decontaminated. The recommended method for decontamination of gutta percha cones is treating them with 1% sodium hypochlorite for 1 min or 0.5% sodium hypochlorite for 5 min but it may cause crystal deposition within the canals which can impede the obturation.[2] So, the purpose of the study is to evaluate the effectiveness of herbal alternative like aloe vera gel, in different concentration for rapid decontamination of gutta percha cones.

Aloe barbadensis mill is a short succulent herb filled with a clear viscous gel. The name aloe vera derived from the Arabic "Alloeh" which means bitter liquid found in leaves. It has potent antibacterial, antifungal and antiviral properties because of plant's natural anthraquinones.[3]

Aim of the study:

To evaluate and compare the antimicrobial efficacy of 5% and 10% aloe vera gel with 5.25% NaOCl for thier effectiveness in decontaminating gutta percha cones.

Objectives of the study:

· To compare the antimicrobial efficacy of 5%, 10% aloe vera gel and 5.25% NaOCl.

· To compare effectiveness of 5%, 10% aloe vera gel and 5.25% NaOCL in decontaminating gutta percha cone.

Reference strains which are Staphylococcus aureus, Escherichia coli, Enterococcus faecalis was obtained from department of microbiology, GMERS, Ahmedabad, Gujarat.

Preparation of aloe vera extract:

Leaves were washed with distilled water first and then fresh pulp was taken out **(Figure 1.1 A)** which was left in open air for 2-3 days to remove its moisture and dried in hot a ir oven at 80^0 C for 48 hours, then powdered.

5% and 10% aloe vera gel were made by dissolving 5 gm and 10 gm of aloe vera powder in 100 ml ethanol respectively **(Figure 1.1 B)**. The contents were then filtered and filtrate was evaporated for dryness.

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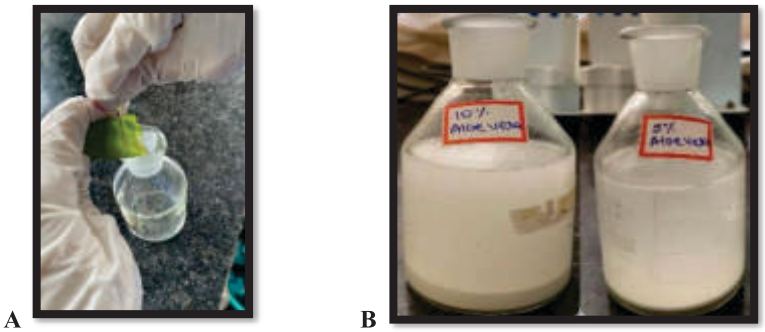

Fig 1.1

Antimicrobial activity of Aloe vera:

Antimicrobial activity of extract was checked by using agar well diffusion technique. Reference strains were cultured overnight in thioglycolate broth and culture was streaked on a plate of chocolate agar. **(Figure 1.2 C)** 3 wells of 5 mm*5 mm were made on the surface of the agar plate **(Figure 1.2 D)**. Wells were filled using micropipette with 5% Aloe vera, 5.25% NaOCl and 10% aloe vera and labelled 1, 2, 3 respectively and then incubated at 37^{0}C for 24 hours and monitored for development of clear zones around the extracts. The antibacterial activity was assessed by the diameter of inhibition zone.

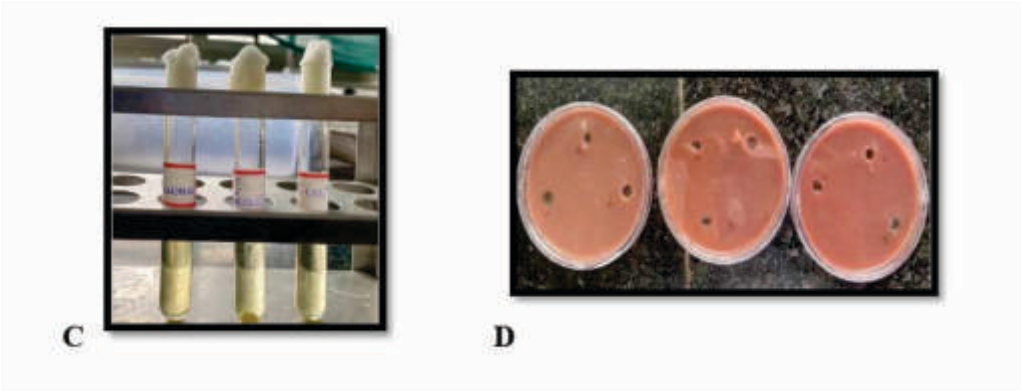

Fig 1.2

Gutta Percha decontamination:

A new pack of DiaDent size 35 of gutta percha points was opened under sterile conditions and 30 gutta percha cones were taken out using a sterile tweezer and divided in to 3 groups with 10 gutta percha each and decontaminated for one minute in 5%, 10% Aloe vera and 5.25% NaOCl and cleaned with sterile gauze **(Figure 1.3 E)** and incubated at 37^{0}C for 24 hrs. in thioglycolate broth and monitored for the development of turbidity **(Figure 1.3 F)**.

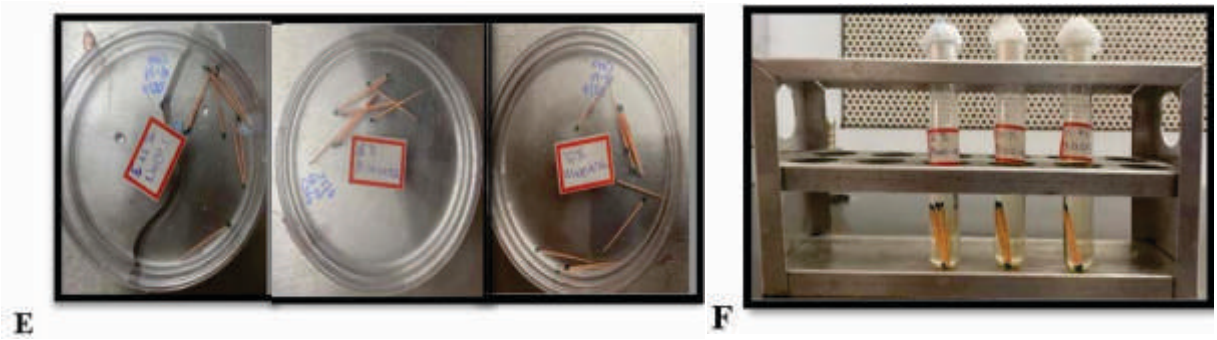

Fig 1.3

Results:

The antimicrobial efficacy was assessed by the presence of zones of inhibition. Staphylococcus aureus, Escherichia coli, Enterococcus faecalis showed 19 mm, 26 mm and 25 mm inhibition zones respectively for 10% aloe vera which was almost equivalent to 5.25% Sodium hypochlorite used as the control but they showed no zones of inhibition for 5% aloe vera. **(Figure 1.4, Table1).**

Fig 1.4

The decontaminating efficacy was then assessed by the occurrence of turbidity in the thioglycolate broth. The gutta percha cones which decontaminated with 5% aloe vera and 5.25% NaOCl showed maximum and moderate turbidity respectively while cones decontaminated with 10% aloe vera remained clear even after 24 hours, indicating the absence of the microbial contaminants **(Table2)**.

Statistical analysis was done using chi square test at 5% level of significance showed no significant difference in antimicrobial efficacy of 10% aloe vera and 5.25% NaOCl and also 10% aloe vera and 5.25% NaOCl are equally effective in decontaminating gutta percha cones and exhibited better effectiveness than 5% aloe vera.

Table1: Zones of inhibition (in mm) obtained against the test organisms

	1) 5% Aloe vera	**2) 5.25% NaOCl**	**3) 10% Aloe vera**
Staphylococcus aureus	**0**	**16 mm**	**19 mm**
E. coli	**0**	**23 mm**	**26 mm**
E. faecalis	**0**	**22 mm**	**25 mm**

Table 2: Efficacy of materials used in study for decontaminating gutta percha cones

Solution	**Turbidity**
5% Aloe vera	**2**
10% Aloe vera	**0**
5.25% Sodium hypochlorite	**1**

(2 – maximum turbidity, 1 – moderate turbidity, 0 – no turbidity

Table	P value
Table 1	0.951
Table 2	0.3678

Table 3: Statistical Analysis is done using Chi square test at 5% level of significance.

Discussion:

The primary cause of failure of endodontic therapy is the presence and persistence of microorganisms in the root canal. Improper cleaning and shaping, inadequate filling of the canal, and the use of contaminated materials for these procedures can be a possible explanation for this problem. The critical step during endodontic therapy is the sterilization of endodontic instruments and materials.[1]

Gutta-percha cones which are commonly used for filling the canals has several advantages such as biocompatibility, radio-opacity, antibacterial activity, easily removed from the canal, dimensionally stable and it does not stain the tooth structure.[4] Even though gutta-percha cones are manufactured under aseptic conditions, they can easily be contaminated by improper storage, aerosols, and physical handling. Studies have shown the presence of microorganisms in 5-19 % of freshly opened gutta-percha packs. Although the number of these organisms was comparatively low at the time of packaging, clinically, it is routine practice for dentists to use gutta-percha points 'straight out of the box' without an idea about its sterility.[5,6]

Various chemical agents have been used for chairside disinfection of gutta-percha such as NaOCl, Chlorhexidine, glutaraldehyde, povidone iodine, MTAD.[7]

Sodium hypochlorite 5.25% has been found to be effective in decontaminating GP cones. However, it is imperative that after disinfection, the GP cone should be rinsed in ethyl alcohol to remove crystallized sodium hypochlorite before obturation as the crystals may impair the hermetic seal.[8]

Aloe vera has been used from time immemorial for the treatment of a multitude of ailments ranging from peptic ulcers to its use in cosmetics. It has a well-established antimicrobial activity ascribed to compounds that are now specifically identified as p-coumaric acid, ascorbic acid, pyrocatechol and cinnamic acid. Another major advantage is that Aloe vera gel has been found to be effective in decontaminating GP cones within one minute. To substantiate these results, further in-depth studies incorporating more isolates from clinical samples are required.[9]

The study was conducted in two parts, in first part antimicrobial efficacy of all the three solutions against E. faecalis, S. Aureus, E. coli which are commonly found in infected root canal, using the agar well diffusion method was checked. In second part efficiency of all 3 solution to decontaminate gutta percha by placing them in thioglycolate broth for presence of turbidity was checked.

The antimicrobial efficacy was assessed by the presence of zones of inhibition. Staphylococcus aureus, Escherichia coli, Enterococcus faecalis showed 19 mm, 26 mm and 25 mm inhibition zones respectively for 10% aloe vera which was almost equivalent to 5.25% Sodium hypochlorite used as the control which is in accordance to the study done by Athiban PP et el. where they found the similar kind of inhibition zones.[8] Although 5% aloe vera didn't show any inhibition zones. The decontaminating efficacy was then assessed by the occurrence of turbidity in the thioglycolate broth. The gutta percha cones which were decontaminated with 5% aloe vera and 5.25% NaOCl showed maximum and moderate turbidity respectively while cones decontaminated with 10% aloe vera remained clear even after 24 hours, indicating the absence of the microbial contaminants which is in accordance to the study done by K.V.L Jyothsna et el where they evaluated the samples by presence or absence of turbidity in

nutrient broth.[7] Statistical analysis was done using chi square test at 5% level of significance showed no significant difference in antimicrobial efficacy of 10% aloe vera and 5.25% NaOCl and also 10% aloe vera and 5.25% NaOCl are equally effective in decontaminating gutta percha cones and exhibited better effectiveness than 5% aloe vera.

The similar study was done by Athiban PP et el. in which they have compared aloe vera gel with 5.25% NaOCl and showed that cones decontaminated with aloe vera and then placed in the broth remained clear even after 24 hours, indicating the absence of the microbial contaminants.[8] The result of their study were accordance with the result of presented study where aloe vera showed its antimicrobial efficacy after one minute of contact time with gutta percha cones. Kulkarni MU et al. found that long-term effects of A. vera were found to be superior and comparable to 5% NaOCl and 2% CHX against E. faecalis and S. aureus after decontaminating for 3 mins.[10]

In study done by K.V.L Jyothsna et el. in which they compared 3% NaOCl, 2% CHX, aloe vera for 1 and 5 min. They found that 3 % NaOCl was more effective, followed by chlorhexidine and aloe vera solution. After the disinfection procedure, here, cones were incubated in a nutrient broth medium at 370^0C for 48 hours.[7] whereas in this study, gutta percha cones were incubated at 37^0C for 24 hours in thioglycolate broth.

As we have used aloe vera which is an herbal antiseptic we can also use some other herbal antiseptic agents. In a study done by Mukka PK et el., they concluded that all the herbal solutions were found to be effective in disinfection of gutta percha. However, Pancha Tulsi possesses superior antibacterial activity when compared with aloe vera.[11]

Here in this present study, the aloe vera powder was dissolved in ethanol which is also a potential disinfectant which could have affected the result and also shelf life of the 10% aloe vera is not known.

Although gutta percha cones are usually provided in aseptic packages, once opened and used, they may be contaminated. So routine endodontic treatment should include this timesaving and rapid procedure of chairside disinfection of gutta-percha for every case as a part of treatment.[7]

Conclusion:

Within the limits of this study, it can be concluded that 10% Aloe vera gel can be used effectively for decontaminating GP cones within a short duration instead on 5.25% sodium hypochlorite, and it holds a promising future as a medium for storage of gutta percha points but it still needs further evidences and studies to be done.

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ASSESSMENT OF KNOWLEDGE AND ATTITUDE OF GENERAL PRACTITIONERS WHILE MANAGING CHILDREN IN THEIR DENTAL OPERATORY

Original Article

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Abstract:

Aim: To assess the knowledge and attitude of general practitioners while managing children in their dental operatory.

Materials and method: A survey was carried out where 150 dental surgeons were given a questionnaire consisting of information regarding behaviour management techniques and perspectives of dental surgeons while dealing with children at dental clinic.

Results: Most of the dental surgeons preferred calling pediatric dentist for treating children. They are aware about the behaviour management techniques and prefer non-pharmacological techniques over pharmacological ones. They prefer distraction, positive reinforcement, TSD over HOME, voice control and physical restraints. Most of them preferred sedating the child over GA.

Conclusion: The general practitioners do have knowledge about various behaviour management techniques but are not able to implement them effectively so to avoid hassle they do not treat children in their day-to-day practice and prefer calling a pediatric dentist.

Keywords: Behaviour management techniques, general practitioners, Managing child patients, pharmacological, non-pharmacological

Introduction:

Children are not young adults, their behaviour, attitude, ability to understand, imagination, logical thinking, reasoning, etc., vary considerably from that of adults. Moreover, every child is different from each other.[1] Management of behaviour is an integral component while treating children in dental practice. The experience of the children during the first dental visit becomes his experience for lifetime. They should be properly managed so as to shape their behaviour in favourable way.[2]

The pediatric treatment triangle shows that parents play a major role while treating a child. It is necessary to gain the trust of the parents as the fear and anxiety might be transferred from parent to the child. Communication has to be established with parents prior to the appointment of the child thereby, alleviating their fears.[3]

The children are not usually co-operative in the dental procedure. Every child has to be managed in a different manner according to his age and understanding. Proper knowledge of different behaviour management techniques is necessary with which the dental procedure can be carried out efficiently. The most commonly used techniques are tell-show-do, audio-visual distraction and modelling and hand over mouth exercise (HOME) is the least preferred.[4] In some unco-operative and fearful patient it may be necessary to perform the treatment under sedation or general anesthesia.

Treating children requires formal training and knowledge. Since the general practitioners are the usually visited by the parents for treatment of their children. The aim of this study is to assess of knowledge and attitude of general practitioners while managing children in their dental operatory.

Method:

A cross sectional study was conducted with 150 dental surgeons (from Ahmedabad district) selected by stratified cluster sampling method. A self-constructed questionnaire consisting of 22 questions as shown in Figure 1 was distributed to dental surgeons. The close-ended questions were asked regarding preference for treating child or not and knowledge about various behaviour management techniques like voice control, modelling, distraction, HOME, TSD, positive reinforcement, sedation and general anesthesia.

An online questionnaire was distributed to two groups: group 1- dental practitioners with the clinical experience of more than 3 years and group 2- dental practitioners with the clinical experience of less than 3 years. The results were collected through the Google forms application.

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Figure 1: Questionnaire

1. Name *_____
2. Do you perform treatment on children at your clinic?
   - Always
   - Sometimes
   - never
3. Do you prefer calling a pediatric dentist for performing treatment on child?
   - always
   - sometimes
   - never
4. Do you find child co-operative during treatment?
   - always
   - sometimes
   - never
5. Are you aware about the ' behaviour rating scales' for assessing child's behaviour?
   - yes
   - no
6. Are you aware of different 'behaviour management techniques' that can be used to achieve co-operation?
   - yes
   - no
7. Which behaviour management technique would you prefer? a. Pharmacological b. Non pharmacological
   - a
   - b
8. Do you allow the parent to stay in the clinic while the treatment is being performed?
   - always
   - sometimes
   - never
9. Do you demonstrate the procedure to the child before performing?
   - always
   - Sometimes
   - Never
10. Do you use words/ phrases to encourage the child?
    - always
    - sometimes
    - never
11. Do you ever modify your voice or tone to direct child's behaviour?
    - always
    - Sometimes
    - Never
12. Do you praise the child when he/she does something that is asked to do?
    - always
    - Sometimes
    - Never
13. Does playing video or music direct the child's focus away from dental treatment?
    - always
    - Sometimes
    - Never
14. Do you show the syringe needle and say that it would pain?
    - always
    - sometimes
    - never
15. Do you sedate the unco-operative child?
    - always
    - sometimes
    - never
16. Do you prefer to treat the child under general anaesthesia in a hospital to achieve cooperation?
    - always
    - sometimes
    - never
17. Do you perform treatment on elder sibling prior to child's treatment to expect specific behaviour?
    - always
    - sometimes
    - never
18. Are you aware of HOME technique?
    - yes
    - No
19. Do you know the protocol to be followed for HOME?
    - yes
    - No
20. Do you promise the child any complimentary gifts if he/she co-operates with you?
    - always
    - sometimes
    - Never
21. Do you immobilize the child by yourself, the dental staff or parent when needed?
    - always
    - sometimes
    - never
22. Do you stop the procedure if any discomfort is felt by the child?
    - always
    - Sometimes
    - Never

Results:

Table 1: Preference for treating the child or calling a pediatric dentist			
	always	**sometimes**	**never**
Prefer treating	4.26%	29.79%	64.89%
Calls pediatric dentist	62.77%	26.60%	9.57%

Table 2: Knowledge about behaviour management		
	yes	**no**
Aware about behaviour rating scales	19.15%	79.79%
Aware about behaviour management	14.89%	84.04%

Table 3: Preference for type of non-pharmacological management			
	always	**sometimes**	**never**
Allow parent to stay in clinic	52.13%	40.43%	6.38%
Demonstrate procedure to the child before performing	64.89%	31.91%	2.13%
Use words to encourage the child	70.6%	27.28%	1.06%
Modify voice or tone	47.87%	45.87%	5.19%
Praise the child	74.47%	23.40%	1.06%
Play video or music to distract child	53.11%	35.32%	8.51%
Treat elder sibling	11.7%	69.15%	17.02%
Promise gifts	43.62%	47.87%	7.45%
Immobilize the child	10.64%	68.09%	20.21%
Stop the procedure	73.40%	25.53%	0%

Table 4: Preference for pharmacological management			
	always	**sometimes**	**never**
Sedate the child	52.13%	40.43%	6.38%
Treat under G.A.	5.32%	40%	54.68%

Discussion:

Understanding of child psychology and managing the behaviour accordingly plays an important role during the treatment of children. Children should be guided towards a desirable behaviour so as to successfully perform the treatment and instil a positive attitude towards dentistry.

The results of the present study showed that most of the dental surgeons do not treat child in their regular routine. If parents bring children to the general practice, the dentist usually prefer calling the pediatric dentist so as to manage and treat the patient. The examination of children is a difficult task for the dental surgeons as they usually do not co-operate easily.[5]

Presence of parents, especially mother has a greater impact on child as it provides the sense of safety to the child. Margaret Mahler in her theory of separation-individualization laid emphasis on importance of the relationship between a child and her mother.[6] Though presence of parents being useful, sometimes it also creates problems during treatment. In present study, 52.13% of the dental surgeons preferred always treating child in the presence of the parents while 40.43% said they sometimes allow parents in the operatory and only 6.38% did not allow the parents in the operatory. Similar results were found in a study conducted by Shroff *et al*. in 2015 in which they concluded that a greater number of undergraduate dentists prefer the parents to be present in the dental operatory during the treatment.[7]

Among the two major categories of behaviour management, majority of the dentists in this study preferred to opt for non-pharmacological behaviour management strategies similar to the study by Ravindran, *et al*.[1] Various studies have been conducted for the parental acceptance of behaviour management techniques and most of them preferred non-pharmacological ones over pharmacological ones and had shown lower acceptance for the aversive methods. The studies conducted by Sharath *et al*.[9] and Adair *et al*.[10] and Sotto *et al*.[11] have suggested that TSD is considered as the essential treatment plan for the child in their study and was highly accepted by parents too.

Dental anxiety influences the behaviour of children in the operatory. The behaviour management techniques such as modelling, distraction, positive reinforcement can be used to reduce anxiety of the child. Modeling is not only helpful in acquisition of new behaviors but also in reducing undesirable behavior. In this study, 12% of the dentists always used modelling whereas 69% sometimes used it in their practice. Johnson and Machen reported that same age and gender is effective within live modeling. Rajasekhar et al. revealed that most of the participants have responded for siblings as an effective model in their study.[8]

Another technique that has been found to be effective is positive reinforcement as it provides sense of accomplishment during this stage of development and strengthens the future behaviour. In this study, 74% of the dentists praised the child for good behaviour during treatment and 43% also gave gifts. Rajasekharan et al. in his study found positive reinforcement to be effective over other methods in day-to-day practice.[8]

The aversive techniques such as voice control, HOME, physical restraints are usually not preferred in dental clinics but they are sometimes used in un co-operative patients with parental consent. The results of this study stated that most of the dentists are aware of HOME technique and the protocol used for it. Oredugba and Sanu reported that HOME is the less frequently followed management techniques[12]. In contrast to this, Allen et al. stated that traditional behavior management techniques, namely TSD, restraints, HOME were better than the newer ones such as modelling.[13]

In the age of 2-4 years, concept of centration can be observed among children where the child has tendency to focus or center on only one aspect and ignore other aspects of a multifaceted experience. The focus is on the most striking or compelling aspect of the experience. Distracting the child by leading him to focus on other interesting and curious aspects in the environment would be helpful.[8] In this study, 80% of the dentists used AV aids for distracting children during the treatment. Barreiros D *et al.* in 2018 concluded that AV distraction reduced anxiety levels in children.[14]

In the present study, a greater number of dentists preferred not to perform procedure under general anaesthesia. They preferred limiting this treatment for unco-operative patients. Whereas, sedation was preferred by most of the dentists (52.13%- always, 40.43%- sometimes). Nitrous oxide

(N2O) is an attractive agent for sedation in pediatric dentistry because it provides rapid onset and offset of sedation. Similarly, Boynton *et al*.[15] in 2007 and Brahm *et al*.[16] in 2013 had concluded in their study that maximum number of undergraduate dentists prefer conscious sedation rather than general anesthesia. In contrast, Eidelman E et. al in 2000 found that quality of treatment performed under GA is better than under conscious sedation.[17]

Conclusion:

The general dental practitioners do know about different techniques but are not able to effectively implement them so as to achieve child's co-operation. They usually refrain from treating the children in day-to-day practice as it takes lot of time and efforts to deal with them.

The behaviour management techniques if used wisely and appropriately, treatment can be performed successfully in a child with positive approach towards dentistry.

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In-vivo evaluation of multiple factors association with non-carious cervical lesions

Original Article

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Abstract

Aims: In vivo-evaluation of multiple factors associated with non-carious cervical lesions.
Material and Methods: This in vivo study consisted of a clinical survey of NCCL & its relation with oral hygiene practice, tooth brushing habits, parafunctional habits, chewing habits. The subjects were clinically examined to detect presence and location of NCCLS, signs of parafunctional habits and chewing habits. According to the presence and absence of NNCLthe participants were divided into two groups- control group (no NNCL presence) and a test group (NCCL present). After the examination participants were asked to fill an oral hygiene practice self-report questionnaire. To examine the deformation of tooth brush bristles each participant was given a new and identical extra soft tooth brush incombination with a tooth paste. The participants were requested to use the tooth brush andtooth paste for their normal daily tooth brushing for 30 days and were collected to analyze the deformation of bristles.
Statistical analysis: The deformation of tooth brush bristles was statistically associated with Presence of NCCL'S ($p < 0.01$)
Results: In this in vivo study we found that 78% of population of test group with presence of non-carious cervical lesions showed deformation of tooth brush bristles whereas 84% of population of control group showed no deformation of tooth brush bristles with absence of non-carious cervical population. Also 68% of total population showed light to moderate deformation.
Conclusions: This study concluded that there is positive correlation between prevalence of NCCL and tooth brushing habits.
Key-words: Non-carious cervical lesion, Tooth brush bristles, oral hygiene habit

Introduction

A Non-Carious Cervical Lesion (NCCL) is the loss of dental hard tissue near the cementoenamel junction without the development of caries. It is a common pathology that confronts dentists with a complex etiology and treatment plan. NCCLs are often mentioned as the patient's main complaint due to discomfort and sensitivity caused by dentin exposure[1].

Excessive hand force during toothbrushing can cause trauma to the protective periodontium, causing gingival recession. The action of these forces in conjunction with the abrasiveness of toothpaste can cause wear in the cervical region of the teeth, which may contribute to the presence of NCCLs, given that oral hygiene and the number of daily brushings is linked with the frequency of NCCL occurrence[2].

Making a timely diagnosis of NCCLs is of fundamental importance. Non identification of the etiological factors of these lesions can lead to inadequate treatment, decreased success of restorative treatments, and increased clinical complaints. It is important to verify the relation between NCCLs and tooth- brushing in order to create a better understanding of the involved mechanisms and consequently select the appropriate treatment[3].

Materials and Method

Hundred patients (age group- 20-25 years) visiting Ahmedabad dental college and hospital were included in the study. Preceding the research, all interested patients were made aware about the study design and they gave informed consent. Experimental procedures were approved by the Ethical Committee of the Ahmedabad dental college and hospital.

The research was divided into three steps: 1) clinical assessment; 2) oral-hygiene practice self-report questionnaire; and 3) visual analysis of toothbrush bristle deformations.

First of all, clinical examination of all the participants individually with sterile mirror and probe to detect the presence of NCCLs as well as the location of the NCCLs in the teeth was done. Loss of dental tissue near the cementoenamel junction without the development of caries were considered as NCCLs. The clinical selection of

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subjects was based on the criteria of complete dentition, not necessarily with the presence of third molars

After the clinical examination, the participants were divided into two groups according to the presence or absence of a NCCL: a control group (no NCCL present) and a test group (NCCL present).

The participants filled out an oral-hygiene practice self-report questionnaire that included the following questions

· About the number of daily tooth-brushings (e.g., "How many times a day do you brush your teeth? One, two, three, four, or more than four times a day),

· Characteristics of the bristles of toothbrushes commonly used by the respondent (e.g., "What kind of toothbrush do you use to brush your teeth?" Soft, medium, or hard),

· Type of tooth paste (e.g., "What kind of toothpaste do you use regularly for oral hygiene?" With or without abrasive and with or without fluoride)

· The intensity of the force applied during toothbrushing (e.g., "Do you think that you brush your teeth with excessive force?" No, a little, or very much).

· Frequency of changing the tooth brush (e.g., "How often do you change your tooth brush?" After 1 month, after 3 months, after 6 months, don't change).

· About cleaning the tooth brush (e.g., "How do you clean your tooth brush?" In normal water(tap), In chlorhexidine.

· Are you left-handed tooth brushes or right-handed tooth brushes?" Right, Left).

· Related to tooth sensitivity (e.g., "Do you feel sensitivity in your teeth? Yes frequently, yes sometime, No),

· Other oral hygiene practices (e.g., "Do you use any type of mouthwash along with tooth brushing? Yes, No),

· About chewing habits and parafunctional habits (e.g., "Do you have any assorted habits chewing tobacco, betel nut or pan Masala? Yes, No).

· Presence of parafunctional habits (e.g., "Do you have any signs of parafunctional habit like clenching of teeth, traumatic occlusion or attrition? Yes, No)

To enable analysis of toothbrush bristle deformation, i.e. the collapse under force of bristles on an individual brush head, all participants were provided with new and identical extra soft tooth-brushes. The quality of the toothbrushes and their packaging were verified prior to distribution among participants. Only brushes with uniform tufts, placed perpendicularly to the base of the head, were used. The participants were requested to use the toothbrush and toothpaste for their normal daily toothbrushing for a period of 30 days, keeping the brushes dry during non-use. After this period, the toothbrushes were collected, decontaminated with chlorhexidine gluconate 2% and analysed.

Analysis was conducted by visual observation of the deformation of the bristles. This deformation of bristles was classified according to the following three categories: light, moderate, severe. The result was analyzed based on two classifications-

(a) (b) (c)

Visual examination of tooth brush bristles.

(a)LIGHT (b) MODERATE (c) SEVERE

(I) Deformation and no deformation
(ii) Severity of deformation- light, moderate and severe

Result

In this in vivo study we found that 78% of population of test group with presence of non-carious cervical lesions showed deformation of tooth brush bristles whereas 84% of population of control group showed no deformation of tooth brush bristles with absence of non-carious cervical population. Also 68% of total population showed light to moderate deformation.

The self-report questionnaire concluded that 88% of population has a habit of brushing twice a day. Considering the type of tooth brush used, 67% of cases used soft tooth brushes and only 8% of cases used ultrasoft tooth brushes. Abrasive tooth paste was used by 58% of total young population. 88% of cases from both test group and control group applied little forces during tooth brushing. 90% of population changes their tooth brushes after every 3 months. Hence the result of questionnaire showed no statistical difference between oral hygiene habits and prevalence of non-carious cervical lesions.

	Test group	**Control group**	Chi Square	DF	P Value	Sig/Non Sig
	(Presence of NCCL)	(Absence of NCCL)				
No deformation	12	42	36.23	1	<0.001	Sig
Deformation	38	8				

	Test group	**Control group**	Chi Square	DF	P Value	Sig/Non Sig
	(Presence of NCCL)	(Absence of NCCL)				
No deformation	12	42	37.19	2	<0.001	Sig
Deformation						
light	19	6				
Moderate	15	2				
severe	4	0				

For Calculating Chi Square Moderate and Severe have been clubbed as one of the class had a frequency of Zero

Table 1- Correlation between tooth brush bristles and prevalence of NCCL

Toothbrush practices	Test group	Control group (Absence of NCCLS)	Chi Square	DF	P Value	Sig/Non Sig
A- Frequency of brushing						
Once a day	7	5	0.379	1	0.538	Non Sig
Twice a day	43	45				
B- Type of tooth brush						
Soft	32	35	3.164	3	0.367	Non Sig
Medium	7	10				
Hard	6	2				
Ultrasoft	5	3				
C- Type of tooth paste						
Abrasive	32	26	1.478	1	0.224	Non Sig
Non abrasive	18	24				
D- Force applied						
No force	6	2				Non sign
A little force	42	46				
Very little force	0	2				
Not observed	2	0				
E-How often do you change your tooth brush?						
3 Month	47	43	1.778	1	0.182	Non Sig
6 Month	3	7				
F- Left-handed or right-handed?						
Left	4	3	0.154	1	0.695	Non Sig
Right	46	47				

Table 2- Survey of oral hygiene practice

Discussion

The uncertain etiology and diagnosis of NCCL have led to a confused approach to its clinical management. The prevalence of NCCLs recorded by literature has revealed results as conflicting as 2% to 90%. In this in vivo study we have correlated the prevalence of NCCL, tooth brushing habits and oral hygiene habits in young population. Age is also an important factor to be considered. Age represents cumulative NCCL effects, increasing likelihood of its prevalence and severity with age. Therefore, the prevalence and severity of NCCLs are likely to increase with age. Many studies have also shown a link between NCCL frequency and oral hygiene habits[4].

Statistical analysis of this in vivo study did not reveal a significant relation between tooth brushing and NCCL frequency. These results contradict the findings in literature that relate the frequency of NCCLs to frequency of daily toothbrushing. Though deformation of tooth brush bristles were seen in test group with presence of NCCL. If severity of deformation of bristles was analyzed, majority of population showed light to moderate deformation. Severe deformation of tooth brush bristles was seen in 2-3% of cases. A

significant association was found between NCCL and teeth sensitivity in this study. It is supported by a study done on Swiss adults in which 84.6% patients with NCCL presented with hypersensitivity. These results were in contrast to Hina et al, who found no sensitivity in 71% of patients with NCCL present. The reason for teeth sensitivity is due to enamel loss at cervical area leading to dentin exposure. However long standing NCCL gradually may become less sensitive due to formation of reparative or sclerotic dentine[5].

Use of hard tooth brush and excessive brushing has been found to be associated with NCCL significantly. Our results are similar to John J. Dzakovich who worked on relationship between abrasion and NCCL. His results showed that horizontal brushing method with tooth pastes was capable of tooth loss at cervical areas[6]. Bartlett DW et al. showed greater frequency of NCCL in patients who brushed twice daily, compared with those who brushed less frequently. However, frequency of brushing was not found to be associated with NCCL significantly in this study. Radentz WH et.al showed use of hard tooth brush is incapable of abrading enamel but capable of producing surface roughness in dentine, it indirectly supports the concept that the abrasion and erosion have a secondary role in causing NCCL[7]. Radents WH et.al study showed tooth brush abrasion is strongly suspected as contributing to the formation of the majority of wedge-shaped lesions, whereas the presence or contribution of occlusal stresses in the direct formation of these lesions could not be measured directly[8].

Apart from clinical examination and tooth brush analysis patients were also asked to fill up a self-report questionnaire. Self-report questionnaires have been the most commonly used method in the literature to evaluate clinical parameters such as frequency of daily tooth brushing, characteristics of bristles of toothbrushes used by respondents, type of toothpaste, and applied force during tooth brushing. Other questions related to oral hygiene practices like cleaning of tooth brushes, changing the old tooth brush, and use of mouthwash were also included in the survey. Presence of any chewing habits and parafunctional habits were also asked as they are also contributing factors to development of NCCL. The results of questionnaire showed no relation between daily tooth brushing habits, oral hygiene practices and prevalence of NCCLs. As the survey was done in young population there were very few cases who had tobacco chewing habits and para functional habits like clenching and bruxism[9].

Though David and Winter reported the role of erosion and abrasion in NCCL. That is only one clinical study that has investigated the progression of cervical wear lesion affected by dietary acids and frequency of tooth brushing. However, in this study, acidic drinks are not found to be associated with cervical wear significantly[10].

Recognizing and understanding the etiology of NCCL have effect on prevention and management of such lesions. Due to this, correlation among these factors and NCCL could not be established. Hence this study cannot conclude about chewing habits, parafunctional habits and development of NCCL. Hence Recognizing and understanding the etiology of NCCL may affect on prevention and management of such lesions[11].

These questionnaires might not be an ideal method to collect accurate data, because awareness can affect the quality of answers. However, limitations of this study are- a different brushing technique, different method of toothbrush storage, humidification of the brush prior to brushing, quantity of toothpaste (which can alter deflection and deformation of bristles), and the commitment of participants to use the toothbrush for the duration of the research[12].

Furthermore, the measurement of toothbrush deformation by calculating the superficial area of the bristles is limited by the fact that this method only captures externally directed deformations, whereas inward deformations remained undetected. Hence one isolated factor is not able to cause NCCL development.[13] Traction forces caused by mastication, malocclusion, or parafunctional habits are the primary etiological factors of NCCLS, thus conferring secondary importance to other buccal conditions related to the loss of dental structure[14].

It is up to the practitioner to investigate possible

factors contributing to the development of NCCLs. Awareness and prevention of these factors will enable meeting the needs of patients in a more accurate and assertive way[15].

Conclusion

The conclusion of this in vivo study is the type of toothbrush and tooth brushing habits may affect the development of NCCL. Besides various oral hygiene practices, there are many etiological factors like malocclusion, forces during mastication or parafunctional habits which may affect the prevalence of NCCL. This study was performed in young population so that further preventive measures related to oral hygiene practice and tooth brushing habits can be taken.

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Modified Tandem Appliance to Control developing Class III

Case Report

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ABSTRACT

Most developing Class III patients have a retruded maxilla. Early management in mixed dentition is linked to improved patient compliance and perhaps even an improved orthopaedic response, which can lead to positive outcomes. The purpose of this report is to describe a new modified tandem appliance design and its role in treatment of a growing Class III malocclusion. An 11-year-old male patient with an anterior cross bite and a retrognathic maxilla is presented. The therapeutic outcomes of a new, modified tandem appliance at the mixed dentition stage be appreciated. The anterior cross bite was fixed in 4 months, and a 3 mm positive overjet was established after using the appliance consistently for 9 months. The patient's profile underwent a remarkable improvement utilizing this.

Key Words : Anterior cross bite, Class III malocclusion, New modified tandem appliance

INTRODUCTION

A skeletal Class III malocclusion, which affects 8% to 22% of orthodontic patients, is a common orthodontic issue. One of the abnormalities that is the most challenging to comprehend is class III malocclusion. Studies done to determine the etiological characteristics of a Class III malocclusion revealed that the deformity affects the entire craniofacial complex and is not just limited to the jaws. The majority of individuals with Class III malocclusions displayed skeletal and dentoalveolar components together[1]. Complex[2,3] factors interact to cause the phenomenon. They may work in concert or alone, or they may neutralise one another. In the development of Class III malocclusion, hereditary along with environmental factors plays a significant role. The prevalence of Class III malocclusion is variable and depends upon the different ethnic groups and different methods of classification used[4]. The early management of Class III malocclusion with midface deficiency is necessary because maxilla is the template for the mandible in the early stage of development. The current clinical protocol for midface deficiency was orthopaedic maxillary protraction by means of elastics to an extraoral facemask. In the present case report a new modified tandem appliance for the management of developing Class III malocclusion, which is more patient friendly and simpler than the earlier one has been presented.[5]

APPLIANCE DESIGN

The appliance has three components, two fixed and one removable. The upper fixed appliance consist of bands on permanent 1st molars, transpalatal arch and palatal expansion arms. Soldered buccal arms are used for elastic traction. The lower appliance comprises bands on permanent 1st molars, lingual holding arch, fixed bite plane for posterior occlusal coverage[6] and buccal facebow tubes. A 0.045" headgear facebow with the outer bows, modified for elastic attachment is inserted into the lower tubes. Circumferential clasps on first deciduous molars and are used for mechanical retention, which augment the stability of lower appliance and prevent rocking of it in the upward direction at anterior segment during elastic traction.

CASE REPORT

A male patient of age 11 years with chief complaint of backward positioning of upper front teeth was diagnosed with skeletal class III with maxillary retrognathism and a normal mandible. On extraoral examination, he has mild concave facial profile with midface deficiency, competent lips and no temporomandibular joint disorder or facial asymmetry [Figure 1]. Intra oral examination revealed class III subdivision molar relationship on right side and deciduous canines on upper right and upper & lower left sides, class II div 2 incisal relationship with an anterior crossbite in relation to central incisors & left

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primary canines and a negative overjet of 2 mm. [Figure 2]. No forward functional shift of

Fig. 1. Pre-treatment extra oral photos showing mild concave profile with maxillary deficiency.

Fig. 2. Pre-treatment intra oral pictures showing reverse overjet and class III subdivision molar relationship.

mandible was noted on closing movement of mandible. The family history was non-contributory.

On analysis of lateral head cephalogram patient had Class III maxillomandibular relation (ANB = −6°, Wits appraisal = BO 6mm ahead of AO). There was vertical growth tendency with FMA 30°, facial axis angle 3°, and Jarabak ratio of

Fig. 3. (A) Pre-treatment lateral cephalometric radiograph. B) Pre-treatment orthopantomograph radiograph.

VARIABLES	PRE-TREATMENT	POST-FUNCTIONAL	NORMAL
ANB	-5°	-3°	2°
Wits	BO 6 mm ahead of AO	BO 2 mm ahead of AO	BO 1 mm ahead of AO
SN-GoGn	38°	38°	32°
A-Na perp	- 6 mm	- 4mm	0 ± 2 mm
Midfacial length	65 mm	71 mm	81.7 ± 3.4
Mandibular length	98 mm	100 mm	99.3 ± 3.6
Jarabak ratio%	56.56%	58.58%	62-65%
U1-NA	27°/7 mm	30°/9mm	22°/4 mm
L1-NB	21°/5 mm	4°/22mm	25°/4 mm
S line-Upper lip	1 mm	1mm±	2 mm
S line-Lower lip	4 mm	2mm	± 2 mm

Table 1. Pre and post functional lateral cephalogram.

56.56%. Maxilla was deficient and retrognathic with normal mandible. Upper and lower incisors were normally placed in their basal bone [Figure 3 and Table 1].

TREATMENT ALTERNATIVES

The patient was provided with treatment options such as Face mask and chin cup, but the patient did not opt for it.

TREATMENT PLAN AND PROGRESS

For early management of the case, we planned to use the new modified tandem appliance with the objectives of relieving anterior cross bite as early as possible to provide harmonious jaw growth. Bite registration was done after fabrication of the band on upper and lower first molars. The upper and lower models were mounted on the articulator with wax bite and then appliance was fabricated in laboratory. After fabrication of appliance; it was properly finished, polished and bands were cemented by glass ionomer luting cement. Modified face bow was adjusted so that the junction of outer and inner bow should fall at the commissure of lips for easy elastic traction application. An 8 oz elastic was used for 4 weeks, followed by 14 oz. Initially, patient was instructed to wear the appliance minimum of 10-12 h/day, including while sleeping. The wear time was

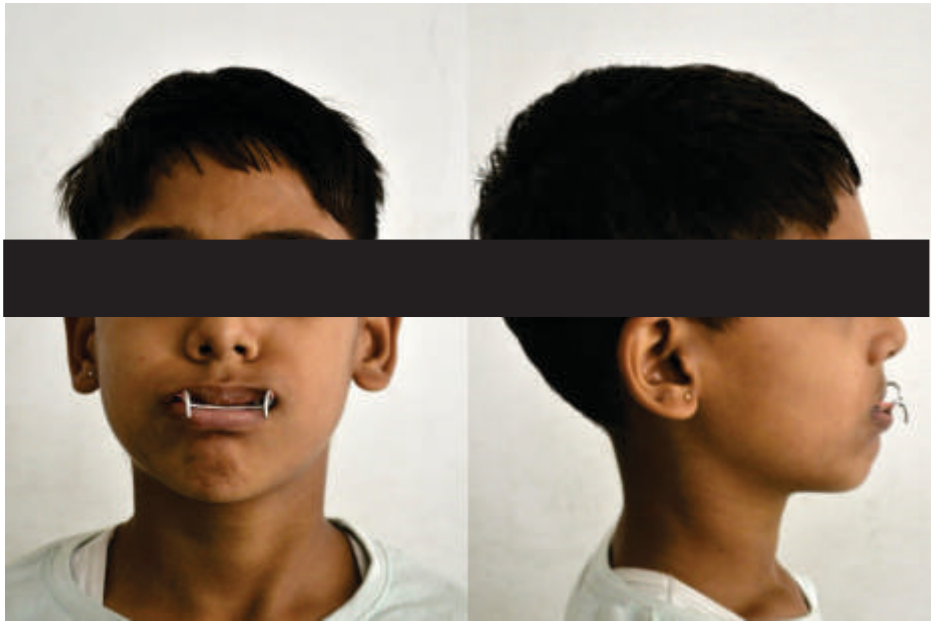

Fig. 4. Extra oral picture of modified tandem appliance in place

Fig. 5. Intra oral picture of modified tandem appliance in place.

gradually increased up to 14-16 h/day. Patient was advised to visit after 1 week to monitor the compliance and check proper adjustment of appliance, and then scheduled to recall every 4 weeks to monitor progress.

RESULT

After 4 months of appliance wear anterior cross bite was fully corrected, so at this stage we removed posterior bite blocks and continued with the protraction of maxilla. After another 6 months of appliance wear, there was positive overjet of 3 mm. The oral hygiene maintenance with the appliance was excellent. After 9 months of total appliance wear, there was positive overjet, convalesced molar occlusion and pleasing facial profile. Cephalometric evaluation revealed a skeletal improvement, an increased vertical dimension, and improvement in facial balance.

Fig. 6. Post functional extra-oral pictures showing normal overjet and improvement in facial profile.

Fig. 7. Post functional intra-oral pictures showing normal overjet and class III molar and class I cuspid relationship.

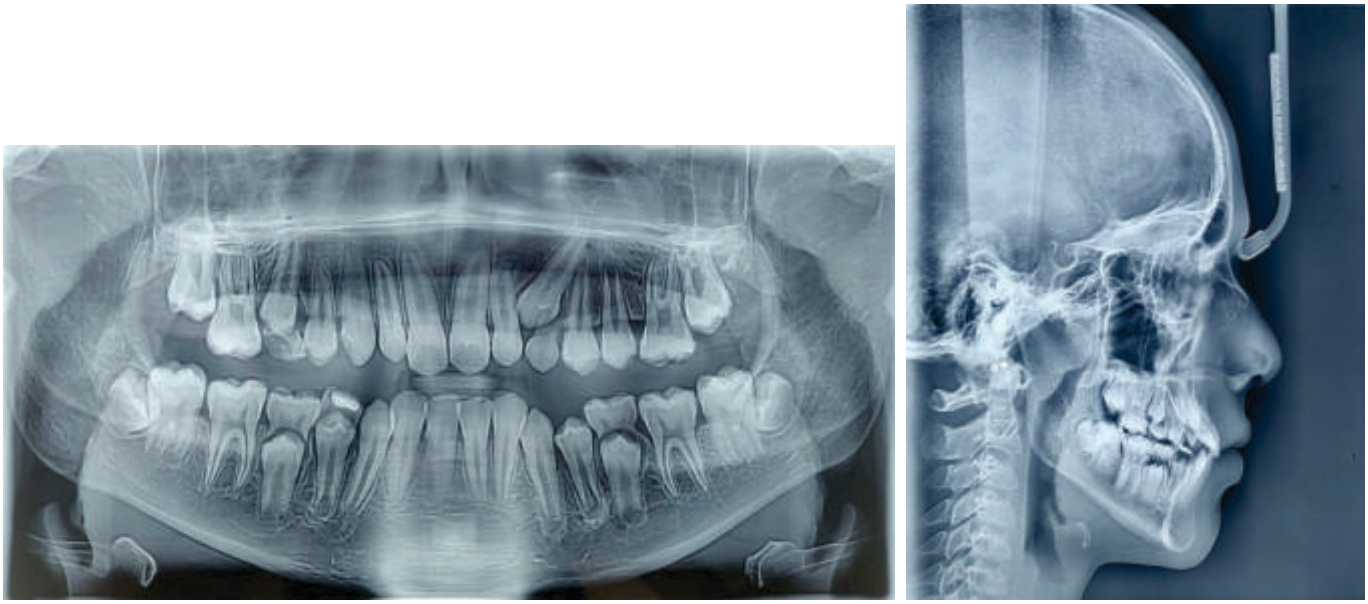

Fig. 8. (8.1) Post-treatment lateral cephalometric radiograph. 8.2) Post-treatment orthopantomograph radiograph.

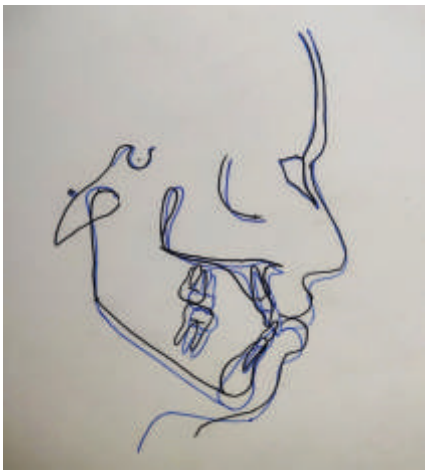

Fig. 9. Superimposition of pre and post functional lateral cephalogram.

DISCUSSION

A developing Class III malocclusion is one of the most challenging problems in orthodontics. It requires the early diagnosis and management. The objective of early orthodontic treatment of developing Class III malocclusion is to create an environment in which a more favourable dentofacial development can occur. The optimal time to intervene a developing Class III malocclusion is at the time of the initial eruption of the maxillary incisors. The therapeutic use of a Balters' Bionator[7] appliance is suggested in three subjects with anterior cross bite in mixed dentition by Giancotti et al. Turley presented the therapeutic results of orthopaedic treatment with palatal expansion and custom protraction headgear[8]. Tsai suggests the use of rapid palatal expansion and standard edgewise appliance to resolve an anterior cross bite. Rabie and Gu have used a simple method for the early management of pseudo-Class III malocclusion in the mixed dentition with fixed appliance. The therapeutic use of a new modified tandem appliance is suggested in developing Class III malocclusion. A positive overjet and overbite at the end of the treatment appears to maintain the anterior occlusion[9]. The overcorrection is required for long term stability in growing Class III malocclusion; because skeletal patterns generally continue to grow in the original direction after initial treatment. The increased level of patient cooperation with this appliance, combined with the ability to protract the maxilla, makes this appliance extremely valuable in early treatment of developing Class III malocclusion. In the present case there has been forward and lower rotation of the mandible which could have been prevented by giving chin cup along with the appliance but as the patient did not wish to wear it desirable results could not be achieved[10]. The new modified tandem appliance provides a tooth born anchorage system that combines skeletal and dentoalveolar movement[11]

CONCLUSION

The new modified tandem appliance has more fixed components and is an alternative to non-compliant patients who refuse to wear heavy extra oral orthopaedic appliances. It can also be used with upper arch expansion. It will be a valuable tool in the armamentarium of orthodontics to cope up with the developing Class III malocclusions.

Advantages of modified tandem appliance :

•Less bulky than a face mask and fixed components increase patient acceptance.

•Less expensive compared to conventional Tandem appliance.

•Upper incisors are not bonded and engaged so there's minimal force on teeth to procline them.

•Since the force vector is closer to the centre of resistance of maxilla, protraction can be expected rather than mesial tipping of upper molars.

Disadvantages of modified tandem appliance:

•Clockwise rotation of mandible and increase in lower facial height maybe undesirable in typical class III cases.

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Socket preservation using novabone for future implant perspective

Case Report

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ABSTRACT

Alveolar bone loss may occur due to a diversity of factors such as periodontitis, aggressive manipulation during extractions, endodontic pathology and facial trauma. Socket preservation provides greater control and predictability in preventing site collapse and esthetic compromise. It is a simplified, minimally invasive regenerative approach for optimizing the preservation of the hard and soft tissue components of the alveolar ridge immediately following tooth extraction. The preservation of bone volume is of major importance in order to ensure the proper implant and esthetic rehabilitations.

Keywords : Socket, Bioactive Glass, Novabone

INTRODUCTION:

Soft tissue contour depends on the basic bone anatomy. Following tooth extraction, sockets undergo a remodeling process that influences the implant rehabilitation treatment of the edentulous areas[1]. Alveolar bone loss may occur due to a diversity of factors such as periodontitis, aggressive manipulation during extractions, endodontic pathology and facial trauma. Most extractions are done with no regard for maintaining the alveolar ridge. Extraction of tooth and succeeding healing of the socket frequently results in osseous abnormalities of the alveolar ridge, including decreased height and width of the residual ridge[2,3]. The severity of the healing form may pose a problem for the clinician in 2 ways: one it creates an esthetic problem in the fabrication of a restoration supported by implant or in the construction of a conventional prosthesis; and it may make the placement of an implant perplexing.[4] However, it is possible to minimize such glitches by simply carrying out ridge preservation procedures in extraction sockets using grafting materials with or without barrier membranes[5,6].

Prevention of alveolar bone loss post-extraction was first described by Greenstein (1985) and Ashman and Bruins (1985). Cohen (1988) was the first to coin the term socket preservation, a technique planned for prosthetic socket maintenance, ridge preservation, and ridge augmentation. Basic socket preservation, although similar in all cases, varies with the method of socket closure. As a result, there are a number of different socket preservation procedures namely:

1. Connective tissue graft (Langer and Calangar, 1980)
2. Socket seal or free gingival graft (Landsberg and Bichacho, 1994)
3. Bio-Col or resorbable hemostatic plug technique (Sklar, 1999)
4. Guided bone regeneration
   1. Nonresorbable membrane
   2. Resorbable membrane
   3. Normal restorability (4–6 weeks)
   4. Extended restorability (4–6 months)
5. Alloderm or acellular dermal graft (Misch, 1998)
6. Prosthetic "pontic" socket plug
   1. Removable (Misch, 1998; Kois and Kan, 2001)
   2. Fixed (Kois, 1998; Spear, 1999; Sklar, 1999)
7. Combination epithelialized subepithelial connective tissue graft (Stimmelmayr 2010)
8. Modified socket seal surgery with composite graft approach (Misch and Misch, 1999)

To preserve bone at the future implant site socket preservation techniques have been employed, also known as socket seal surgery, which involve the placement of different bone graft materials in the socket[7,8]. The literature also confirms that socket grafting can considerably reduce early bone loss[9,10].

In this Study we are using Novabone® which is a synthetic absorbable osteoconductive bone graft

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substitute composed of a calcium phosphosilicate bioactive glass.

CASE REPORT

A 33year-old female with a noncontributory medical history, presented to Department of Periodontics at Ahmedabad dental hospital with chief complaints of bleeding & swollen gums. Clinical examination showed garde III mobility in 24 tooth. The prognosis of this tooth was hopeless so extraction was advised, followed by socket preservation procedure keeping in mind future implant rehabilitation.

Phase I treatment was given to patient which include scaling and root planning of oral cavity. Patient's vital signs were determined and assessed before surgical treatment. To minimize vasoconstriction, a local anesthetic (lidocaine 2%), with minimal epinephrine concentration, i.e. a maximum of 1:100,000, was administered in the area of 24.

To minimize the mechanical pressure and trauma to the alveolar bone, a slow a nd gentle rotating force was used while extracting the tooth.

Thumb support against the labial aspect of the alveolus and a check on the state of the soft tissue walls of the fresh extraction socket was done to ensure intactness. The fresh socket was debrided of granulation tissue and residual periodontal ligament fibers followed by a thorough evaluation of the remaining bony socket.

Following the extraction, ab gel was placed in the socket followed by osteoconductive bone graft (Novabone) was placed. then cross matress sutures are taken. Antibiotics and oral analgesics were prescribed. A 0.2% chlorhexidine

Fig. Pre- Operative Socket View Irt 24

Fig. Socket Grafting With Ab Gel + Sybograft

mouthwash was prescribed every 12 hours for 2-week duration post-surgically. Patient was instructed not to use a toothbrush or mechanical cleansing at the surgical area and only a soft diet was advised for the first 2 weeks of the healing process. Sutures were removed after 10 days of surgery and healing was found to be satisfactory with no bone graft exposed in the oral cavity.

The patient did not report any untoward consequences. The patient was assessed after 3 months and 6 months.

DISCUSSION

The failure to preserve the anatomy of hard and soft tissues usually results in esthetic failures and compromises the final results. Socket preservation

Fig. Cross Mattress Sutures In Place Irt 24

Fig. Post- Operative View

Fig. Pre-operative Iopa Irt 24

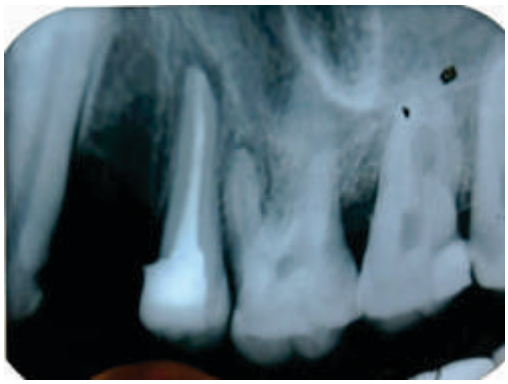

Fig. Post – Operative Iopa After 6 Months Irt 24

After six months a good bony healing was noticed both clinically and radiographically

provides greater control and predictability in preventing site collapse and esthetic compromise. It is a simplified, minimally invasive regenerative approach for optimizing the preservation of the hard and soft tissue components of the alveolar ridge immediately following tooth extraction[11].

Various grafting materials have been used to preserve the socket before implant placement like autograft, allograft, xenografts, alloplasts. In this Study we are using Novabone® which is a synthetic absorbable osteoconductive bone graft substitute composed of a calcium phosphosilicate bioactive glass.

The particles of the graft are irregular in form, measuring from 90-170μm.

Bioactive glass composes of 46.1 mol% SiO_2, 26.9 mol% CaO, 24.4 mol% Na_2O, and 2.5 mol% P_2O_5[12]. Bioactive glass forms a carbonated hydroxyapatite layer on their surfaces once exposed to simulated body fluids or implanted in vivo. It has been theorized that these bioactive properties guide and promote osteogenesis, allowing rapid formation of bone.

Schepers et al in 1998 conducted a study to analyze the efficacy of narrow size range bioactive glass particles for the treatment of bone defects prior to implant placement. Partial edentulous areas were created on both sides of the mandible of six beagle dogs. Bioactive glass particles were immediately packed on one side and other side was left vacant as a control. Analysis revealed that more bone tissue and increased remodeling activity at the interface was seen in the implants placed in bioactive glass treated areas which was statistically more significant as compared to implants placed in untreated regions[14].

Antonietta M. Gatti et al investigated the ability of PerioGlas® in the socket preservation.. Granules of the PerioGlas® exhibited a biodegradation involving precipitation of calcium phosphate which works as a scaffold for osteoblasts colonization. All cases studied revealed the bioactivity of these granules resulting in formation of new bone and biodegradation of the glass. After 2 years of clinical follow-up, all the implants were efficaciously loaded and seemed stable[15].

Arthur et al evaluated the effectiveness of an acellular dermal matrix material as a membrane to cover the implant and a bioactive glass as a grafting material in case of immediate implant placement in the extraction socket. After 6 months, they found that the mineralized tissue had completely occupied the defect around the implant[16].

CONCLUSION

Loss of teeth often result in hard and soft tissue collapse, therefore the preservation of bone volume is of major importance in order to ensure the proper implant and esthetic rehabilitations. Today the commonly used method for ridge preservation procedure is a bone graft material placed in the extraction socket and covered by a cross or non-cross linked membrane followed by complete or partial flap closure. The decision to use socket preservation technique should be made on a case-by-case basis. Surgeons should be familiarized with the wide array of techniques and materials used in order to optimize and preserve the anatomy of bone and soft tissues.

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ABSTRACT

A frenum is a fold of mucous membrane, usually with enclosed muscle fibers, that attaches the lips and cheeks to the alveolar mucosa and/or gingiva and underlying periosteum. Ankyloglossia, commonly known as tongue tie, is a congenital oral anomaly which limits the tongue's range of motion. Ankyloglossia management should be considered at any age considering the risk-benefit evaluation and because of the highest vascularization and mobility of tongue; lingual frenectomy should be performed with less traumatic events to avoid post-operative complications. In this article we report a case of 17 years old female with ankyloglossia, complaining of difficulty in speech. It was surgically treated with proper healing and good patient satisfaction.

Key words: Frenum, Ankyloglossia, Tongue tie

INTRODUCTION:

A frenum is a fold of mucous membrane, usually with enclosed muscle fibers, that attaches the lips and cheeks to the alveolar mucosa and/or gingiva and underlying periosteum. Ankyloglossia, commonly known as tongue tie, is a congenital oral anomaly which may decrease mobility of the tongue tip and is caused by an unusually short, thick lingual frenulum, a membrane connecting the underside of the tongue to the floor of the mouth.[1] The first use of the term ankyloglossia in the medical literature dates back to the 1960s, when Wallace[2] defined tongue-tie as "a condition in which the tip of the tongue cannot be protruded beyond the lower incisor teeth because of a short frenulum linguae, often containing scar tissue." A lingual frenum attachment limits the tongue's range of motion. The term free-tongue is defined as the length of tongue from the insertion of the lingual frenum into the base of the tongue to the tip of the tongue. Clinically acceptable, normal range of free tongue is greater than 16 mm.[3]

Kotlow Classification of ankyloglossia

- Class I - Mild ankyloglossia (12-16 mm)
- Class II - Moderate ankyloglossia (8-11 mm)
- Class III - Severe ankyloglossia (3-7 mm)
- Class IV - Complete ankyloglossia (< 3 mm)

Frenectomy is the usual procedure to release the lingual frenulum done traditionally using scalpel, electrocautery & now with soft or hard tissue lasers.[4] Ankyloglossia management should be considered at any age considering the risk-benefit evaluation and because of the highest vascularization and mobility of tongue; lingual frenectomy should be performed with less traumatic events to avoid post-operative complications.

CASE REPORT:

A 17 years old female reported to the Department of Periodontics, with complaint of difficulty in speech. General examination of the patient was normal. No relevant Medical history was present. On intraoral examination the individual was diagnosed with ankyloglossia (tongue tie) and was classified as Class II ankyloglossia by utilizing Kotlow assessment. There was neither any gingival recession in relation to mandibular incisors lingually nor any malocclusion present. Surgical frenectomy of the lingual frenum was planned. The patient was informed about the treatment procedure and informed consent was obtained.

PROCEDURE:

Frenectomy was performed with scalpel using blade no. 15. The procedure was carried under local anesthesia with 2% lignocaine hydrochloride. A retraction suture (3-0 silk) was placed at the tip of the tongue to facilitate retraction and to facilitate the visibility in the area of the operating field. The incision was started from the base of the tongue with simultaneous

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suturing for the approximation of the tissues and reduce the bleeding in the working field. The wound edges were then approximated with 3-0 black silk sutures. Analgesics and antibiotics were prescribed. Swelling and pain was present on the 1st postoperative day, which subsided with the continuation of medication. One week post-operative image showed the formation of slough over the operated site (extending along base of the tongue and floor of the mouth) indicating the process of healing. Patient was advised tongue exercises after 1 week. One month post-operative image shows complete healing.

Fig Pre-operative showing class- II ankyloglossia

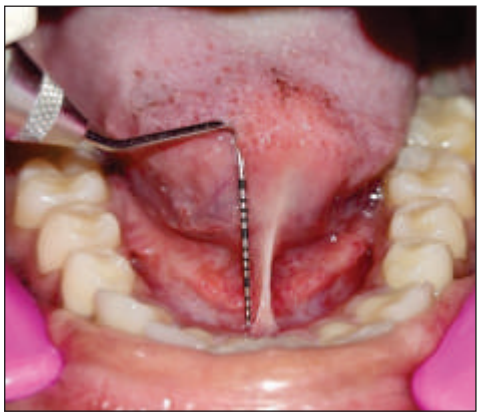

Fig Pre- operative

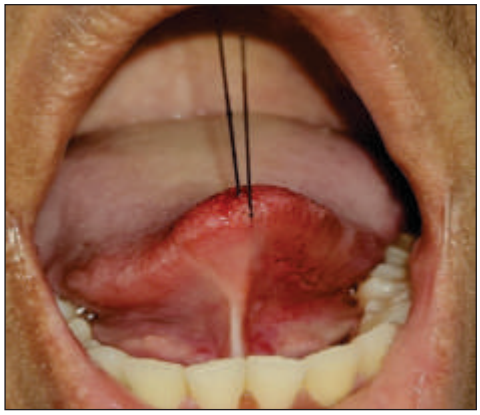

Fig Extention of tongue

Fig Placement of sutures

Fig 1 week follow up showing healing process

Fig 1 month follow up

DISCUSSION:

Ankyloglossia is a Greek term which means "agkilos" for curved and "glossa" for tongue and is more commonly called "tongue-tie". It is a congenital anatomical variation characterized by a short lingual frenulum, which may result in the restriction of tongue movement and can thus impact oral functions.[5,6]

During the 4th week of gestation, the tongue's origin is from the 1st, 2nd and 3rd pharyngeal arches. In this period, grooves are formed laterally to the structure and it can move freely, except for the region adhered by the lingual frenulum, initially at the apex of the tongue. As the development occurs, the frenulum cells undergo apoptosis and they tend to migrate distally to the medial region of the lingual dorsum, which explains the possible interferences in cell control and the incomplete migration, or even its non-occurrence resulting in an ankyloglossia.[7]

Diagnosis is based on a clinical examination. Tongue mobility and appearance associated with the insertion, as well as the attachment and the shortness of the lingual frenulum, should be evaluated. Furthermore, instances of speech difficulty resulting from the limited tongue movements can be checked by vocalizing some letters and words (sounds such as "t", "d", "r", "n", and "l", and words like "ta", "te", time, water, cat, etc.).[5,8]

Several publications have investigated the influence of the tongue and lingual frenulum on maxillofacial anomalies such as mandibular prognathism, maxillary protrusion and anterior open bite. Yoon et al. showed in their recent cross-sectional cohort study that the restriction of tongue mobility was associated with the narrowing of the maxillary arch and the elongation of the soft palate, which may affect maxillofacial development.[9]

Several management options exist for the treatment of tongue-tie. They include observation, speech therapy, otolaryngotherapy; frenotomy, frenectomy, Z-plasty, and laser frenectomy, and they have the capacity to deliver satisfactory results, often in a shorter time than expected. If the intervention of a speech therapist and otolaryngotherapist fails to resolve speech and tongue related problems, then it may be necessary to consider surgical protocol. Surgical interventions are absolutely safe at any age, including infants and adults, but strictly require postsurgical tongue reeducation and speech therapy to achieve satisfactory results.[8]

Surgical management of tongue-tie can be classified into 3 techniques:

– frenotomy defined as simple cutting of the frenulum;

– frenectomy defined as complete excision, i.e., removal of the whole frenulum;

– frenuloplasty that includes various methods to release the tongue-tie and correct the anatomic situation.

Late postoperative complications after ankyloglossia management are rare. Various complications include bleeding, blockage of Wharton's duct while suturing on the ventral surface of the tongue leading to retention cyst, and damage to the lingual nerve causing numbness of the tongue tip.[10] A recent systematic review conducted by Bin-Nun et al. mentioned that the yearly number of ankyloglossia-related articles has increased dramatically in the past few years without bringing interesting evidence.[11] If this trend continues, much more solid evidence (randomized controlled trials and systematic reviews) should accumulate about diagnosis and management of tongue-tie, as it relates to breastfeeding and other outcomes.

CONCLUSION:

Ankyloglossia or tongue-tie in most cases is a relatively harmless condition and the treatment is relatively simple effective and safe. In the present case report, lingual frenectomy was done by scalpel technique which provides practical benefit to the patients. There is no enough evidence in the literature to draw any sound conclusion about the timing of surgery for ankyloglossia. Furthermore, no specific surgical method can be favored over others or suggested as favor any one the modality of the choice.

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Facemask Therapy With Alt-RAMEC Approach To Correct Skeletal Class III Malocclusion

Case Report

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ABSTRACT

Class III malocclusion is one of the most challenging problems to treat in the mixed dentition. The etiology involves both genetic and environmental causes. With adults, orthognathic surgery and dental camouflage is the viable treatment option. Although treatment in the late mixed or early permanent dentition can be successful, results are generally better in the deciduous or early mixed dentition. A variety of treatment alternatives exists for patients in the developing stages of a Class III malocclusion. The following case shows early treatment of a young patient with Angle's class I malocclusion superimposed with class III skeletal jaw basis with severe sagittal and transverse discrepancy of the maxilla and mandible, using a facemask.

KEY WORDS

Class III malocclusion, Anterior crossbite, Alt-RAMEC approach

Class III malocclusion is associated with a deviation in the sagittal relationship if maxilla and mandible, defined by a deficiency and/or a backward position of the maxilla, or by prognathism and/or forward position of the mandible. It has been estimated that 1 to 5% of the Caucasian population has this malocclusion. Prevalence in Asian populations ranges from 9 to 19%. According to reports, prevalence in the Indian population is at 3.4%.[1] Several factors including genetics, ethnicity, environmental and habitual have been implicated in the etiology of this malocclusion.

Early techniques for the management of class III malocclusion centred on severely restricting the growth of the mandible. Delaire reintroduce facemask therapy for maxillary protraction in 1976, it is more than a century after it was first described in Germany. Petit[2] modified the facemask of Delaire by increasing the amount of force and shortening the treatment period. McNamara[3] suggested that rapid maxillary expansion (RME) may enhance the protraction effect of maxillary suture system. In the last two decades, RME and facemask combination has become the standard protocol in the management of growing patient with maxillary deficiency.[4] It has been reported that the amount of maxillary protraction was 5-6 mm in 5 months under the protocol of alternate rapid maxillary expansion and treatment done using facemask and expansion with Alt-RAMEC approach in young patients.[5]

Diagnosis and etiology

A 10 years and 11 months old female patient presented with the chief compliant of forwardly placed lower front teeth with Angle's class I Dental malocclusion superimposed on class III skeletal jaw basis.

Extra oral finding showed concave profile with anterior divergence, average clinical FMA and average nasolabial angle. (Figure 1)

Intra oral findings suggested Angle's class I molar relationship bilaterally with class III incisor relationship with negative overjet of 2 mm and overbite of 4mm. Permanent incisors and first molars in both the arches were present and mandibular canines were erupting.

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Fig 1 Pre-treatment extra oral photographs

Fig 2 Pre-treatment extra oral photographs

Fig 3 Pre-treatment OPG and Lateral ceph

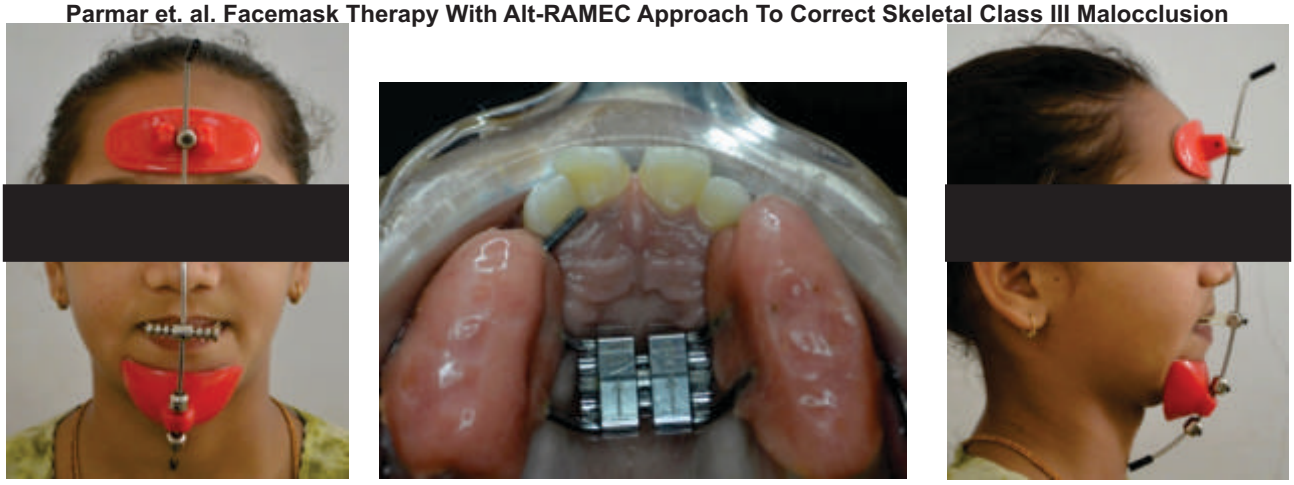

Fig 4 With Facemask and RME

PARAMETERS	PRE-TREATMENT	POST-FUNCTIONAL
MAXILLA		
SNA	75	78
N Perpendicular-Pt A (mm)	-5	-3
Angle of convexity	-13	-7
Midfacial length, Co-Pt A(mm)	71	78
MANDIBLE		
SNB	80	80
N Perpendicular-Pog (mm)	-1	-2
Effective mand. length, Co-Gn(mm)	97	104
Facial angle	90	89
MAXILLA-MANDIBLE		
Witts	BO 6mm ahead of AO	BO 3mm ahead of AO
ANB	-5	-2
VERTICLE		
FMA	21	23
GoGn Sn	27	28
Y-Axis	64	64
MAXILLARY INCISOR		
U1-NA (mm)	5	7
U1-NA	27	30
U1-SN	105	108
U1_PP	67	66
MANDIBULAR INCISOR		
L1-NB (mm)	3	-2
L1-NB	23	17
IMPA	91	84
L1-APog(mm)	4	2
SOFT TISSUES		
Nasolabial angle	90	88
H-angle	6	11
OTHERS		
Interincisal angle	131	139
Saddle angle	128	127
Articular angle	139	135

Fig 5 Post Functional extra oral photographs

Fig 6
intra oral photographs

Fig 7 Post Functional OPG and Lateral cep h

Deciduous maxillary canines and molars in maxillary and mandibular arch were also present. (Figure 2)

Cephalometric findings suggested retrognathic maxilla and orthognathic mandible with average inclination of upper and lower anterior teeth. (Figure 3)

Treatment objectives

The purpose of treatment was to correct the sagittal and transverse arch discrepancies through stimulation of maxillary growth and redirection of mandibular growth and to correct concave profile. To achieve class I canine relationship along with ideal overjet and overbite with coinciding midlines. And also to correct rotation and inclination of individual tooth. An alternative to this treatment was to delay fixed-appliance therapy until the permanent dentition had erupted. However, this plan would have required a camouflaged treatment at later stage.

Treatment plan

The treatment planning included the following assessment of growth potential: Average growth pattern with 65–85% growth remaining according to cervical vertebral maturation index. Skeletal maturity index showed stage 4.

The appliance included upper maxillary bonded splint with Hyrax expansion screw (9mm) and petit type facemask. In the first phase, Alt RAMEC approach was carried out for 8 weeks that is one week of opening the expansion screw and following week of closing the screw. The follow up was taken every week. In the second phase, Petit type of face mask was delivered with 3/8" 8oz elastics. (Figure 4) After two weeks elastics were changed to ½" 14oz and continued for another 14 days. Follow up was taken every two weeks. The appliance was worn full time (about 20 hours/day) for 11 months and then records were taken. The patient was retained using a Frankel-3 appliance (20 hours per day), with the patient removing the appliance only during activities such as eating and playing sports.

Treatment result

Patient compliance was excellent with both the facemask and the elastics. The patient displayed a bilateral end on molar relationship. The SNA angle had increased while SNB remained the same resulting in a normal jaw relationship (ANB = -2). Normal overbite (2 mm) and overjet (1mm) were achieved, and the midlines were centered. Buccal cross bite was corrected. The patient's face appeared symmetrical with competent lips. The esthetic balance was significantly improved in the lateral view and the lips were in a normal relationship. Cephalometric analysis confirmed that the concave profile had been straightened.

Discussion

The facemask therapy for the management of midface deficient class III malocclusion has conventionally been recommended in the deciduous and mixed dentitions. However, clinical corrections of the malocclusion has been shown to occur by a combination of skeletal and dental movements. The orthopaedic approach has a significantly lower cost and risk potential associated with making it an attractive alternative to surgery. We have chosen Facemask RME therapy for achieving maxillary skeletal protraction for correction of the patient's maxillary deficiency.

Conclusion

This case report shows that skeletal Class III malocclusion with maxillary deficiency in a growing individual can be successfully managed using the Alt-RAMEC approach with facemask procedure. Thus careful case selection, patient cooperation, and long-term stabilization ensure a treatment result that is successful, stable, and aesthetic.

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NON - SURGICAL TREATMENT OF PERI - IMPLANTITIS:

Case Report

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ABSTRACT

Peri-implantitis has always been one of the most important biological complication of dental implants. It is proved to be inflammatory in nature and associated with the plaque accumulation in the peri - implant tissues. It can progress on the basis of several factors like the bad oral hygiene habits and also the comorbidity factors. Different treatment modalities are being discussed over a period of last 30 years with the surgical as well as non - surgical methods having their own advantages and disadvantages. In this case report, we describe a case report with a non - surgical treatment approach to treat peri-implantitis with the protocol based on the application of the mechanical as well chemical debridement and use of systemic antibiotics over a period of time. The case showed good results with absence of clinical signs of inflammation with the help of clinical assessments (probing depth, bleeding or suppuration, color of the mucosa and the presence of pain.)

Keywords: Peri-implantitis, Non-surgical therapy, Subgingival irrigation, Systemic antibiotics

INTRODUCTION:

Over last 30 years, dental implants have evolved to be the most effective treatment for partial and complete edentulous arches, that provides masticatory function as well as esthetics. Moreover, in last few decades with the spread of dental implants, it has also come into light the importance of preventing, diagnosing and treating the peri-implant diseases. [1-5]

Under the term peri-implantitis , there's plaque associated pathological condition of the peri-implant tissues , which is characterized by inflammation of mucosa with progressive bone loss near the dental implants in the absence of signs such as bleeding or suppuration during the probing, the diagnosis can be done with the combination of following criteria: depth of probing not less than 6mm, appearance of bleeding or suppuration during this measurements, bone loss level with apical direction not less than 3mm. [6-8] As per the prevalence of peri-implantitis, during the first ten years after the placement of implant it varies from one person to 47 person as per the systemic review of Derks and Tomasi(2015) and also about 85% as per the work of Dreyer(2018) [9-10], specially with the poor oral hygiene, habits like smoking and comorbidity conditions.

As per different clinical trials and reviews, the method of treatment will be multiple stage protocol which includes treatment of acute inflammation with the help of systemic antibiotics, mechanical and chemical disinfection of implant surface in order to achieve sufficient implant stability and later reconstructive surgery if required [8].

The aim of this article is to present a clinical situation of peri-implantitis and to explain the opportunity of using non-surgical methods with relatively satisfying results with proper function and esthetics

Case report: A 37 years old female patient presented at the Department of Periodontics and Oral Implantology, Ahmedabad Dental College and Hospital, reporting with mild pain and bleeding while performing oral hygiene measures at the site of implants placed in mandible for more than 4 years.

The patient was systemically healthy and a non-smoker and gave the informed consent send for the diagnostics, treatment and use of photographs. Clinical examination showed that patient was rehabilitated with a fixed prosthesis supported by two implants in the anterior mandible. The peri-implant mucosa surrounding the implants in 32 and 42 position on visual examination showed signs of inflammation (redness and swelling) as shown in figure 1. More than 4mm of probing depth and presence of bleeding on probing, tissue retraction and suppuration were also observed.

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Radiographic signs were also seen (figure 2)

The authors decided to perform non-surgical treatment, following the patient's will (who refused surgical treatment at first) and the results were evaluated over time specially the soft tissue healing following the treatment. We proposed the removal of etiologic factors and professional oral hygiene methods to achieve the stability of dental implant. The patient was prescribed with 0.2% chlorhexidine mouth wash to be used for 10 days twice daily. After a period of 7 days, subgingival irrigation with 2% chlorhexidine was done at the site of inflammation. Systemic use of antibiotics (metrodinazole 400 mg twice daily) was prescribed for 10 consecutive days.

At the end of the prescribed treatment the patient presented with significant reduction of inflammatory signs (reduction of probing depth, bleeding on probing, suppuration and tissue retraction). The reduction in radiographic signs were also seen (figure 3 and figure 4).

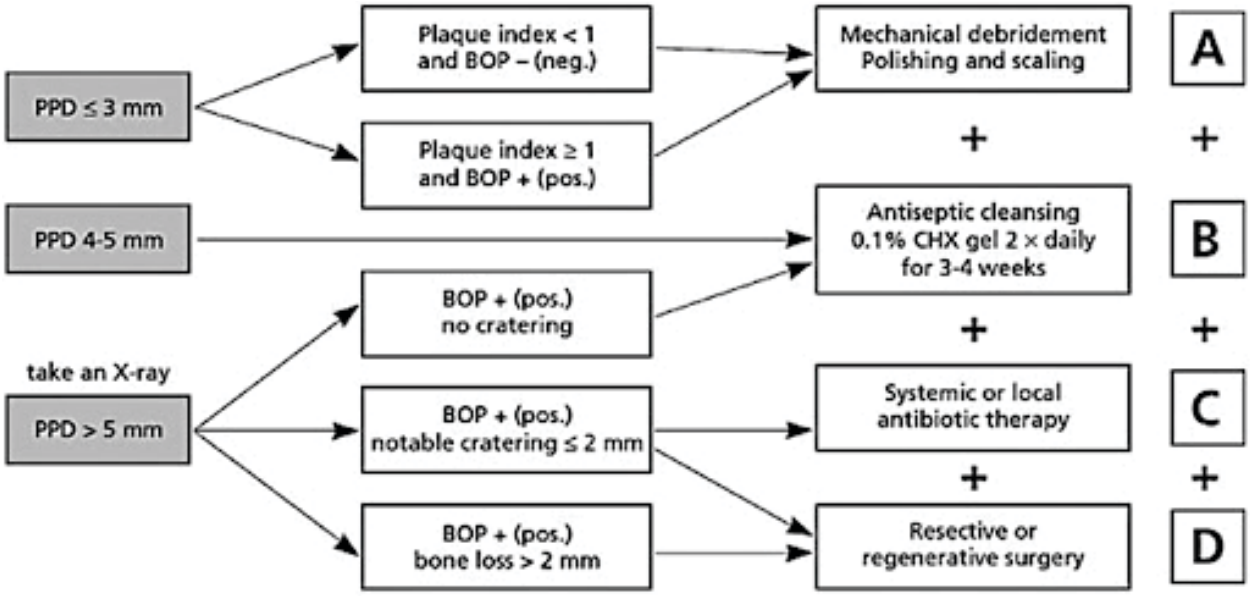
Fig. 1 PRE-OPERATIVE CLINICAL

Fig. 3 POST-OPERATIVE CLINICAL

Fig. 2 OPERATIVE RADIOGRAPHIC

Fig. 4 POST-OPERATIVE RADIOGRAPHIC

Discussion: In the present case, the authors attempted to demonstrate a non-surgical method for the treatment of peri-implantitis which can be easily repeated and made available at all clinics. Constant communication between doctor and patient should be achieved for full compliance and cooperation of the patient during the treatment. In present case scenario, there was acute abscess like condition so we planned to proceed with non-surgical treatment modality. As there was relief in clinical signs and symptoms we shifted the patient for further on maintenance therapy as per the CIST protocol (Lang et al., 2004)



Placement of dental implant and prosthetic loading leads to bone tissue remodeling and up to some extent of physiological bone resorption. This may depend of presence or absence of micro gap in the system. The bone loss of more than 1mm associates with hidden mucosa inflammation even in condition of absence of clinical signs of mucositis [12].

Poor oral hygiene may lead to formation bacterial plaque near the dental implants which may be a potential predictor for development of mucositis and peri-implantitis [8]. Even after long uneventful period of tissue health it was demonstrated that just 3 weeks without oral hygiene are sufficient to cause peri-implant tissue inflammation with bio film accumulation and bleeding of probing [13]. The prevalence of mucositis in people that refrained from personal oral hygiene measures was found to be up to 48% [14]. The minimal procedures that can be provided, may include application of subgingival irrigation for control of microbial biofilm and prevention of further spreading of infection. The systemic use of antibiotics for similar purpose were also discussed [11], in a systemic review suarez-lopez del amo f. et al. (2016) analyzed different approaches for periimplantitis and mucositis treatment. Outcomes of non-surgical treatment are effective for decreasing the inflammation, however for regeneration of bone they are less effective [15].

Conclusion:

Prognosis of the affected implant will be directly related upon the early detection and treatment of peri-implant mucositis and peri-impantitis. Event though the studies dealing with different treatment modalities are not comparable, some clinical improvement immerges with the use of non-surgical therapy in terms of resolution of inflammation and bone healing. This observation along with our knowledge of indisputable role of periodontal pathogens in the etiology of periimplantitis indicates some form of non-surgical therapy should be incorporated with any other strategy for dealing with this problem.

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AESTHETIC CROWN LENGHTENING : Balancing the Pink & White

Case Report

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ABSTRACT

The goal of crown lengthening is to provide a tooth crown dimension adequate for a stable dentogingival complex and for the placement of a restorative margin, so as to achieve the best marginal seal and an aesthetically pleasing final restoration. The esthetic crown lengthening requires gingivectomy procedures to expose the needed additional tooth structure; therefore, a minimum of 2 to 5 mm of keratinized tissue is necessary to ensure the gingival health. This present case report the installation of definitive prosthesis was carried out after the healing period of the gingiva, in order to obtain the aesthetic position of the prosthetic margin.

Key Report: Keratinized attached gingiva, Biologic width, Internal Bevel Incision Crown Lengthening Procedure

INTRODUCTION:

Crown lengthening is a surgical procedure designed to increase the extent of supragingival tooth structure for restorative or esthetic purposes by apically positioning the gingival margin, removing supporting bone or both.[1]

Various Indications for crown lengthening Procedure are teeth with subgingival caries or extensive caries that shortens the tooth, fractures, and short clinical crowns caused by incomplete exposure of the anatomic crowns. And several techniques such as gingivectomy, undisplaced flap with or without osseous surgery, apically repositioned flap with or without resective osseous surgery, and orthodontic forced eruption with or without fibrotomy have been proposed for clinical crown lengthening. But to decide the type of technique biologic width plays a very important role.

Biologic width is defined as the physiologic dimension of the junctional epithelium and connective tissue attachment, according to the pioneering study conducted by Gargiulo et al.[2] In this study, the authors demonstrated that humans, in average, show a connective tissue attachment of 1.07 mm, above the alveolar bone crest, and a junctional epithelium, below the base of the gingival sulcus, of 0.97 mm. The combination of these two measurements constitutes the biologic width, that is, 2.04 mm in average. Ingber et al. suggested that an additional 1 mm might be coronally added to the 2 mm dentogingival junction, as an optimal distance between the bone crest and the margin of a restoration, to permit healing and proper restoration of the tooth.[3] In addition, during an esthetic crown lengthening procedure, bone removal plays an important role in the final location of the free gingival margin after healing.

The ultimate goal of crown lengthening is to provide a tooth crown dimension adequate for a stable dentogingival complex and for the placement of a restorative margin, so as to achieve the best marginal seal and an aesthetically pleasing final restoration.[4]

In this case report we aim to describe the surgical sequence of crown lengthening to apically reposition the dentogingival complex, in addition to an esthetic restorative procedure.

CASE REPORT

A 61 year – old male patient with a non-contributory medical history, with no history of smoking and alcohol consumption presented to Department of Periodontics at Ahmedabad Dental hospital with short clinical crowns and diastema**(Fig-1)**. On extraoral examination there were no significant findings with normal lip line and minimal gingival display while smiling. On dental examination revealed that his 11,12,13,14,15,21 treated endodontically. The Periodontal examination revealed good oral hygiene with minimal plaque and calculus deposits. The gingiva was pink and firm, and papillae were intact. On clinical examination revealed shallow probing depths of 1.5 – 2.5 mm in all teeth with no mobility and 5 mm of

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keratinized attached gingiva along with crown to root ratio 1:3 **(Fig 3)**. Radiographic examination shows 11,12,13,14,15,21 with root canal fillings with minimal interdental bone loss and roots were found to be of adequate length **(Fig-2)**. As the patient wants to undergo full mouth rehabilitation and better esthetics , crown lengthening procedure recommended to increase the extent of supragingival tooth structure and to allow a healthy, optimal relationship between restoration and periodontium. Patient was informed thoroughly the Pros & Cons of surgical technique.

Initially, an impression of the maxilla was obtained to prepare a surgical guide in silicon. **(Fig- 10)**After giving local anesthesia (lidocaine 2%) , transgingival probing was done around the intended teeth and found that 2-2.5 mm of soft tissue present above the alveolar crest**(Fig-4-Fig-9**). After inserting guide in mouth and the new gingival margin was registered with a No. 15 Bard-Parker blade**(Fig-11).** Initial internal bevel incision was performed 3 mm apical to the gingival margin so as to achieve the scalloped contour both on labial and palatal aspect**(Fig-12 & Fig-13**). As there was sufficient amount of attached gingiva (5 mm) present, to give a remaining 2 mm around the restoration, so the procedure most suitable was crown lengthening followed by resective osseous procedure. Hence a full thickness mucoperiosteal flap was raised**(Fig-14).** Osseous resection was performed using low speed handpiece and carbide bur under copious saline irrigation to maintain the biologic width . The flap was repositioned and sutured**(Fig-15)** .Chlorhexidine rinse 0.2% bid was prescribed for 2 weeks, and the patient was given appropriate postoperative instructions. After one week , suture removal is done and good healing observed with increase in crown-root ratio**(Fig-16 & Fig-17)**. After 3 months follow-up temporary prosthesis given**(Fig-18)**.

FIG-1 - Pre-Operative View

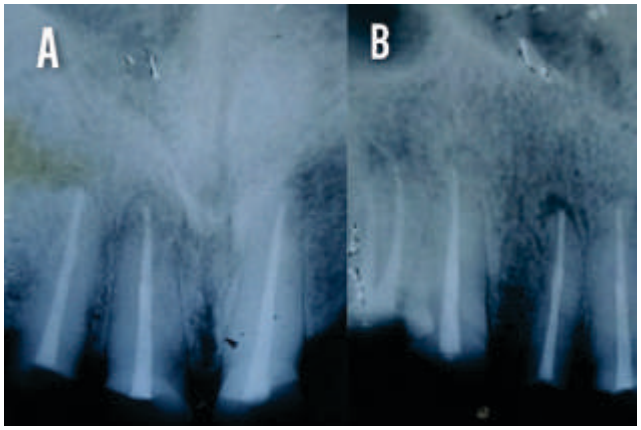

FIG-2 A: Endodontically treated 11,12 & 21
B: Endodontically treated 13,14,15

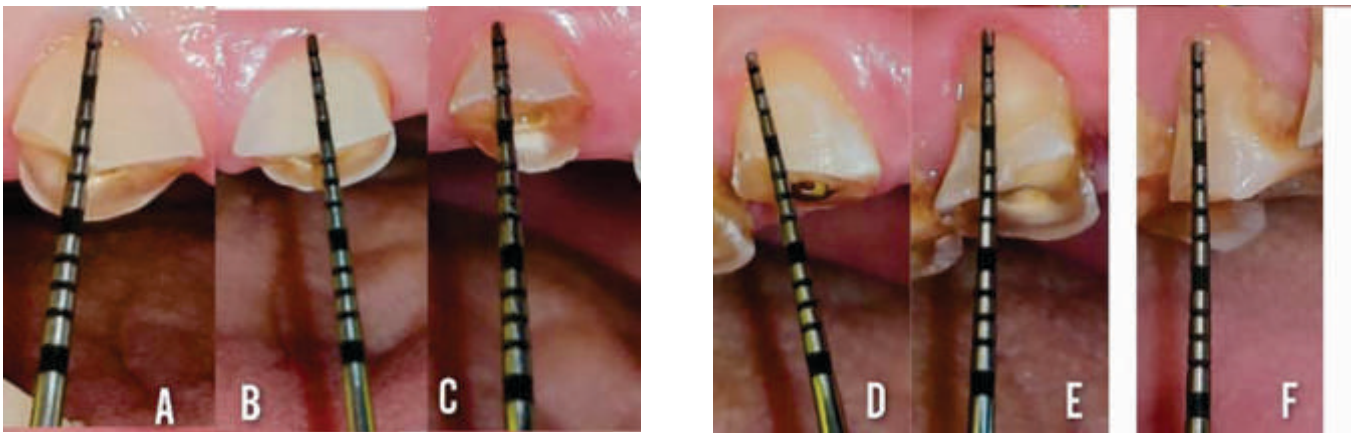

FIG-3-PRE- OPERATIVE

A: Crown length irt 11 is 6mm
B: Crown length irt 21 is 5.5mm
C: Crown length irt 12 is 3 mm
D: Crown length irt 13 is 5mm
E: Crown length irt 14 is 6 mm
F: Crown length irt 15 is 6 mm

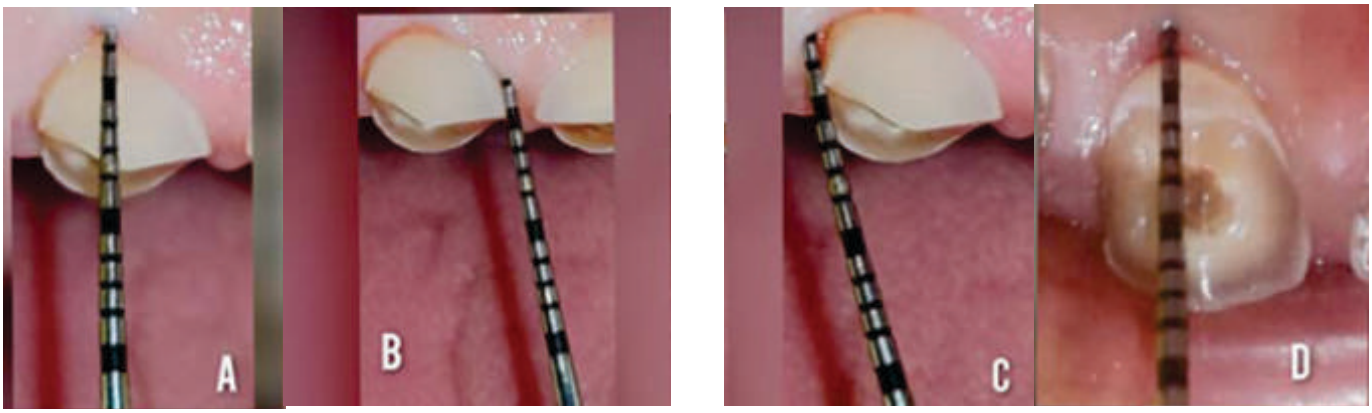

FIG-4

A: Biologic width on Mid-Buccal irt 11 is 2.5mm
B: Biologic width on Mesio- Buccal irt 11 is 2.5mm
C: Biologic width on Disto-Buccal irt 11 is 1.5mm
D: Biologic width on Mid-Palatal irt 11 is 2 mm

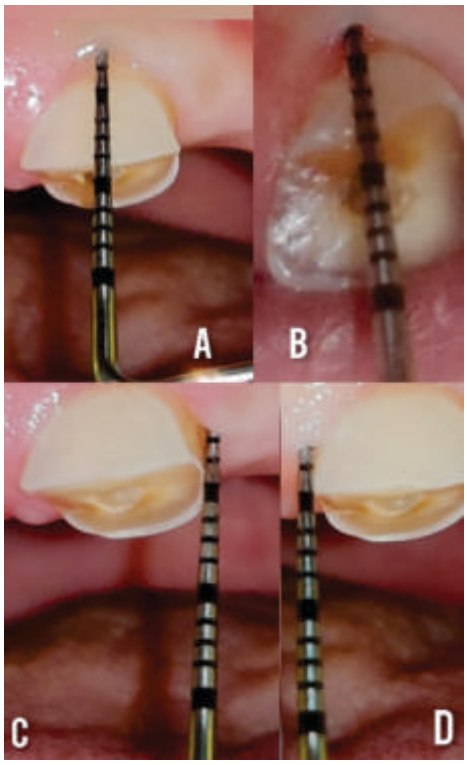

FIG:5

A: Biologic width on Mid-Buccal irt 21 is 1.5mm
B: Biologic width on Mid-Palatal irt 21 is 3mm
C: Biologic width on Disto-Buccal irt 21 is 2mm
D: Biologic width on Mesio-Buccal irt 21 is 2mm

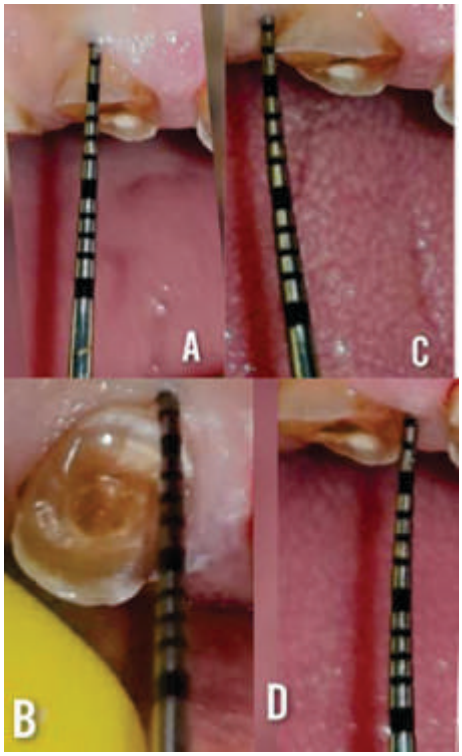

FIG:6

A: Biologic width on Mid-Buccal irt 12 is 1.5 mm
B: Biologic width on Mid-Palatal irt 12 is 2 mm
C: Biologic width on Disto-Buccal irt 12 is 1.5 mm
D: Biologic width on Mesio-Buccal irt 12 is 2 mm

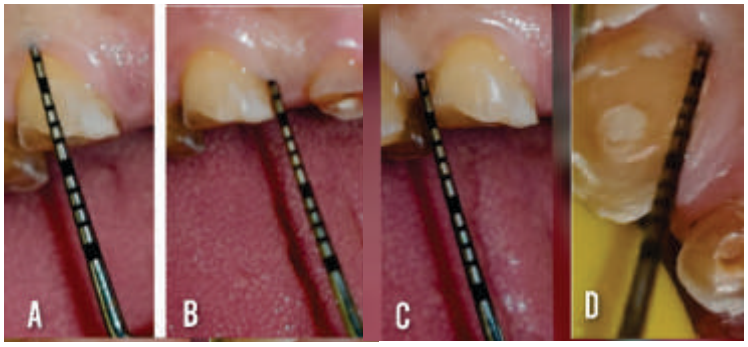

FIG:7

A: Biologic width on Mid-Buccal irt 13 is 2.5mm
B: Biologic width on Mesio-Buccal irt 13 is 2 mm
C: Biologic width on Disto-Buccal irt 13 is 2 mm
D: Biologic width on Mid-Palatal irt 13 is 2.5mm

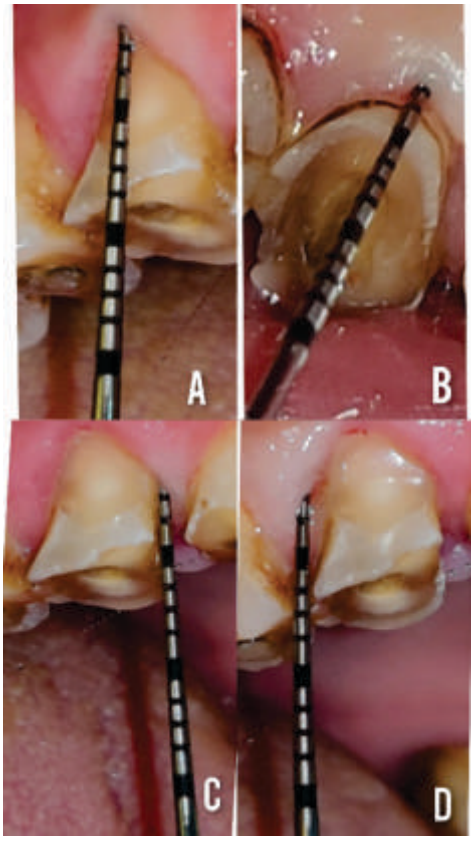

FIG:8

A: Biologic width on Mid-Buccal irt 14 is 1.5mm

B: Biologic width on Mid-Palatal irt 14 is 2mm

C: Biologic width on Mesio-Buccal irt 14 is 2mm

D: Biologic width on Mesio-Distal irt 14 is 2mm

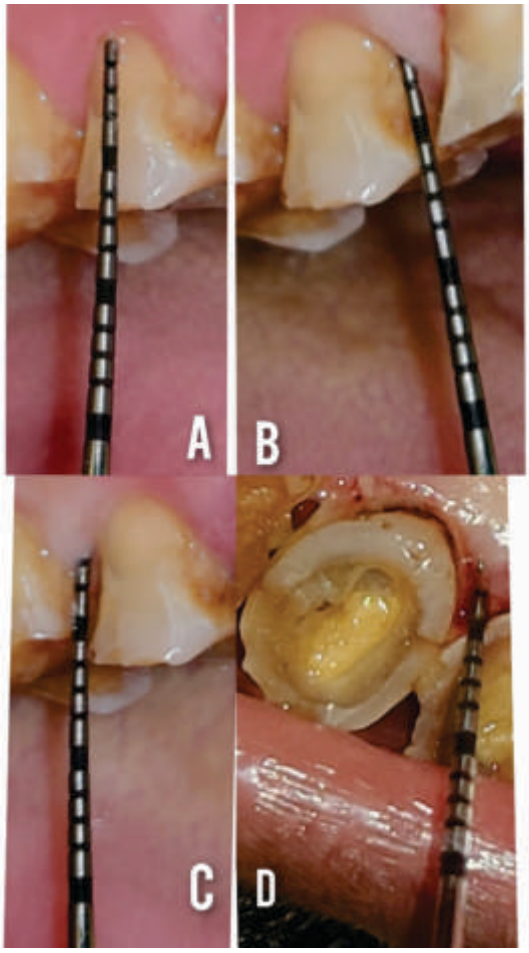

FIG:9

A: Biologic width on Mid-Buccal irt 15 is 1mm

B: Biologic width on Mesio-Buccal irt 15 is 2mm

C: Biologic width on Disto-Buccal irt 15 is 2mm

D: Biologic width on Mid-Palatal irt 15 is 3mm

FIG:10 Surgical guide is placed

FIG:11 After inserting guide in and the new gingival margin was registered with a No. 15 Bard-Parker blade

FIG:12 Internal Bevel Incision is given

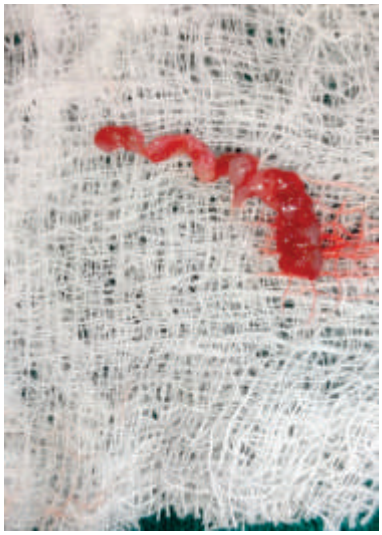

FIG:13- Excised Tissue

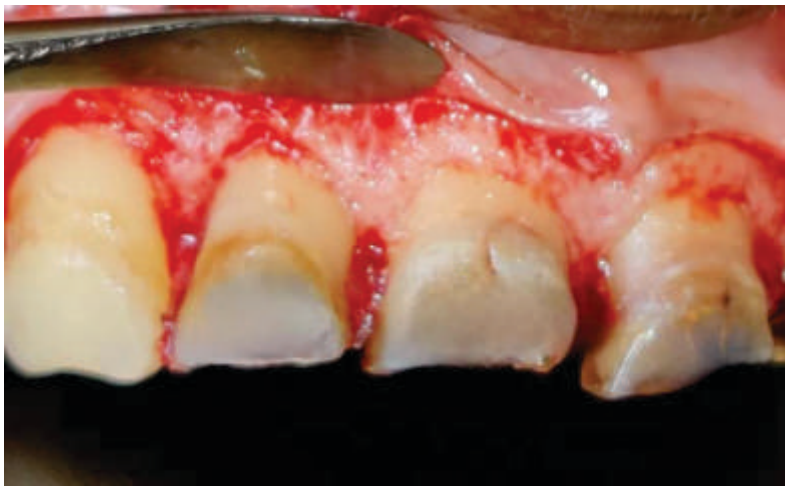

FIG:14 Reflection of Flap irt 11,12,13,14 & Bone trimming is done

FIG:15 - Sutures in Place irt 11,12,13,14,15,21

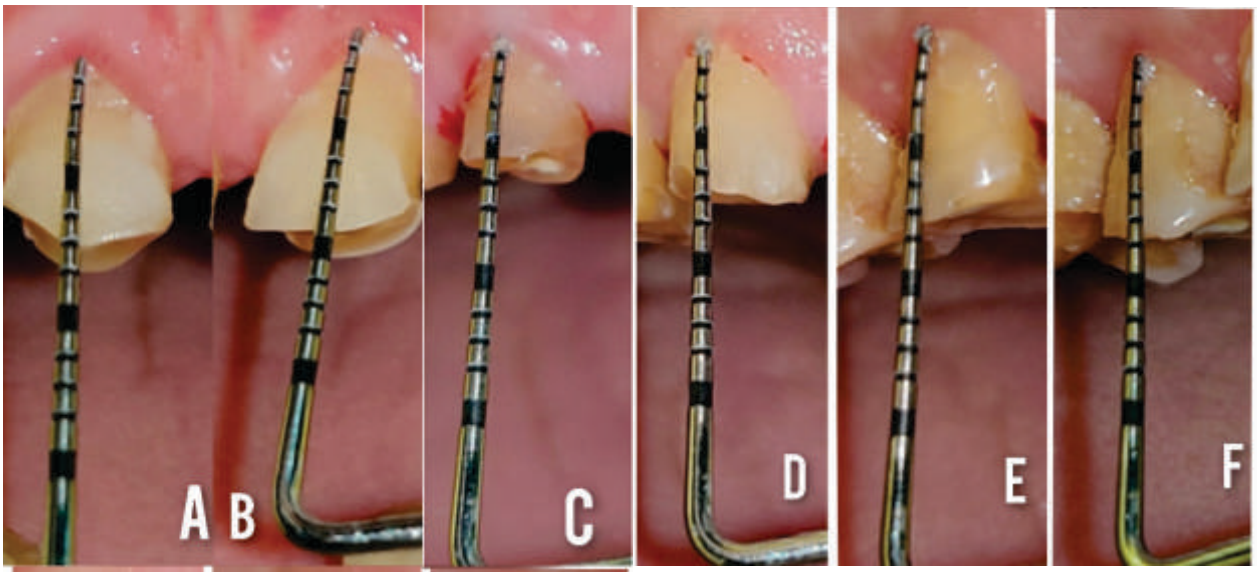

FIG:16-
POST- OPERATIVE
A: Crown length irt 11 is 7 mm
B: Crown length irt 21 is 8.5 mm
C: Crown length irt 12 is 5 mm
D: Crown length irt 13 is 7mm
E: Crown length irt 14 is 7 mm
F: Crown length irt 15 is 8 mm

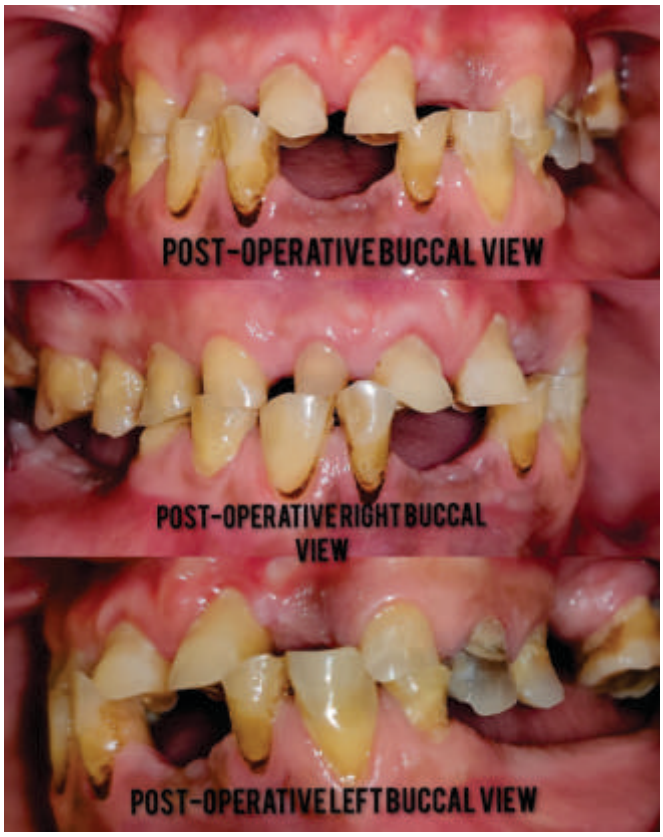

FIG:17- Post-Operative View

FIG: 18-Temporary Restoration Given

DISCUSSION

Crown lengthening is performed for aesthetic improvement during restorations and in teeth with subgingival caries or fractures; in addition, this surgical procedure can establish an accurate bone width.[5] Since esthetic crown lengthening surgeries are the elective procedures that aims to improve the appearance of teeth and gums, such procedures are++ interdisciplinary procedures aimed towards full mouth rehabilitation giving good esthetic and functional clinical outcomes. The clinician should make it clear that crown lengthening surgery for sound teeth is limited by a certain length of teeth, which cannot be exceeded.[6,7]

The esthetic crown lengthening requires gingivectomy procedures to expose the needed additional tooth structure; therefore, a minimum of 2 to 5 mm of keratinized tissue is necessary to ensure the gingival health.[8,9] Moreover, the management of the papilla is another important aspect of the surgery. The interproximal bone should be carefully removed in order to maintain the anatomic structures, so that the interproximal tissues are allowed to coronally proliferate; the papilla should replace the distance from the bone crest to the base of the contact area (about 5 mm or less).[10,11] To have a harmonious and successfully long-term restoration, the distance between the crestal bone and prosthetic margins, which allows recreating the biological width, should be at least 3 mm .[12] Several studies suggest that the biologic width reestablishes itself after crown lengthening procedures, in 6 months.[13-16] For this reason, in this present case report the Placement of definitive prosthesis was carried out after the complete healing of gingiva in order to obtain the aesthetic position of the prosthetic margin.

CONCLUSION

Crown lengthening surgery is a viable option for facilitating restorative therapy or improving esthetic appearance. However, to plan crown lengthening procedure, the whole periodontal condition of the patients and their hygiene habits should be evaluated first. The selection of the appropriate technique depends on the clinician's personal preferences and experiences. Out of the array of different techniques the clinician applies and modifies them depending on the case.

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AN ERA OF BIOMIMICRY: ENAMEL MATRIX DERIVATIVE

Review Article

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Abstract:

A group of leading experts were gathered to discuss what has now been 20 years of documented evidence supporting the clinical use of enamel matrix derivative (EMD). Original experiments led by Lars Hammarstrom demonstrated that enamel matrix proteins could serve as key regenerative proteins capable of promoting periodontal regeneration including new cementum, with functionally oriented inserting new periodontal ligament fibres, and new alveolar bone formation. This pioneering work and vision by Lars Hammarstrom has paved the way to an enormous amount of publications related to its biological basis and clinical use. Twenty years later, it is clear that all these studies have greatly contributed to our understanding of how biologics can act as mediators for periodontal regeneration and have provided additional clinical means to support tissue regeneration of the periodontium.

Keywords: Emdogain, Osteogain, Periodontal Regeneration.

Introduction:

Over 20 years ago, a team of researchers in Sweden including Lars Hammarstrom, Sven Lindskog and Leif Blomloff found that enamel matrix proteins (EMPs) could be utilized as a biological agent capable of periodontal regeneration (Hammarstrom *et al*. 1991, 1992, 1995). These reports originated from previous studies 15 years earlier by Lindskog *et al*. and Slavkin *et al*. reported that certain EMPs (which until then were considered enamel specific proteins) were deposited on the surface of developing tooth roots prior to cementum formation and may play a possible role in cementogenesis (Lindskog 1981a, b, Lindskog & Hammarstrom 1981, Slavkin *et al*. 1989). These observations led to the hypothesis that EMPs may play an integral role in the future differentiation of periodontal tissues prior to cementum formation, and has been the basis of a number of biological and clinical studies thereafter demonstrating that EMPs are proteins secreted by Hertwig's epithelial root sheet capable of promoting periodontal regeneration (Gestrelius *et al*. 1997 Hammarstrom *et al*. 1997, Heij 1997, Zetterstrom *et al*. 1997). The purified fraction derived from the enamel layer of developing porcine teeth was given the working name enamel matrix derivative (EMD) and has been the basis of numerous publications investigating its future use in periodontal regeneration.

The major components of EMD are amelogenins, a family of hydrophobic proteins that account for more than 90% of the total protein content derived from different splice variants and post-secretory regulation, all controlled from the expression of a single gene (Lyngstadaas *et al*. 2009). These proteins self-assemble into supramolecular aggregates that form an insoluble extracellular matrix and function to control the ultrastructural organization of the developing enamel crystallites (Lyngstadaas *et al*. 2009). Other proteins found in the enamel matrix include enamelin, ameloblastin (also called amelin or sheathlin), amelotin, apin and various proteinases (Bartlett *et al*. 2006, Margolis *et al*. 2006). Although these proteins are expressed in less quantity, further investigation has confirmed their valuable roles in various aspects of periodontal regeneration discussed later in this article. The aim of this review article is to provide the reader with four important aspects concerning integral research avenues on EMD over the past 20 years. Lastly, the article will discuss future avenues of research including the five key early studies leading to the development of Osteogain, a new product incorporating EMD with better physicochemical properties for improved protein

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adsorption of EMPs to bone grafting materials.

Biology of Periodontal Regeneration with Enamel Matrix Proteins:

The aim of the first section of this article is to summarize that EMD exerts a significant influence on cell behaviour of many cell types by mediating cell attachment, spreading, proliferation, differentiation and survival, as well as expression of transcription factors, growth factors, cytokines, extracellular matrix constituents and other molecules involved in the regulation of bone remodelling (Bosshardt 2008). Furthermore, EMD has been shown to play a significant role in wound healing favouring soft tissue regeneration and angiogenic activity (Miron *et al*. 2014b)

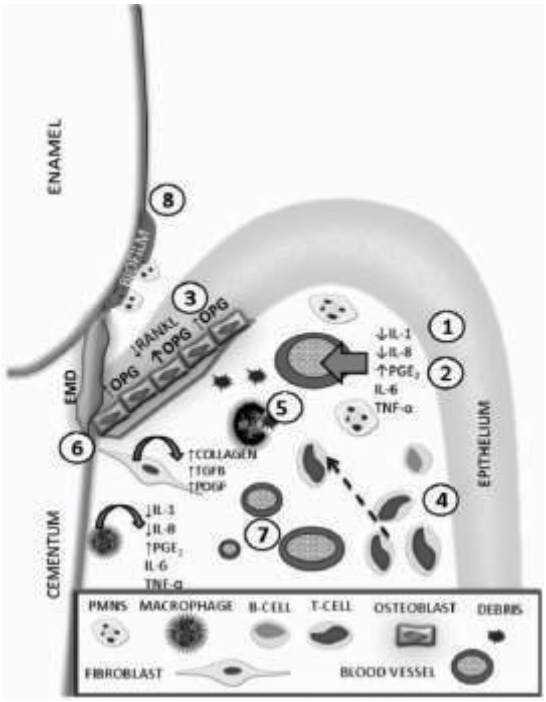

Fig. 1. Diagram depicting inflammation-modifying changes induced by enamel matrix derivative. Following application of EMD, decreased production of IL1b and IL8 (1) and increased levels of PGE2 (2) are observed with little differences in TNF-alpha expression. EMD also substantially changes the OPG/RANKL balance by increasing OPG and decreasing RANKL levels, resulting in diminished osteoclast formation/activity (3). EMD also increases the proliferation and migration of T-lymphocytes (4), which enable tissue debridement by macrophages (5). Furthermore, EMD promotes mesenchymal cell differentiation into hard tissue-forming cells and also improves PDL cell regeneration (6). Microvascular cell differentiation and angiogenesis are improved following EMD application (7) and studies demonstrate that EMD also lowers bacterial numbers (8), resulting in a reduced inflammatory state[1].

Clinical Applications of EMD:

The regeneration of lost periodontium remains the ultimate goal in periodontal regenerative therapy. A large number of techniques, including – but not limited to – root surface modification, bone and bone substitute grafting, GTR, biological mediators, and combination thereof have been employed to fulfil true periodontal regeneration. For each of the above-mentioned techniques, limitations and complications have been associated with their use, and it may thus not be surprising that the search for the ideal biomaterial capable of true periodontal regeneration continues. Over the years, the use of biologics (growth factors) has become more prominent in daily practice. A plethora of documented research from in vitro, in vivo and clinical trials is now available for enamel matrix proteins that now spans over two decades. In this section, we briefly summarize 20 years of clinical research and provide an evidenced-based flow chart for relevant clinical indications for the use of EMD either alone or in combination with a bone grafting material or barrier membrane.

Safety of EMD:

We start by describing the accumulated evidence for EMD used in a clinical setting regarding patient safety. It is important to note that amelogenins are a highly conserved gene across a variety of species including porcine and human. For these reasons, incompatibility or allergic reactions after treatment with EMD have not been reported in any clinical trial that were the direct result of EMD (Zetterstrom *et al*. 1997, Petinaki *et al*. 1998, Nikolopoulos *et al*. 2002, Froum *et al*. 2004). The results from this study further showed that treatment of intrabony defects with EMD resulted in a significant reduction in probing depths (PDs) and gain in clinical attachment level (CAL) (Froum *et al*. 2004). Following these preliminary human studies, the use of EMD has now been utilized for the treatment of a variety of defects in over 60 randomized clinical trials and over 1 million patients worldwide. No patient allergic reaction or adverse event has been reported over this 20 year period.

Clinical outcomes following non-surgical periodontal therapy:

To date, only two randomized, placebo-controlled clinical studies have evaluated the effects of EMD as adjunct to non-surgical periodontal therapy (Scaling and root planing) (Gutierrez *et al*. 2003, Mombelli *et al*. 2005). In both studies, EMD failed to show any beneficial effect. Therefore, it is recommended that EMD is combined with surgical periodontal therapy and a treatment guideline will be later provided highlighting the clinical indications supporting regenerative periodontal therapy with enamel matrix proteins.

Clinical outcomes in intrabony defects using EMD alone:

Heijl *et al*. published the first multicenter, randomized, placebo-controlled study evaluating the effectiveness of EMD for the treatment of intrabony defects. In that study, contra-laterally located intrabony defects were treated with either open flap debridement (OFD) alone or with additional application of EMD (Heijl *et al*. 1997). Following 36 months of healing, the results demonstrated that EMD significantly improved CAL gains and pocket depths. It was also concluded from radiographic analysis that a progressive bone gain following application with EMD amounted to 2.6 mm (66% fill) at the end of the evaluation period when compared to control defects, which showed no significant bone gain (Heijl *et al*. 1997). A subsequent controlled clinical study further showed that OFD in combination with EMD led to a three times greater defect fill when compared to OFD alone (Froum *et al*. 2001). Furthermore, additional benefits following regenerative procedures demonstrated that EMD led to significantly higher soft tissue density in three clinical studies (Trombelli *et al*. 2002, Yilmaz *et al*. 2003, Jentsch & Purschwitz 2008). Tonetti *et al*. investigated the use of EMD in regenerative therapy of deep intrabony defects in 172 patients with advanced chronic periodontitis in 12 centres (Tonetti *et al*. 2002). All patients had at least one intrabony defect of > or =3 mm. The surgical procedures included access for root instrumentation using either the simplified or the modified papilla preservation flap in order to obtain optimal tissue adaptation and primary closure.

After debridement, roots were conditioned for 2 min with a gel containing 24% EDTA followed by application of EMD in the test subjects, whereas omitted in the controls. The results of this trial indicated that regenerative periodontal surgery with EMD offers an additional benefit in terms of CAL gains, PPD reductions and predictability of outcomes with respect to papilla preservation flaps alone (Tonetti *et al*. 2002).

On the other hand, one randomized, doublemasked, placebo-controlled clinical trial failed to demonstrate any advantage for treatment of EMD when compared to placebo for the treatment of intrabony defects (Rosing *et al*. 2005). In 2009, Esposito *et al*. demonstrated in a Cochrane database systematic review that the use of EMD alone after 1 year significantly improved probing attachment levels (1.1 mm) and PPD reduction (0.9 mm) when compared to a placebo or control (Esposito *et al*. 2009). However, the high degree of heterogeneity observed among trials suggests that results should be interpreted with caution (Esposito *et al*. 2009).

Clinical outcomes in intrabony defects using EMD or GTR:

Another series of experiment focused primarily on comparing the use of EMD to GTR using either

non-resorbable or bioabsorbable membranes (Pontoriero *et al*. 1999). The results from these studies demonstrated that the use of EMD or GTR led to significantly comparable results and that both treatments led to substantially higher CAL gains and defect fill when compared to OFD alone for the treatment of single intrabony defects (Heijl *et al*. 1997, Pontoriero *et al*. 1999, Okuda *et al*. 2000, Silvestri *et al*. 2000, Froum *et al*. 2001, Sculean *et al*. 2001b, Tonetti *et al*. 2002, Zucchelli *et al*. 2002). Furthermore, the use of EMD in combination with antibiotics or root conditioning agents was investigated. It was found that the use of EMD in combination with postoperative administration of an antibiotic regimen (i.e. amoxicillin and metronidazole (Sculean *et al*. 2001a,b) or doxycycline (Eickholz *et al*. 2014)), a selective cyclooxygenase-2 inhibitor, or EDTA root conditioning did not additionally enhance periodontal regeneration (Sculean *et al*. 2001a, 2003a, 2006, Parashis *et al*. 2006, Eickholz *et al*. 2014).

Interestingly, a new series of studies have now reported that the effects of EMD may be maximized when minimally invasive surgical techniques (MIST) are applied, thus improving initial wound stability while minimizing patient morbidity (Cortellini & Tonetti 2007, Cortellini *et al*. 2008, Harrel *et al*. 2010). Although these authors show that MIST alone provides similar results to MIST plus EMD, these concepts have been the basis of more focused research in recent years and future investigation aims to predictably restore lost periodontal tissues via minimally invasive surgeries as discussed later in this article. These data indicate that although the use of EMD is generally characterized by improved periodontal regeneration with or without membrane use, the findings from a number of clinical studies have demonstrated that anatomical factors such as defect configuration seem to play an important role in EMD-induced periodontal regeneration. This concept is further discussed within the subsection on clinical indications for EMD.

Clinical outcomes in recession defects using EMD alone or as adjunct to soft tissue grafting:

The use of EMD has been investigated in several controlled clinical studies for the treatment of buccal Miller class I and II gingival recessions by means of coronally advanced flap (CAF). In the majority of cases, the additional use of EMD led to more formation of keratinized tissue and long-term stability of the results compared to CAF alone (Hagewald *et al*. 2002, Cueva *et al*. 2004, Spahr *et al*. 2005, Castellanos *et al*. 2006, Pilloni *et al*. 2006, Cairo *et al*. 2008, 2014) (Fig. 4). One randomized controlled clinical study comparing treatment of Miller class I and II recessions demonstrated that after a healing period of 2 years, complete root coverage could be maintained in 53% in patients treated with EMD versus 23% in the control group (Spahr *et al*. 2005). Comparable results were reported from various other groups for the treatment of either Miller class I or class 2 recession defects with topical application of EMD leading to better results (Cueva *et al*. 2004, Castellanos *et al*. 2006, Pilloni *et al*. 2006, Cairo *et al*. 2008). Another study has compared the use of EMD to a connective tissue graft (CTG) for the treatment of buccal Miller class I and II recessions with CAF (McGuire & Nunn 2003). The results from that study demonstrated very similar results after 1 year for mean root coverage.

A recent consensus conference concluded that at single recessions, the addition of autologous CTG or EMD under CAF improves complete root coverage and may be considered the procedure of choice at maxillary anterior and premolar teeth (Tonetti & Jepsen 2014). Histological evaluation of human biopsies in recession defects was then performed to analyse periodontal regeneration (Heijl 1997, McGuire & Cochran 2003). It was found that the application of EMD during conjunction with CAF resulted in enhanced formation of root cementum, periodontal ligament and alveolar bone while treatment with a CAF and a connective graft or CAF alone (McGuire & Cochran 2003) was characterized by a long junctional epithelium and even signs of root resorption. Comparable results were reported in a multicenter, controlled clinical trial (Rasperini *et al*. 2011). More recently, Roman *et al*. evaluated whether the combination of EMD with a subepithelial connective tissue graft (SCTG) plus CAF would further improve the treatment outcomes of Miller class I and II gingival recessions in 42 patients (Roman *et al*. 2013). Cordaro *et al*. (2012) compared, in a splitmouth

design, CAF with or without EMD for coverage of multiple gingival recession defects with follow-up at 6- and 24 months.

Clinical measurements (recession length, keratinized tissue, probing depth and clinical attachment level) were assessed at baseline and 6 and 24 months after surgery by a blinded examiner. Thus, the accumulated evidence from these studies suggests that the use of EMD for the treatment of gingival recessions utilized alone is capable of enhancing regeneration and improves soft tissue height/ thickness, while the combination with SCTG may further support recession coverage; however, this approach presents great variability in the clinical parameters analysed (Henriques *et al*. 2010, Rasperini *et al*. 2011).

Clinical outcomes with EMD in furcation defects:

The data on the efficacy of the use of EMD in the regenerative therapy of furcation defects are still limited (Sanz *et al*. 2015). In a multicentre, randomized, controlled, split-mouth, clinical trial of mandibular buccal class II furcation defects, a total of 45 patients with 90 comparable defects on contra-lateral molars were treated with either EMD or GTR (Jepsen *et al*. 2004, Meyle *et al*. 2004, Hoffmann *et al*. 2006). At 8 and 14 months, both treatment modalities led to significant clinical improvements. The EMD group showed significantly better results with regard to the primary outcome reduction in horizontal furcation depth as assessed during a 14 months re-entry procedure. Enamel matrix derivative demonstrated a mean reduction in horizontal probing bone level of 2.6 + /- 1.8 mm, and the guided tissue regeneration-treated sites showed a horizontal probing bone level reduction of 1.9 + /- 1.4 mm. Furthermore, with regard to patient-centred outcomes, postoperative wound healing as assessed by questionnaires on pain and swelling was superior following EMD application.

In proximal class II furcation defects, the use of EMD led to a higher conversion rate into class I when compared to OFD alone although complete furcation closure was only rarely found (Casarin *et al*. 2010). In another trial on the treatment of proximal class II furcation defects, the effects of OFD + hydroxyapatite (HA)/b-tricalcium phosphate (b-TCP) filling, or OFD + HA/b-TCP + EMD were evaluated (Peres *et al*. 2013). No significant difference was reported between treatment modalities 6 months after therapy (Peres *et al*. 2013). In summary, the limited data on the effects of EMD in regenerative furcation therapy is encouraging, however, more evidence from further well-controlled studies is clearly needed.

Future Perspectives:

Although EMD has been utilized for a variety of clinical applications over the past 20 years, research concerning its clinical use as well as basic research to further understand its properties and biological effects are still ongoing. This section is divided into the following six subsections: (1) future use of EMD in minimally invasive surgeries, (2) use of EMD for the treatment of supra-alveolar type defects, (3) possible use of EMD for the treatment of periimplantitis and mucosal recessions around implants, (4) characteristics of various fractions of EMD, (5) development of Osteogain, a new product incorporating EMD with better physicochemical properties for bone grafting material adsorption and (6) final remarks.

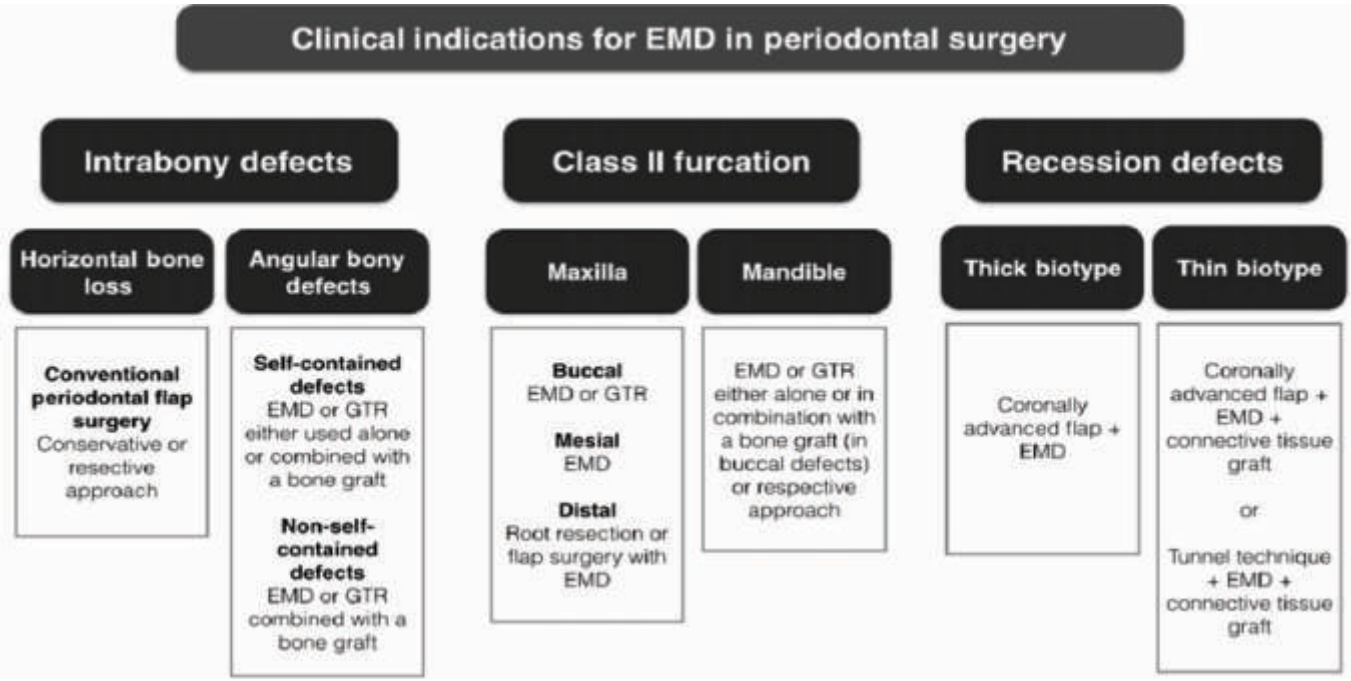

Fig. 2. Flow Chart – clinical indications for the use of EMD in periodontal surgery. Intrabony defect, furcation defect and recession defect regeneration have all demonstrated long-term clinical improvements following treatment with EMD in certain clinical indications[1].

Development of Osteogain, a new carrier system for EMD:

The clinical combination of EMD with a bone grafting material has been one of the most widely used biomaterial combinations utilized for the treatment of intrabony defects. While the majority of studies combining EMD with a membrane do not lead to additional improvements, the use of EMD with a bone grafting material has demonstrated additional clinical advantages. While a recent systematic review and meta-analysis found that the combination of bone grafting material + EMD led to statistically significant better outcomes, large variability between studies were also reported (Lekovic *et al*. 2000, Velasquez-Plata *et al*. 2002, Zucchelli *et al*. 2003, Gurinsky *et al*. 2004, Kuru *et al*. 2006, Guida *et al*. 2007, Trombelli & Farina 2008).

In vitro results have also indicated variability in gene expression when primary human osteoblasts and PDL cells were cultured on various bone grafting materials in vitro with or without EMD thus raising the concern that protein function, stability or adsorption may be responsible factors in the gel-delivery system currently utilized for EMD Recently, the adsorption of amelogenins to bone grafting materials under various conditions was investigated (Miron *et al*. 2015a). These results confirm that large variability existed between the adsorption of amelogenins to different bone grafting material.

More importantly, it was found that the commercially available EMD-gel (Emdogain) adsorbed significantly less protein when compared to a liquid formulation of EMD. These preliminary findings led to a series of five subsequent studies over the past 3 years during the developmental phases of Osteogain, a new product incorporating EMD with better physicochemical properties specifically designed for combining EMD with bone grafting materials.

Conclusion:

It remains hard to believe that over 20 years have now passed since enamel matrix derivative was first introduced as a regenerative agent for periodontal tissues. Equally as surprising, it remains one of the only biomaterials still available for clinical use capable of histologically demonstrating true periodontal regeneration with new cementum formation, periodontal ligament and alveolar bone along with inserting Sharpeys fibres spanning the periodontal apparatus. It is clear that over the years, we have learned a great deal regarding the biological roles of specific

enamel matrix proteins and future investigation is constantly underway to further characterize their effects on cell and tissue behaviour.

It also becomes clinically important to further investigate the use of EMD in both carrier systems described to determine if regenerative outcomes can be even further improved by slight modifications in EMD-carrier systems or through minimally invasive surgeries. During these 20 years, over 900 publications documenting the use of EMD for a variety of in vitro and in vivo studies as well as numerous clinical trials. EMD has remained one of the gold standards for periodontal regeneration using biologics and it remains of interest to discover how the next 20 years of intensive research will further improve EMD clinical outcomes.

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3D-Bioprinting a world to come for Periodontics

Review Article

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ABSTRACT

Dentistry is recently coming to the terms of use of technology and tech-savvy dentists, who nowadays use smart devices to make their life easier. Nowadays, worldwide demand for the organ replacement or tissue regeneration is increasing steadily. Periodontal Regenerative engineering is the convergence of developmental biology, stem cell science and engineering, materials science, and clinical translation to provide tissue patches or constructs for diseased or damaged organs. Various methods have been introduced to create tissue constructs with clinically relevant dimensions. Among such methods, 3D bioprinting provides the versatility, speed and control over location and dimensions of the deposited structures. 3D Bioprinting is a pioneering technology in the field of regenerative medicine that enables the fabrication of living tissues using the living cells by the printing process. 3D printing was initially conceived by Charles Hull in 1986. Hull's concept was based on the idea that successive layers of a base material could be applied on top of each other to 'print' object. Uses of 3D bioprinting in periodontology include bio-resorbable scaffold for periodontal repair and regeneration, socket preservation, bone and sinus augmentations procedures, guided implant placement, peri-implant maintenance, and implant education.

Keyword
Bioprinting, scaffolds, periodontal regeneration

INTRODUCTION :

Technology has slowly and steadily paved its way into dentistry. Researchers are constantly working to integrate technology into dentistry. Of all the latest technological innovations in dentistry, the most talked-about innovation is three-dimensional (3D) bioprinting. 3D Bioprinting is a cutting-edge technology in the field of regeneration that facilitates the fabrication of multiscale, biomimetic, multi-cellular tissues with highly complex tissue microenvironment, intricate cytoarchitecture, structure-function hierarchy, and tissue-specific compositional and mechanical heterogenicity (Vijayavenkataraman S, *et al.*, 2018). Since, periodontitis has become more prevalent disease among the population; periodontal regenerative procedures are needed to restore a normal healthy periodontium.[1] The 3D bioprinting technology allows the fabrication of such structures, which use several biomaterials and various bioprinting methods (Murphy SV and Atala A, 2014). This review article discusses about 3D bioprinting and provides little information about the technology behind 3D printers. It also throws light on using various bioprinting strategies and materials most often used in 3D printed scaffolds for periodontal regeneration.

History of 3D Bioprinting

Bioprinting is a technique that is used to design complex biological structures using bioinks. Before gaining an insight on the 3D bioprinting of the periodontium, it is important to understand the evolution of 3D bioprinting in the medical field. After the invention of Stereolithography by Hull CW in 1983, the concept of printing human organs was developed (Hull CW, 1984).

Earlier, the machine discovered by Hull used UV lasers to engrave the layers of acrylic into shapes, which are then stacked to form objects. The major drawback was that the printer uses written codes to engrave the acrylic, so only simple shapes were created. Later in 1986, Hull discovered the 3D technology of printing and also designed the materials that go into the printers (Hull CW, 1984). In the 1990s, the 3D systems were used to fabricate dental implants and custom prosthetics using materials such as nanocomposites, blended plastics and powdered metals.

The researchers at Wake Forest Institute for Regenerative Medicine [WFIRM] made a synthetic scaffold of a human bladder using the 3D bioprinting technology in the year 2000 (Atala A, 2001). In the process of synthesis of the scaffold, they used the recipient's host cells to overcome the

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problem of host rejection. After 10 years of implantation, the patient had no serious complications. In 2002, again at WFIRM, a team of scientists led by Professor Anthony Atala undertook a bio- printing project of a miniature functional kidney capable of filtering blood and producing urine in an animal model. Then in 2003, Thomas Boland, a scientist from University of El Paso, invented his own designed 3D bioprinter, which uses bioinks to print live tissues (Mironov V, *et al.*, 2003). In 2004, Dr. For- gacs made his debut with his own bioprinter, which during his uprising caused a great change in the scientific community.[2] It was the first device that allowed 3D direct biodegradation i.e., using live cells without the need to build scaffolding (Jakab K, *et al.*, 2004).

In 2006, Noble Prize winner Dr. Shinya Yamanaka discovered that mature cells acquired from cultures can be reorganized again to a stem cell state (Takahashi K and Yamanaka S, 2006). This created a revolution in the field of regenerative medicine and also in 3D bioprinting. In 2009, one of the first commercial Bioprinters from Organovo-NovoGen MMX was created. They aimed at "scaffold-free" printing process. In 2010, Orga-novo-the Bioprinting Company printed the first blood vessel and today the revolution continues on.

Three-dimensional bioprinting

As the term bioprinting implies, that process involves the printing of living tissues. This is done using a 3D bioprinters that uses a computer-aided design model. In this model bioinks are layered through an additive manufacturing process to create tissues that mimic the natural tissues (Murphy SV and Atala A, 2014).

Bioprinting Approaches

The approaches in 3D Bioprinting are: Biomimicry, Autonomous self-assembly and Mini-tissue building blocks.

Biomimicry: This is one of the prime approaches in bioprinting, where the structures are created similar to the natural tissues that are found in humans. They are useful in making similar cellular as well as extracellular tissues as found in humans. It involves the synthesis of biological tissue using the synthetic materials that mimic biological functions (Atala A and Yoo J, 2015).

Autonomous self-assembly: This is the second approach in bioprinting. The basic idea of self-assembly is derived from the concept of embryogenesis and organogenesis where the cells proliferate to their tissues of interest based on signaling molecules, creating their own extracellular matrix as a foundation for the cell replication. The main advantage is that it is scaffold-free. Some of the shortcomings faced by scaffold-based systems are immunogenicity, maladaptation, etc (Atala A and Yoo J, 2015).

Mini-tissue building blocks: This is the third approach in bioprinting. This includes both the techniques of biomimicry and autonomous self-assembly, where the structures are constructed from mini functional tissue components, thereby organizing them into a larger structure of required characteristics (Thomas D and Singh D, 2019).

Types of 3d bioprinting

3D bioprinters are the machines that operate through various mechanisms such as Direct light processing, Fused deposition modeling, Inkjet printing, Extrusion based printing and Laser assisted printing were invented . In this review, we discuss only on the most widely used bioprinter technologies in current practice. Fig1

Inkjet-based bioprinting: This was the first attempt in bioprinting. In this method of bioprinting, the data from computer is fed to printer and it reproduce onto the substrate using ink drops as a non-contact technique (Murphy SV and Atala A, 2014). These printers are of three types-thermal, piezoelectric and mechanical. The cartridge is filled with bioink and during the process they are forced through microfluidic reservoir to an output nozzle. The initial problem involved during the printing process was that the cells died during printing due to immediate drying out of the substrate. This was overcome by encapsulating the cells in a highly hydrated polymers-hydrogels[3]. In thermal inkjet printers, the printhead is heated by an electrical heat which produces pressure to force the bioink from the nozzle (Cui X, *et al.*, 2010). In piezoelectric inkjet printers, when a voltage is applied to the piezoelec- tric material it changes shape and produces acoustic waves to force the bioink into

droplets at regular intervals (Visser J, *et al.*, 2013). In mechanical inkjet printers, application of pressure forces the bioink from the nozzle (Tekin E, *et al.*, 2008).

Micro-extrusion bioprinting: In this method, the printer comprises of a fluid dispensing system and an automatic robotic system for the process of extruding the liquid and bioprinting the structure. This sys- tem comprises of either a pneumatic or screw-driven or piston or a solenoid-based system. The piston and the screw driven systems works mechanically to exhibit pressure necessary to eject the bioink whereas the pneumatic system employs a pressured air for the process (Visser J, *et al.*, 2013). This is a promising technique to create biomimetic struc- tures (Chang R, *et al.*, 2008). The main advantage of this process is its ability to print using bioinks with high cell densities (Murphy SV and Atala A, 2014). The drawbacks are its limited resolution; require high pressure for extrusion of low viscous bioinks which can lead to cell death (Nair K, *et al.*, 2009).

Laser-Assisted Bioprinting (LAB): In this method a laser is used for deposition of bioink on the substrate. The laser pulses are directed through a 'ribbon' containing bioink and this ribbon is supported by titanium or gold layer which absorbs and transfers energy to ribbon (Gruene M, *et al.*, 2011). The bioink and cells are suspended on bottom of the ribbon and when vaporized by laser pulse, they create a high pressure bubble which exerts a pressure on the biomaterial thereby forcing the liquid towards the substrate. The Laser Assisted Bioprinting (LAB) is a scaffold free technique; deposits biomaterials at high resolution. Since, it is a nozzle free method; they eliminate the drawback of biomaterial clogging. It is well-suited for bioinks with varying range of viscosities. The main disadvantage of LAB is that the presence of metallic absorbing layers produces metallic residues on the structure formed; also LAB is very expensive (Murphy SV and Atala A, 2014).

Bioinks

As bioprinting is the process that involves printing of living tissues, the printer essentially requires a bioink to print the tissues. Therefore, bioinks are materials that are required to print the living tissues. The important properties of bioink should be biocompatible, non-toxic, printable, able to withstand mechanical stresses, good shape memory, ability to get nourishment from cells and enhance the metabolic activities of the cells (Gopinathan J and Noh I, 2018).The bioinks are usually comprised of natural polymers, synthetic polymers or combination of both[4].

The living cells used in 3D printing require specific aqueous environment to maintain the cellular functions at appropriate pH, for key nutrients and oxygen diffusion, to create an extracellular matrix, non-toxic environment and to allow printed cells to form new tissue. Such environment is provided by the materials known as hydrogels (Chimene D, *et al.*, 2020). Hydrogels are made from extracellular matrix components like collagen, hyaluronic acid that enables stem cell growth. Since, hydrogels are in liquid polymer state, they are insuffi- cient to support successive cell layering during the printing process; to overcome these limitations, newer techniques are used to strengthen the hydrogels such as nanocomposites, supramolecular bioinks, interpenetrating networks, polymer functionalization and thermoplastic reinforcement (Shafiee A and Atala A, 2016).

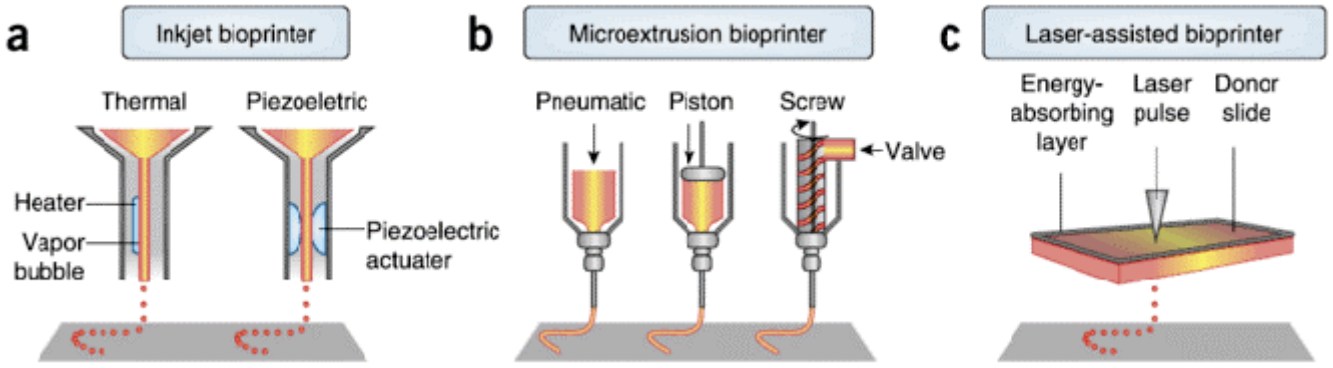

FIG 1 :Methods of 3D bioprinting-1.1) Thermal and piezoelectric mediated inkjet printer, 1.2) Micro-extrusion printer, 1.3) Laser-as- sisted printer (Malda J, *et al.*, 2013)

Steps in bioprinting

Pre-bioprinting: It is the first step in the process where the structure to be printed is designed and modeled as a 3D structure using the Com- puted Tomography (CT) and MRI scans. Every fine detail is recorded and tomographic reconstruction done on the images so that it is print- ed in a layer by layer fashion (Williams J, 2014) Later, the bioinks are prepared by isolation from living tissues and they are allowed to multiply.

Bioprinting: It is the printing process where the designed structures has to be printed using the printers. Here the bioinks are introduced to the printer cartridges and based on the digital model the cells are accumulated in a layered fashion (Ozbolat IT, 2015).[5]

Post-bioprinting: Post-bioprinting process involves maintaining mechanical integrity and function of the 3D printed structure (Wil- liams J, 2014). They control the remodeling and the growth of tissues by sending signals and recently, evolution of bioreactor technologies have caused rapid tissue maturation, vascularization of tissues and in- creased the survival rate of the transplants (Obregon F, *et al.*, 2015). Depending on the type of tissue, the bioreactors differ. Fig2,Fig3

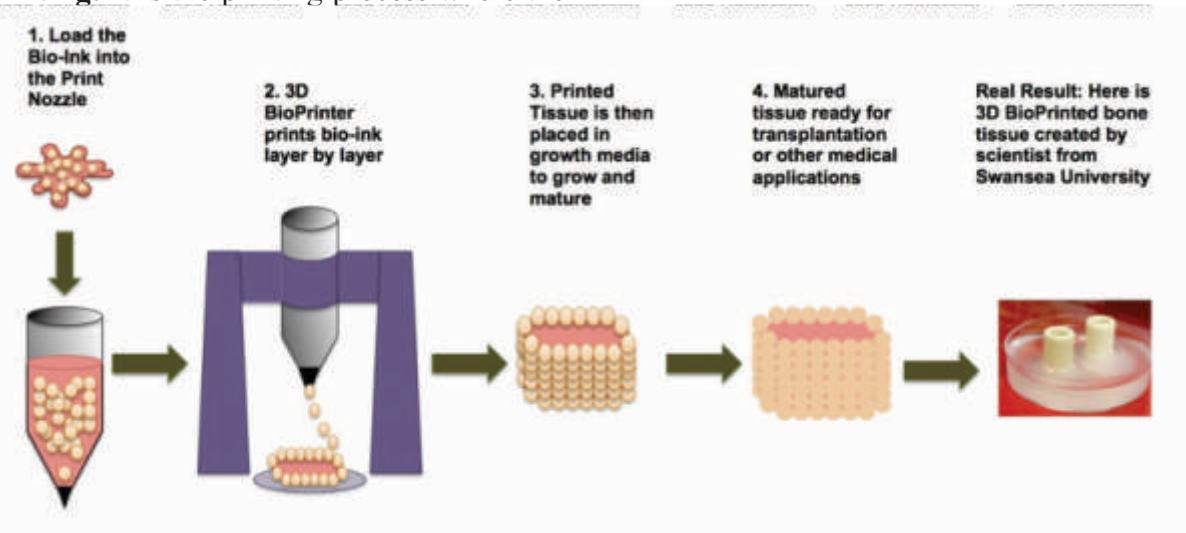

FIG 2 : Represents the layering of cells during the process of bioprinting (Yeong WY and Chua CK, 2014)

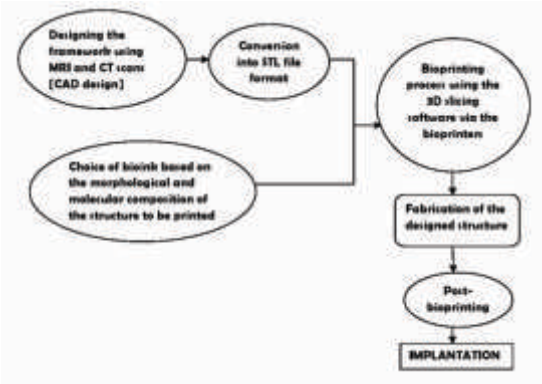

FIG3 :The flowchart depicts the individual processes that are involved in the bioprinting process

Applications of 3d Bioprinting

In dentistry, there is emerging use of this 3D bioprinting technology for its diverse applications and it proves to provide successful treatment options for the patients (Patel R, *et al.*, 2017). In this article, we briefly discuss on the periodontal complex regeneration in the field of periodontology.

In periodontology, the periodontal tissues have a complex organization which requires multilayered

biomaterial constructs to restore the structural and functional integrity at the bone-ligament interface (Vaquette C, *et al.*, 2018). Periodontitis, an inflammatory disease in response to periodontal pathogens affects the periodontium causing destruction of the tissues (Gaviria L, *et al.*, 2017). Therefore, the need for periodontal regeneration procedures is increasing. Hence, many clinical researches are ongoing in the field of 3D bioprinting to restore the lost periodontal structures for the individuals suffering from periodontitis. The periodontium structures are quite complex in morphology and they require special technical knowledge in the printing process.[6]

However, the use of additive manu- facturing technology enables printing of structures with good mechanics and accurate porosities as they enable the use of line spacing, line thickness and resolution changing features (Rasperini G, *et al.*, 2015).

In a case study done by Rasperini G, et al they used a 3D printed bioresorbable scaffold in treatment of a periodontal defect and this was the first application of a personalized 3D printed scaffold in the field of periodontics (Asa'ad F, *et al.*, 2016). But to our catastrophe, this case was a failure at the end of 13th month, which led to surgical removal of the scaffold. This was because the researchers used only PCL which caused wound dehiscence due to slow tissue degradation rate and led to unsuccessful tissue regeneration due to its inferior cell affinity (Aus-enda F, *et al.*, 2019).[7] Therefore, the scientists came to a conclusion that they should use bioinks with faster resorption rate or the PCL should be incorporated with long standing devices like the titanium screws (Carrel JP, *et al.*, 2016). But this is strongly believed that this study has paved the way for further research in field of oral regenerative medicine for improved personalized 3D bioprinted structures.

The main aim of researchers lies in the production of multiphasic scaffolds for periodontal regeneration which includes the periodontal ligament, cementum and alveolar bone. After several studies, the au- thors advocated the use of variety of biomaterials other than PCL for periodontal regeneration using animal models. In a study done by Ras-perini G, *et al.*, they suggested the use of bioceramics to be successful in sinus and bone augmentation procedures (Ausenda F, *et al.*, 2019). The research work by Carrel JP, *et al.* in a sheep animal model for ver- tical bone augmentation procedure used a 3D printed scaffold made of biphasic ceramic-hydroxyapatite and alpha-tricalcium phosphate and compared it to the bovine bone and particulate beta-tricalcium phosphate. The biphasic ceramic was found to be superior and they provided good mechanical integrity without the need of membranes (Sahranavard M, *et al.*, 2020). [8]Use of bio ceramics are recommended for alveolar bone regeneration and for regeneration in non-stress bearing zones, collagen can be used as the biomaterial of choice (Ausenda F, *et al.*, 2019). Chitosan is said to one of the best bioink in regenerative procedures as they are biocompatible, biodegradable, anti-bacterial and hydrophilic in nature (Tayebi L, *et al.*, 2018).[9] In a recent study by Tayebi L, *et al.*, they 3D printed a membrane made of gelatin, elastin and sodium hyaluronate which is found to be biocompatible and bioresorbable and also provided mechanical integrity and required surgical characteristics such as suturability for it application in guided tissue regeneration procedures (Amada P, *et al.*, 2018).[10] Therefore, using the techniques of 3D bioprinting and the availability of wide of range of biomaterials it is more fascinating to create innovations in the periodontal regeneration procedures today.

Shortcoming of 3d bioprinting

Though 3D bioprinting technology is available for many long years, the expensiveness of the 3D bioprinters, high energy consumption, the operation and maintenance cost, clearance from ethical board as it advocates the use of cells and also the requirement of a trained operator have shown to be a barrier for its development (Kahl M, *et al.*, 2019; Rider P, *et al.*, 2018; Kačarević ŽP, *et al.*, 2018). [11]

Conclusion

3D Bioprinting has caused a revolution in the field of regenerative medicine. The WHO has suggested that by 2020, 10% of the global population is affected by the periodontitis, where most of them require periodontal regeneration

procedures. Hence, this use of latest 3D-bio-printing technology seems to improve the regeneration of periodontal tissues facilitating a good oral health status for the patient. Since, there are drawbacks in any technology; they have to be overcome by variety of treatment alternate methods and strategies. Further, researchers in Germany have found an ultra-low cost 3D desktop bioprinters which is easily portable and capable of printing tissues at low expenses, which creates a sense of motivation among the clinicians to use this technology in their routine practices. Many clinical researches and case studies have to be done in 3D-bioprinting of the periodontium using the available biomaterials and latest bioprinting methods to regenerate the periodontium. Being a promising technology in regenerative medicine, it will revolutionize in the field of periodontology hopefully by new researches and studies further .

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Diabetes and Periodontitis: A two-way Relationship

Review Article

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Abstract

Diabetes mellitus and periodontitis are both common, chronic diseases. It is generally accepted that the inter-relationship between diabetes mellitus and periodontitis is a two- way relationship, i.e. the presence of one condition tends to increases the risk and severity of the other, and vice versa. Mechanisms for this two-way relationship are largely unknown. Hyperlipidemia is a group of disorders characterized by an excess of lipids in the bloodstream. Hyperlipidemia increases the risk of diabetes and peridontitis. On the other hand, diabetes and periodontitis could result in hyperlipidemia. The purposes of this review were: (1) examine the two-way relationship between diabetes mellitus and periodontitis; (2) discuss the potential synergistic interactions of hyperlipidemia to both diabetes mellitus and periodontitis; and (3) explore the mechanisms through which hyperlipidemia affects the development of both diseases. The effects of hyperlipidemia on insulin secretion and pro-inflammatory cytokines production (TNF-a, IL-1b) play an important role on the path- ogenesis of diabetes and periodontitis. The purpose of this article is to express the two way relationship between diabetes and chronic periodontitis.

Key words: Diabetes mellitus, Hyperlipidemia, Periodontitis

Introduction

Diabetes mellitus is a group of metabolic disorders characterized by hyperglycaemia caused by defects in insulin secretion, insulin action, or both. There are two main forms of diabetes. Type 1 diabetes is caused by destructive autoimmune process of the insulin-producing pancreatic b cells leading to insufficient insulin secretion. A more common form, type 2 diabetes, is due to a combination of insulin resistance and impaired insulin secretion. In adults, about 90–95% of all diagnosed cases of diabetes are type 2 diabetes. Diabetes mellitus is associated with a range of complications including cardiovascular disease, neuropathy, nephropathy, retinopathy, bunions, osteoporosis, Alzheimer's disease, and cancer. During the last two decades, periodontal disease has been recognized as one of the "classic" complications of diabetes.

Periodontitis was traditionally considered to be a localised oral infection that only affected the periodontium, but is now regarded as a chronic localised infection of the oral cavity that can trigger the host inflammatory immune response at both local and systemic level, and can also be a source of bacteraemia. Nowadays, it is known that periodontitis affects the pathogenesis of certain systemic diseases, and that it can increase their risk of presentation, which has led to the emergence and development of "Periodontal Medicine".

The association between diabetes mellitus and periodontitis has been reported in numerous studies. It is generally accepted that the inter-relationship between diabetes mellitus and periodontitis is a two-way relationship.

In this review, we update studies on the two-way relationship between diabetes mellitus and periodontitis. As hyperlipidaemia is associated with both diabetes mellitus and periodontitis, we attempt to explore the mechanistic role of hyperlipidaemia in the interrelationship between these two highly prevalent chronic inflammatory disorders.

Effect of Diabetes Mellitus and Periodontitis

The relationship between glycaemic control and periodontitis was reported in both cross-sectional and longitudinal studies. Though some studies failed to observe the association between the degree of glycaemic control and periodontitis, most studies generally support good glycaemic control decreases the severity of periodontitis, while poor glycemic control increases the risk of periodontitis. A study in Japan examined the effect of improved glycemic control by intervention therapy on periodontitis in type 2 diabetic patients. Effective glycemic control with reduced HbA1c over the 6-month period improved BOP (bleeding on probing) lesions without periodontal treatment. On the other hand, other studies have reported that

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diabetic patients who had poor glycemic control had increased risk of deep periodontal pockets, severe attachment loss, and progressive bone loss, compared to well-controlled diabetic patients.

It is generally accepted that production of advanced glycation end products (AGEs) is one of the mechanisms by which diabetes appears to affect the periodontal condition. AGEs are irreversible products of non-enzymatic glycation and oxidation of proteins and lipids that accumulate in diabetic plasma and tissue. Binding of AGEs to the cell membrane receptor, RAGEs, activates host cells such as monocytes/macrophages and endothelia cells, resulting in release of pro-inflammatory cytokines such as IL-1b, TNF-a and IL-6. Exacerbated inflammatory response triggered by AGEs contribute to destruction of gingival tissues and tooth supporting bone. On the other hand, blockade of RAGEs significantly suppressed alveolar bone loss in diabetic mice infected with periodontal pathogens. In humans, it has been shown that subjects with both type 2 diabetes and periodontitis had higher expression level of RAGEs compared to that in non-diabetic subjects with periodontitis.

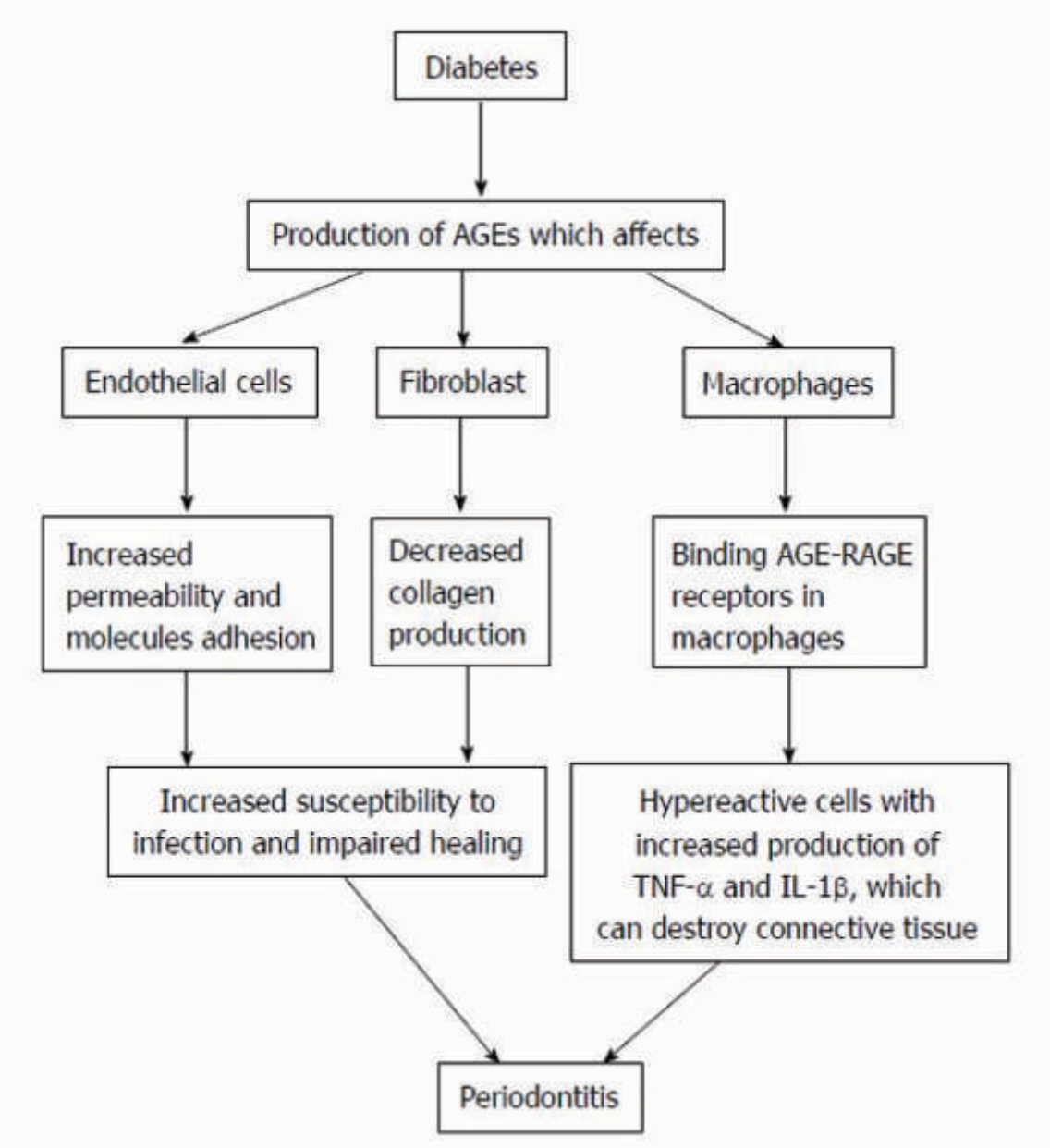

Fig. 1 Effects of diabetes on periodontium

Impact of Periodontitis on Diabetes Mellitus

There is a two-way relationship between diabetes mellitus and periodontitis, i.e. not only is diabetes a risk factor for periodontitis, but periodontitis could adversely affect diabetes mellitus. As inflammation can promote insulin resistance and dysregulated glycemia, it is hypothesized that periodontitis may affect glycaemic control in diabetic patients. Data from the longitudinal study of residents of the Gila River Indian Community revealed that severe periodontitis at baseline was associated with an increased risk of poor glycaemic control (HbA1c > 9%) during a 2-year follow-up period.

However, even hyperglycaemia may manifest its low grade systemic inflammation in periodontium and the causal impact of periodontal infection on incidence of diabetes is still uncertain. Periodontal therapies, including scaling, root planning, localized gingivectomy, dental extractions, were all shown the potentials to improve glycaemic control.

Mechanisms for the impact of periodontitis on diabetes mellitus have been explored by experimental studies, which suggest that pro-inflammatory cytokines may involve in the development of diabetes mellitus when periodontitis presents. In periodontitis, concentrations of pro-inflammatory cytokines TNF-a, IL-1b, IFN-g increased not only in periodontal tissues, but also in serum.

Though increase of serum pro-inflammatory cytokines may related to the spill over from local periodontal tissues, such increase is more like a reflex of host response during hyper-inflammatory state.

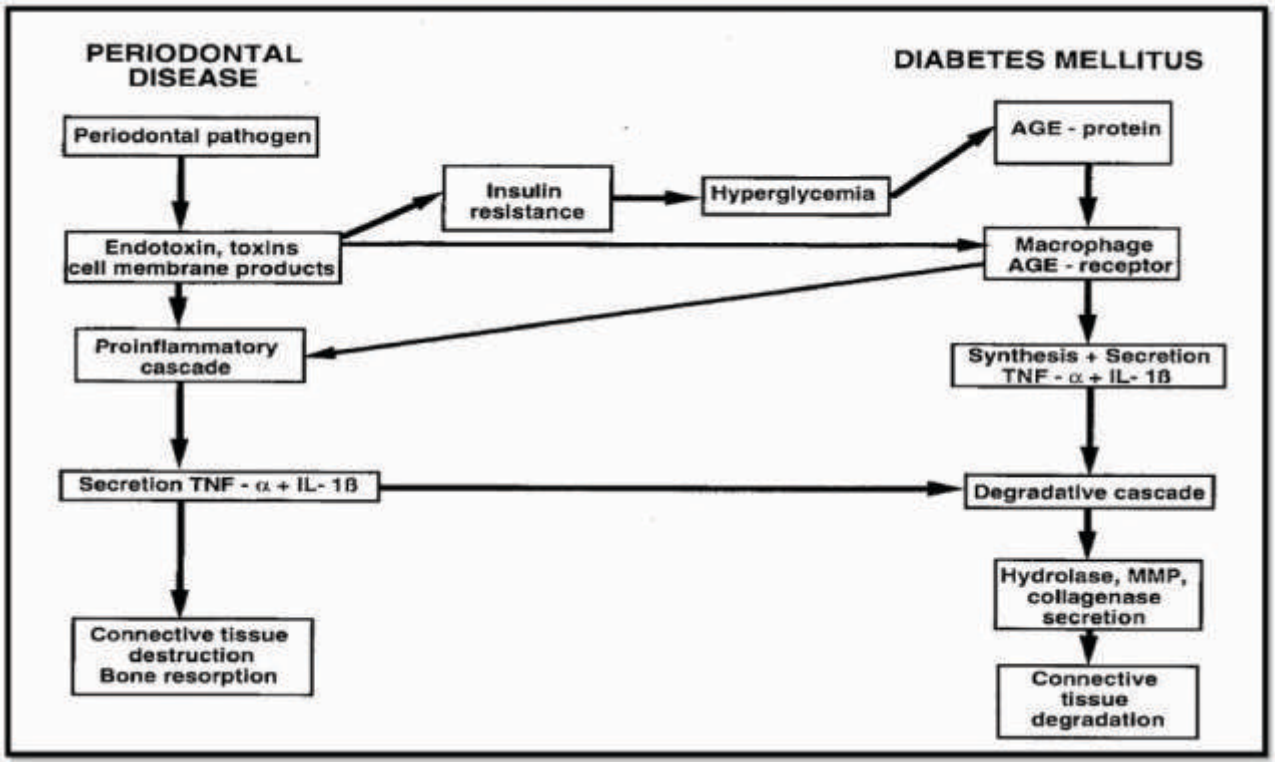

Fig 2 Two way relationship between periodontal disease and diabetes

Diabetes Mellitus and Hyperlipidemia

Hyperlipidemia is a group of disorders characterized by an excess of lipids in the bloodstream. Patients with hyperlipidemia often manifest marked elevations of low-density lipoprotein (LDL), triglycerides (TRG), and omega-6 free fatty acids.49 Elevation of omega-6 polyunsaturated acids in turn contributes to formation of LDL/TRG. Hyperglycemia is often accompanied by hyperlipidemia in both type 1 and type 2 diabetes. A number of studies have reported increased total cholesterol, TRG, LDL, and decreased HDL in diabetic patients.

The nature of fatty acids within the phospholipid bilayer determines the physical properties of membranes due to their effects on receptor responses and operation of membrane- bound enzyme. In diabetic patients, the conversion of omega-6 polyunsaturated fatty acids to active metabolites is impaired because of the inhibition of 6-desaturase enzyme activity caused by insulin deficiency. Cellular functions are affected as less active metabolites are produced, which are key components of cell membrane structure. Like hyperglycemia, hyperlipidemia is also thought to be responsible for impairments in a variety of cell types and development of some diabetic complications.

Large amount of pro-inflammatory cytokines, e.g. IL-1b and TNF-a, are released in diabetic patients due to an exaggerated inflammatory response to Gram-negative bacterial lipopolysaccharide (LPS), especially Porphyromonas gingivalis LPS. Evidences suggest that hyperlipidemia may be related to the hyper-responsive monocytic phenotype in diabetic patients. It has been shown that a 4-week high-fat diet in mice chronically increased plasma LPS concentration two to three times with the increase of the weight of adipose tissue. Cytokines exhibited several biological functions that are related to periodontitis, diabetes, and lipid metabolism: (1) high levels of pro-inflammatory cytokines in periodontal tissues are associated with the risk of periodontits because of their tissue destructive effects. Cytokines are associated with insulin resistance and the risk of diabetes. Cytokines exert effects on lipid metabolism by affecting production of other cytokines, resulting in elevated levels of free fatty acid, LDL, and TRG. The serum lipid elevation effects are due to increased hepatic TRG production and/or decreased TRG clearance.

Periodontitis and hyperlipidemia

Similar to the animal studies, a number of human studies support the positive association between periodontitis and hyperlipidemia. Patients with periodontitis had higher levels of TRG, total cholesterol, and LDL than periodontally healthy controls. On the other hand, patients with hyperlipidemia had higher values of periodontal parameters compared to normolipidemic individuals, indicating that patients with hyperlipidemia are more prone to periodontal disease. Taken all together, current evidences suggest that the association between periodontitis and hyperlipidemia is a bi-directional relationship.

Obesity has a deleterious effect on the lipid profile, leading to increased levels of TRG, total cholesterol, and LDL. The effects of obesity on periodontits have been reported in animals and humans. In animals with periodontits, greater alveolar bone loss has been observed in obese mice and rats than non-obese animals. In humans, an association between obesity and periodontitis was first reported by Saito et al. The study enrolled 241 apparently healthy dentulous Japanese subjects, among them had periodontitis, 145 had no periodontitis. The adjusted relative risk of periodontitis was 3.4 in persons with a BMI of 25–29.9 kg/m2 and 8.6 in those with a BMI 30 kg/m.

The hyperlipidemia axis uniting diabetes and periodontitis and its clinical implications

The two-way relationship between diabetes mellitus and periodontitis has been well documented. Hyperlipidemia is a common risk factor for both diabetes and periodontits. Current evidence suggests a bidirectional relationship between hyperlipidemia and diabetes, and between hyperlipidemia and periodontitis. Thus, hyperlipidemia may serve as a possible mechanistic link for the association between diabetes and periodontitis.

A proposed model linking hyperlipidaemia to diabetes and periodontitis is presented in Fig.3. Diabetes may affect periodontitis by the following potential mechanisms: diabetes is characterized by hyperglycaemia, which is associated with the increased levels of FFA, LDL, and TRG. In hyperlipidaemia status, the production of serum pro-inflammatory cytokines, e.g. IL-1b and TNF-a, are increased due to an exaggerated inflammatory response to Gram-negative bacterial lipopolysaccharide (LPS), especially P. gingivalis LPS. Hyperglycaemia can also directly induce the production of pro-inflammatory cytokines by activating the pro-inflammatory transcription factor nuclear kB (NF-kB). Elevated levels of serum pro- inflammatory cytokines result in

similarly increased levels of pro-inflammatory cytokines in gingival crevicular fluid be- cause this fluid is a serum transudate. Furthermore, the release of pro-inflammatory cytokines from host cells in periodontal tissues is induced by AGE/RAGE pathway during the inflammatory response, leading to destruction of gingival tissues and tissue supporting bone. On the other hand, periodontitis may affect diabetic status via the following potential mechanisms: in periodontitis patients, serum pro-inflammatory cytokines, IL-1b and TNF-a, are significantly increased due to a cytokine cascade caused by bacteraemia and/or endotoxemia. Cytokines induce the elevation of serum levels of FFA, LDL, and TRG by increasing hepatic TRG production and/or decreasing TRG clearance. Infection with P. Gingivalis or other Gram-negative periodontal pathogens may directly increase serum levels of FFA, LDL, and TRG, which has been reported in animal studies. High levels of lipids and/or pro-inflammatory cytokines contribute to insulin resistance by inhibiting insulin signalling or destruction of pancreatic b cells, and increase the risk of diabetes.

Due to the two-way relationship between diabetes and periodontitis, patients with diabetes or periodontitis need to be informed of the increased risk of another disease. As has been shown in this review, hyperlipidemia interacts with diabetes and periodontits, and increases risks of both diseases. Thus, for the clinical management of diabetes and periodontitis, effects of hyperlipidemia need to be considered as part of the treatment regimes. Efforts to develop therapeutic strategies aimed at limiting hyperlipidemia should be advocated. It has been well documented that diet and exercise are both effective in the management of hyperlipidemia. Key recommendations for the management of hyperlipidemia include: reduce intake of saturated fats and trans fats; increase intake of poly- and monounsaturated fats, omega-3 fatty acids, soluble fibre, soy protein, plant stanols and sterols; follow a Mediterranean diet, and regular aerobic exercise. Besides diet and exercise, other treatment strategies aimed at limiting hyperlipidemia may be developed in diabetic patients, especially those of high risk of periodontitis. The importance of maintaining optimal lipid profile in these patients should be emphasized when developing treatment plans.

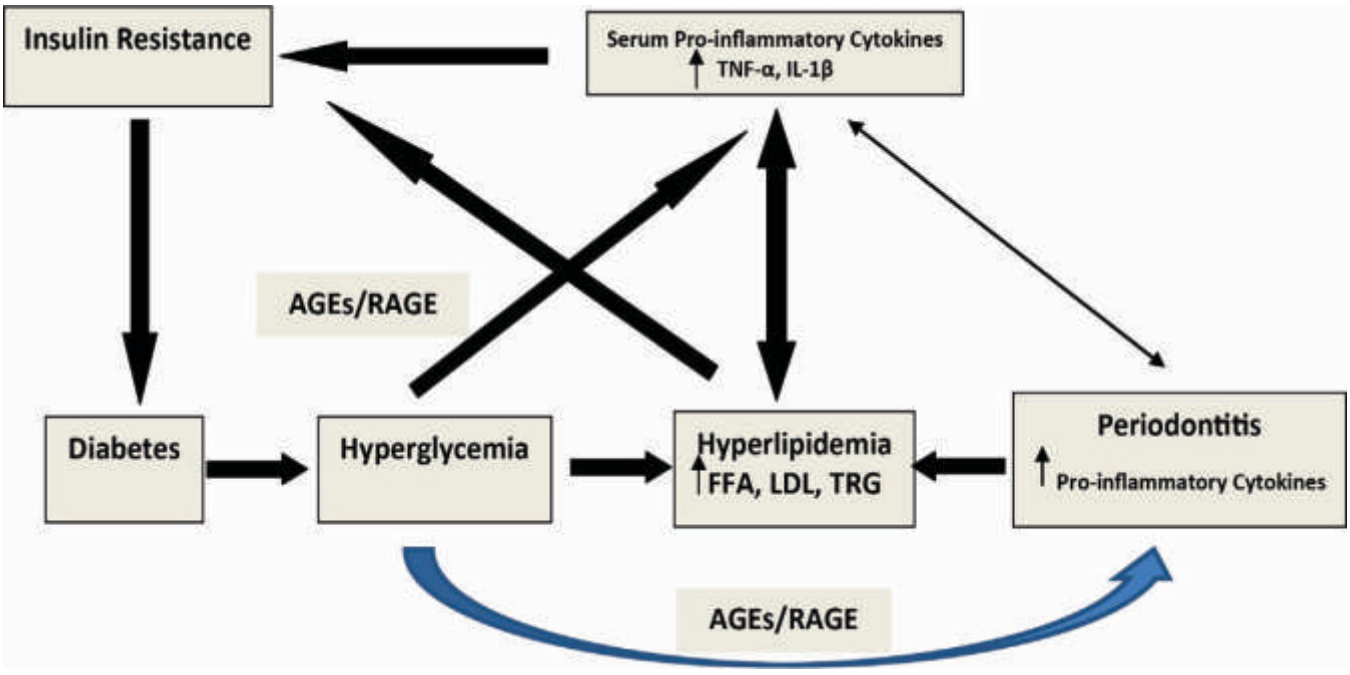

Fig. 3 – A proposed model linking hyperlipidemia to diabetes and periodontitis. Diabetes is associated with the increased levels of FFA, LDL, and TRG. In hyperlipidemia status, the production of pro-inflammatory cytokines, e.g. IL-1b and TNF-a, is increased. Release of pro-inflammatory cytokines from host cells in periodontal tissues is induced by AGE/RAGE pathway during the inflammatory response, leading to destruction of gingival tissues and tissue supporting bone. In periodontitis patients, levels of pro-inflammatory cytokines, IL-1b and TNF-a, are significantly increased. Infection with P. gingivalis or other Gram-negative periodontal pathogens may also directly increase serum levels of FFA, LDL, and TRG. High levels of lipids and/or pro-inflammatory cytokines contribute to insulin resistance by inhibiting insulin signalling or destruction of pancreatic b cells, and increase the risk of diabetes.

Conclusion

In conclusion, hyperlipidemia plays an important role on the pathogenesis of diabetes and periodontitis via its effects on insulin secretion and pro-inflammatory cytokines production (TNF-a, IL-1b). A model is proposed suggesting the possible mechanistic role of hyperlipidemia as a link between diabetes and periodontitis. As our understanding of the inter- relationship between hyperlipidemia, diabetes, and periodontitis, therapeutic strategies aimed at limiting hyperlipidemia should be advocated for the clinical management of diabetes and periodontitis.

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A Prognostic Mapping in Periodontics

Review Article

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Abstract

Prognosis is an integral part of the periodontal practice because it directly influences treatment planning. However, there is limited direct evidence in the literature regarding the assignment of periodontal prognosis. There are several important concepts to consider in developing a system of periodontal prognosis. Historically, several authors have formulated and investigated their own prognostication systems. Results were variable, but they generally showed that systems based on tooth loss were unpredictable over the long term. Therefore, the purpose of this review relevant literature and propose a new periodontal prognostication system.

Key words: Prognosis, Periodontal disease, Periodontal prognostication system

Introduction

Development of an accurate prognosis is an integral component of treatment planning in the practice of periodontics. In addition, assignment of good, long term prognosis is critical in reliably determining an appropriate restorative treatment plan following periodontal therapy, particularly if major prosthetic reconstruction or placement of dental implants is under consideration. The etymologic origin of the term "prognosis" derives from Latin and literally means "foreknowledge". Prognosis is the prediction of the probable course, duration, and outcome of a disease based on a general knowledge of the pathogenesis of the disease and the presence of risk factors for the disease[1].

Prognosis is often confused with the term risk. Risk generally deals with the likelihood that an individual will develop a disease in a specified period. Risk factors are those characteristics of an individual that put the person at increased risk for developing a disease. In contrast, prognosis is the prediction of the course or outcome of a disease. Prognostic factors are characteristics that predict the outcome of disease once the disease is present. In some cases, risk factors and prognostic factors are the same.

There are several important concepts in prognosis. Prognostication systems traditionally are based on tooth mortality. Prognosis also can be described in terms of the stability of supporting tissues. Periodontal stability can be evaluated continually by clinical attachment level and radiographic bone measurements. The second essential element of prognosis is the timing of the projection. The third essential element of prognosis is the consideration of individual teeth versus the overall dentition[2].

Michael K. McGuire *et al*. in 1996 have evaluated the validity of use of clinical parameters for correctly assigning prognosis and predicting tooth survival and change in clinical condition overtime and they concluded there was a relationship between many commonly used clinical factors and prediction of change in clinical status over time as well as tooth loss rate, although the ability to predict the future condition of a tooth varied by tooth type (i.e. molars vs. non-molars) [3]. Machtei *et al*. in 1999 evaluated both clinical parameters and certain immunological and microbiological parameters for predicting change in clinical status over time as well as tooth loss[4]. Nieri *et al*. in 2002, examined subject-level (positive IL-1 genotype), tooth-level (mobility) and site-level (periodontal distruction and bone level) variables as predictors of alveolar bone loss over time [5]. Horwitz *et al*.in 2004, three radiographic measures were found to be predictive of the healing of class II furcation involvement following surgical intervention[6].

Factors affecting prognosis

Prognosis can be divided into overall prognosis and individual tooth prognosis. The overall prognosis is concerned with the dentition as a whole. Factors that may influence the overall prognosis and individual prognosis are given in table 1 [1].

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General factors affecting prognosis:

Patient's age: For two patients with comparable levels of remaining connective tissue attachment and alveolar bone, the prognosis is generally better for the older of the two. For the younger patient, the prognosis is not as good because of the shorter time frame in which the periodontal destruction has occurred; the younger patient may have an aggressive type of periodontitis, or disease progression may have increased because of systemic disease or smoking. In addition, although the younger patient would ordinarily be expected to have a greater reparative capacity, the occurrence of so much destruction in a relatively short period would exceed any naturally occurring periodontal repair.

***Disease Severity*:** The severity of the disease might be slight, moderate or severe depending on depends on pockets depth, level of attachment, bone loss and osseous defect.

Individual prognosis	Percentage bone loss
	Probing depth
	Distribution and type of bone loss
	Presence and severity of furcations
	Mobility
	Crown/root ratio
	Root form
	Pulpal involvement
	Caries
	Tooth position and occlusal relationship
	Strategic value
	Therapist knowledge and skill
Overall prognosis	Age
	Medical status
	Individual tooth prognosis
	Rate of progression
	Patient cooperation
	Economic considerations
	Knowledge and ability of dentist
	Etiological factors
	Oral habits and compulsions

Table 1 Prognostic clinical parameters[1]

Pocket depth: Shallower pockets have a better prognosis than do deep pockets. Deep pockets have a favorable prognosis if attachment and bone levels are high.**Level of attachment:** The determination of the level of clinical attachment reveals the approximate extent of root surface that is devoid of periodontal ligament. Pocket depth is less important than level of attachment, because it is not necessarily related to bone loss. Tooth with deep pockets and little attachment and bone loss has a better prognosis than one with shallow pockets and severe attachment and bone loss[7].

Bone loss and osseous defect: Greater the bone loss, poorer is the prognosis. Three - walled osseous defect provides a scaffold for repair and

good regenerative potential. Two - walled osseous lesion has poorer and one - walled the poorest, prognosis for bone regeneration. Thus, prognosis is related to theheight of remaining bone.

Plaque control: Patient cooperation is essential for satisfactory plaque control, but is also necessary for the control of predisposing and aggravating etiological factors.

Patient compliance: The prognosis for patients with gingival and periodontal disease is dependent on the patient's attitude, motivation and dexterity to keep good oral hygiene. Patient cooperation is more likely to be forthcoming after the patient has been given information about the nature of the problem. Time spent in providing such information and in explaining the rationale behind the treatment plan will improve the chances of achieving a good prognosis**.**

Smoking: Smoking affects the severity of periodontal destruction as well as the healing potential of the periodontal tissues. The prognosis in patients who smoke and have slight to moderate periodontitis is generally fair to poor. In patients with severe periodontitis, the prognosis may be poor to hopeless.

Systemic disease: Patient's health and associated capacity for repair are important factors to consider in developing the treatment plan and prognosis.

Genetic factors: Genetic factors play an important role in determining the nature of the the host response.

Stress: Any emotional condition will interfere with the patient's oral hygiene regime.

Local Factors Affecting the Prognosis

Plaque/calculus: The patient who shows a severe response to minimal amounts of plaque has poorer prognosis than does the patient who exhibits a resistant response in the presence of a considerable amount of plaque. The microbial challenge presented by plaque and calculus is the most important local factor in periodontal disease. Thus, good prognosis is dependent on the ability of the patient and clinician to remove plaque. But when the teeth are drifted or rotated, oral hygiene may be more difficult; in such case the prognosis is poorer.

Subgingival restorations: Tooth with overhangs or a subgingival margin discrepancy has a poorer prognosis than a tooth with well-contoured, supragingival margins.

Anatomic factors:

Short, tapered roots: Teeth with short, tapering roots have a poorer prognosis than do those with long and broad roots. The more favorable the crown-root ratio, the better the prognosis. An upper molar with widespread roots and therefore a large root base has a much better prognosis than a conical - rooted premolar or incisor with the same amount of bone loss.

Cervical enamel projections and enamel pearls: These enamel projections on the root surface have a negative effect on the prognosis.

Root concavities: Prominent root proximal concavities are present on maxillary first premolars, mesiobuccal root of maxillary first molar, both roots of mandibular first molars and mandibular incisors. These are the areas that can be difficult for the therapist and patient to clean and thus, these worsen the prognosis.

Developmental grooves: Grooves on the root are an invagination resulting from incorrect formation of the root. The grooves often begin at the cingulum and extend a variable distance apically on the root - surface between the midpalatal line and the line angle that is why called as cinguloradicular groove. These grooves are found on maxillary lateral incisors (5.6%) and maxillary central incisors (3.4%) which act as plaque - retentive area that are difficult to instrument.

Proposed Classification System

Because tooth loss is influenced by natural and iatrogenic reasons, a periodontal prognostication system based on the probability of disease progression is hereby proposed. Individual tooth prognosis is based on the prediction of future stability of the periodontal supporting tissues. For the sake of simplicity, three primary classifications are proposed table 2

Study	Classification				
	Good	Fair	poor	Questionable	Hopeless
Hirschfeld and Wasserman, 1978[8]				1. Furcation involvement. 2. A deep, noneradicable pocket. 3. Extensive alveolar bone loss. 4. Marked mobility in Conjunction with probing depth (2 or 2.5 degrees on a scale of three).	
Becker et al., 1984[9]				Teeth with more than one of the following problems: 1. Bone loss close to 50% of the root length. 2. Probing depths of 6 to 8 mm. 3. Class II furcation involvement with minimal interadicular space. 4. Presence of deep vertical groove on palatal aspect of maxillary incisors. 5. Mesial furcation involvement of maxillary first bicuspids.>50% attachment loss resulting in a poor crown/root ratio. Poor root form. Class II furcations not easily accessible to maintenance care, or Class III furcations. ‡2+ mobility. Significant root proximity.	Teeth with more than one of the following problems: 1. Loss >75% of the supporting bone 2. Probing depths >8 mm. 3. Class III furcation involvement. 4. Class III mobility with tooth movement in mesial-distal and vertical directions. 5. Poor crown/root ratios. 6. Root proximity with minimal interproximal bone and evidence of horizontal bone loss. History of repeated periodontal abscess formation.

McGuire and Nunn, 1996[3]	Control of the etiologic factors and adequate periodontal support as measured clinically and radiographically to ensure the tooth would be relatively easy to maintain by the patient and clinician assuming proper maintenance.v	Approximately 25% attachment loss as measured clinically and radiographically and/or Class I furcation involvement. The location and depth of the furcation would allow proper maintenance with good patient compliance	50% attachment loss and Class II furcations. The location and depth of the furcations would allow proper maintenance, but with difficulty.	>50% attachment loss resulting in a poor crown/root ratio. Poor root form. Class II furcations not easily accessible to maintenance care, or Class III furcations. ‡2+ mobility. Significant root proximity.	Inadequate attachment to maintain the tooth in health, comfort, and function. Extraction was performed or suggested.

Table 2 classification for determination of prognosis[2]

Classification And Regression Trees (CART)

The traditional method for assignment of prognosis involves a subjective process based on commonly taught clinical parameters and the therapists experience and training. There is no established universal set of criteria for assignment of periodontal prognosis, and thus different practitioners may assign varying prognoses for the same tooth, which may be problematic for referring dentists, third-party payment plans (e.g. dental insurance companies) and the patients themselves, as, rather than providing guidance for treatment planning, it creates further uncertainty. In order to remedy this situation Martha E. Nunn *et al*. in 2012 embarked on a long-term project to establish objective criteria for assignment of prognosis based on actual outcome and that was Classification And Regression Trees (CART). They extended the method of CART for survival to accommodate multivariate failure time data such as tooth loss and restoration failure observed in dental research, by applying techniques used for multivariate survival analysis to CART for survival in which they used two approaches[1]:

1) The marginal goodness-of-split approach

2) The multivariate exponential model with gamma frailty

They collected data of 100 well maintained periodontal patients who were diagnosed with moderate to severe periodontal disease, in order to determine evidence-based criteria for assignment of prognosis based on commonly taught clinical parameters.

Based on the first split on furcation involvement in the marginal goodness-of-split approach, further survival tree modeling was performed using stratification by molars and non-molars figure 1.

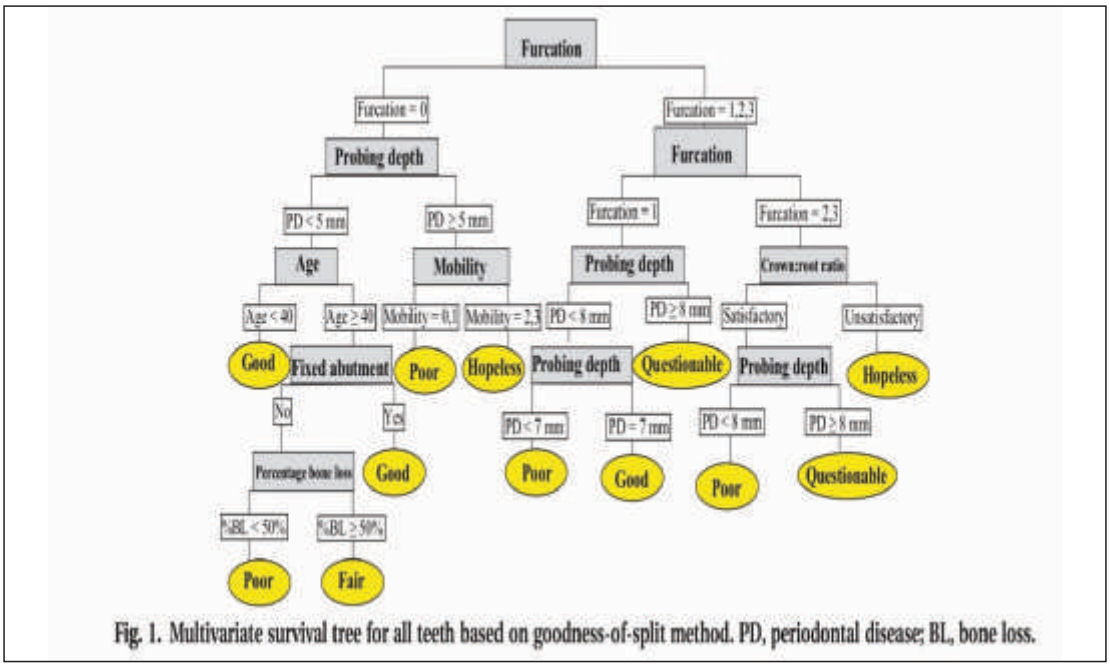

Fig. 1. Multivariate survival tree for all teeth based on goodness-of-split method. PD, periodontal disease; BL, bone loss

Fig. 1. Multivariate survival tree for all teeth based on goodness-of-split method. PD, periodontal disease; BL, bone loss[1]

The best performance in terms of prediction was obtained from the multivariate exponential survival trees shown in Figs 2 and 3. Figure 2 shows the final multivariate exponential survival tree for non-molars. Probing depth, untreated bruxism (i.e. parafunctional habit without a bite guard), oral hygiene, mobility, removable abutments and mean percentage bone loss were all significant factors in the multivariate exponential survival tree for predicting tooth loss over time in non-molars.

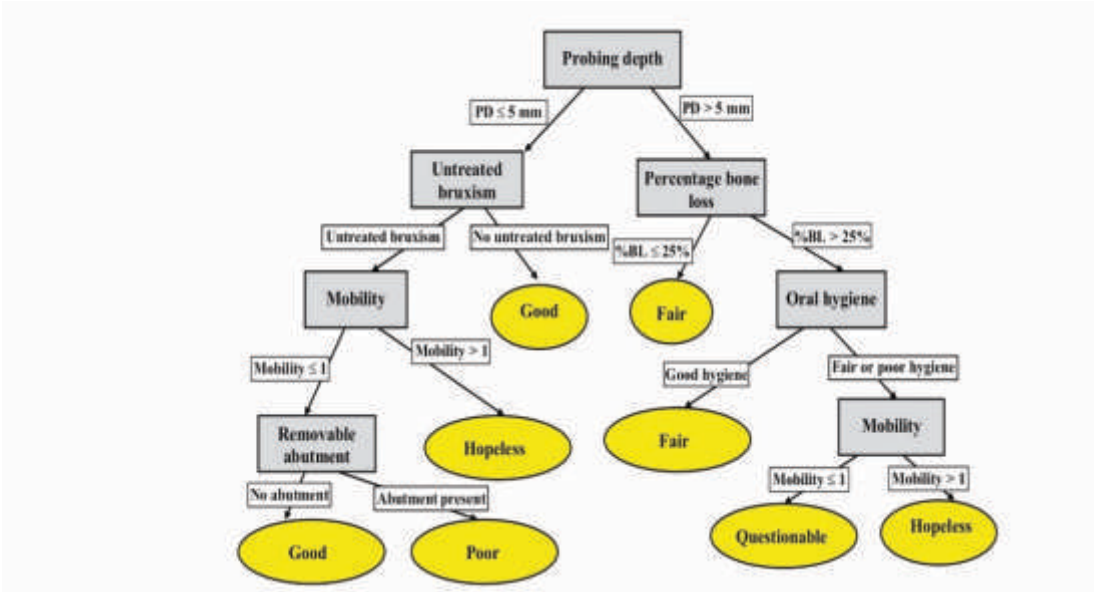

Fig. 2 Multivariate exponential survival tree for non-molars. PD, periodontal disease; BL, bone loss[1]

Figure 5 shows the final multivariate exponential survival tree for molars. Based on Fig. 5, crown/root ratio, probing depth, furcation involvement, root form, untreated bruxism, oral hygiene, mobility, bite guard, mean percentage bone loss and family history of periodontal disease were all significant factors in the multivariate exponential survival tree:

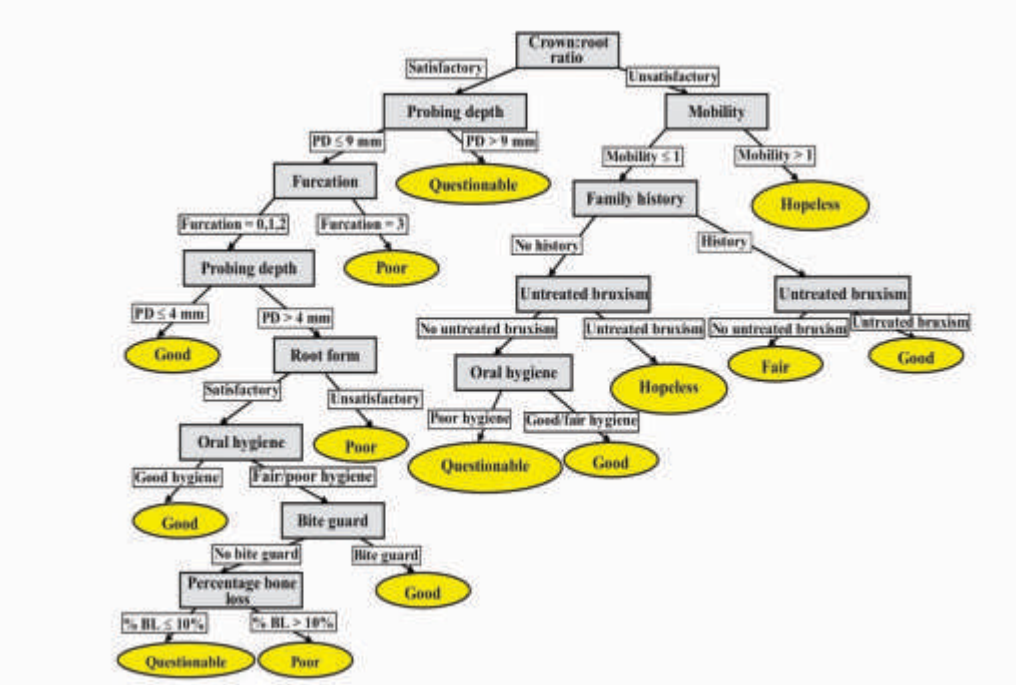

Fig. 3 Multivariate exponential survival tree for molars[1]

PROGNOSIS OF PATIENTS WITH GINGIVAL AND PERIODONTAL DISEASES

Prognosis of Patients with Gingival Diseases

Gingivitis associated with dental plaque only: Prognosis for patients with gingivitis associated with dental plaque only is good, provided all local irritants and other local factors contributing to plaque retention are also eliminated. Plaque-induced gingival diseases modified by systemic factors: Long-term prognosis for these patients depends not only on control of bacterial plaque, but also on control or correction of systemic factors. Plaque-induced gingival diseases modified by medications: The severity of drug induced gingival enlargement can be limited by controlling the plaque.

Surgical intervention is usually necessary to correct the alterations in gingival contour. Continued use of the drug results in recurrence of the enlargement, even following surgical intervention. Long term prognosis is dependent on whether the patient's systemic problem can be treated with an alternative medication that does not have gingival enlargement as a side effect. Gingival diseases modified by malnutrition: The prognosis in these patients may depend on the severity and duration of the deficiency and on the likelihood of reversing the deficiency through dietary supplementation.

Non-Plaque-induced gingival lesions: Prognosis depends on elimination of the source of the infectious agent. In patients with atypical gingivitis seen in dermatologic disorders, prognosis is linked to management of the associated dermatologic disorder. Prognosis of patients with allergic, toxic, and foreign body reactions, as well as mechanical and thermal trauma, depends on elimination of the causative agent.

Prognosis of Patients with Periodontitis

Chronic Periodontitis: In cases where the clinical attachment loss and bone loss are not very advanced (slight to moderate periodontitis), the prognosis is generally good, provided the inflammation can be controlled through good oral hygiene and the removal of local plaque-retentive factors. In patients with more severe disease, as evidenced by furcation involvement and increasing tooth mobility, or noncompliant patients prognosis may be downgraded from fair to poor.

Aggressive Periodontitis: The clinical, microbiologic, and immunologic features

suggest that patients with aggressive periodontitis would have a poor prognosis. However, in cases of localized aggressive periodontitis, the patients often exhibits a strong serum antibody response to the infecting agents, which may contribute to localization of the lesions. When diagnosed early, conservative therapy with oral hygiene instruction and systemic antibiotic therapy, can result in an excellent prognosis.

Periodontitis as a Manifestation of Systemic Diseases: Systemic diseases alter the ability of the host to respond to the microbial challenge presented and this may affect the progression of disease and therefore the prognosis. Unless the systemic disease can be corrected, these patients present with a fair to poor prognosis. In case of genetic disorders that alter the host response, prognosis is generally fair to poor.

Necrotizing Periodontal Diseases: With control of both the bacterial plaque and the secondary factors, such as acute psychologic stress, tobacco smoking, and poor nutrition, the prognosis for a patient with NUG is good. With repeated episodes of NUG, the prognosis may be downgraded to fair. In patients with NUP the prognosis depends on not only reducing the local and secondary factors, but also on dealing with the systemic problem.

Conclusion

The determination of periodontal prognosis has been arbitrary. The proposed prognostication system, based on stability and evidence-based modification factors, may be more predictable. Eventually, with accumulation of longitudinal data from many practices, we should be able to develop evidence-based prognostic indicators that can be utilized by periodontists, dentists, third-part payment plans and patients to determine the optimum treatment plan in each case, based on evidence-based prognosis**.**

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EVALUATION OF DIFFERENT TECHNIQUES FOR EASE OF RETRIEVAL OF CEMENT RETAINED IMPLANT SUPPORTED FIXED DENTAL PROSTHESIS: A SYSTEMATIC REVIEW.

Review Article

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ABSTRACT

Aim: To evaluate different techniques to retrieve cement retained implant supported fixed dental prosthesis (ISFDP).

Material and Methods: A broad search of the dental literature in PUBMED, google scholar and by hand search was conducted using appropriate keywords between 2001 to 2021 by applying inclusion and exclusion criteria. This search yielded 629 titles, out of which 109 titles were excluded by applying the year criteria and 365 studies by screening titles. 95 studies were excluded after abstract analyses and 20 studies were excluded after reading full text. The remaining 31 studies were included in this study and were divided into three groups on basis of method to locate screw access hole (SAH) and retrieve the prosthesis. First group included eight studies and was based on identification markers used to locate SAH. Second group included seven studies and was based on digital photographs used to locate SAH. Third group included 16 studies and was based on radiographs and customized guide stent.

Results: In the first group identification markers like lingual slot, cross pinning, external staining and a special ledge along with SAH was used. They helped locating SAH but have disadvantages like technique sensitivity, plaque accumulation, need of special instruments. The second group consisting of digital photographs required records to be preserved and also it located the SAH two dimensionally. While in the third group the guide stent and radiographs located the SAH three dimensionally but it also required records to be preserved and radiation exposure to patient is increased along with cost.

Conclusions: It can be concluded that the technique to retrieve cement retained ISFDP should be selected on basis of clinical situation and ease of dentist. The methods that included three dimensional techniques to retrieve the prosthesis are preferred over other techniques because of its precision to locate SAH.

Keywords: Technical complications in dental implants., Retrieval of cement retained implant supported prosthesis., Removal of cement retained implant prosthesis.

INTRODUCTION:

Dental implants are considered to be a scientifically and clinically proven treatment option for many types of edentulism.[1] Dental implants have proven dependable success as support structures for overdentures, single prostheses, and fixed partial dentures, owing in large part to ongoing advancements in implant design, implant surface engineering, clinical techniques, prosthetic components, and dental materials. [2,3]

Two types of restorations may be used in implant cases; screw-retained or cement-retained[4] and the choice of restoration depends on clinicians' preference, available interridge space, aesthetics and cost.[5] Both cement- and screw-retained designs have benefits and shortcomings in their clinical and technical performances.[6,7]

Screw-retained prostheses have the main advantage of retrievability in the event of screw loosening or screw fracture.[8] This type of prosthesis has shown excellent marginal integrity and is more indicated in patients with limited interocclusal distance. Nevertheless, it presents some disadvantages such as compromised aesthetics, difficulty establishing occlusion, and ceramic prosthesis fracture because of the presence of the screw access hole (SAH) on the occlusal surface.[9,10]

A cement retained prosthesis offers easier fabrication, a more passive fit, lower cost, easier access in the posterior region, and the ability to compensate for malpositioned implants. [8.9] This type of prosthesis eliminates the unesthetic Screw access hole, producing a more aesthetic ceramic restoration that is more resistant to chipping and fracture and with a more precise occlusion. However, retrievability is difficult, and the

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removal of excess cement is demanding.[11,12,13] Pauletto[14] et al and Gapski[15] et al reported that residual cement can lead to soft tissue inflammation, bone loss around implants, and implant failure.

After implant rehabilitation, clinicians may need to remove the prosthesis because of ceramic fracture, screw loosening, abutment screw fracture, exchange of components, design modification, removal of retained cement that leads to peri-implantitis, or unacceptable gingival recession. [9]

With screw-retained prostheses, the clinicians can retrieve the crown by identifying the screw access hole and removing the restoration with a high-speed diamond rotary instrument. The problems occur with cement-retained prostheses, the retrievability process may cause damage to the components of the crown. In addition, application of force during crown removal may damage the intaglio surface of the implant or fracture the abutment screw. [9] The protection of the integrity of the implant is foremost to the preservation of the crown. For this reason, practitioners may be reluctant to use forceful measures to unseat the crown from the abutment and may often choose to sacrifice the crown. This creates a situation whereby the crown, and potentially the abutment, must be refabricated.[16]

A more cost-effective approach is to create a confined access opening in the crown to engage the loose retaining screw, retighten it, and repair the opening. The challenge here is to locate the screw position with minimal damage to the restoration, abutment, and possibly implant. [17] Many techniques have been described in the literature for retrieval of cement retained implant supported fixed dental prosthesis.

The purpose of this systematic review is to describe different techniques used for retrieval of cement retained implant supported fixed dental prosthesis.

Manual searches of the references of all full-text articles and relevant articles also selected from the electronic search were also performed. Both abstract and full text articles were included.

SELECTION OF STUDIES:

The review process consists of two phases. In first phase titles and abstracts of the search were initially screened for relevance and the full text of relevant abstracts were obtained and accessed. The hand search of selected journals as well as search of references of the selected studies were also done. The articles were obtained after first step of the review process using the following inclusion and exclusion criteria.

INCLUSION CRITERIA:

- Articles published between year 2001 to 2021.
- Randomized controlled trials.
- Controlled clinical trials.
- Prospective and retrospective studies.
- Invitro studies.
- Case and technical reports.
- Different techniques to retrieve cement retained fixed implant prosthesis.
- Articles in English language.

EXCLUSION CRITERIA:

- Animal studies.
- Studies with missing data.
- Studies not in English language.

RESULT OF SEARCH:

The database search yielded 629 titles, out of which 109 titles were excluded after search filter was applied between 2001-2021. 365 articles were discarded after reading the titles and 95 articles were discarded after reading the abstract. 20 studies were excluded after reading full text. 9 studies were excluded on basis of inclusion and exclusion criteria. And thus finally 31 studies were selected for data extraction.

The articles selected on the basis of inclusion criteria were divided into 3 groups. First group included 8 studies with **identification markers**. Second group included 7 studies with **digital photographs.** Third group included 16 studies with **radiographs and customized guide stent**.

First group were divided into 4 subgroups. First subgroup includes studies on **cross pinning**, second subgroup includes studies on **lingual slots**,

third subgroup includes studies on **external staining** and fourth subgroup includes studies on **screw access hole with supportive ledge.**

Third group is divided into 3 subgroups. First subgroup included studies on **2D radiographs**, second subgroup included studies on **3D radiographs** and third subgroup on **customized guide stents.**

FLOW CHART FOR SEARCH STRATEGY:

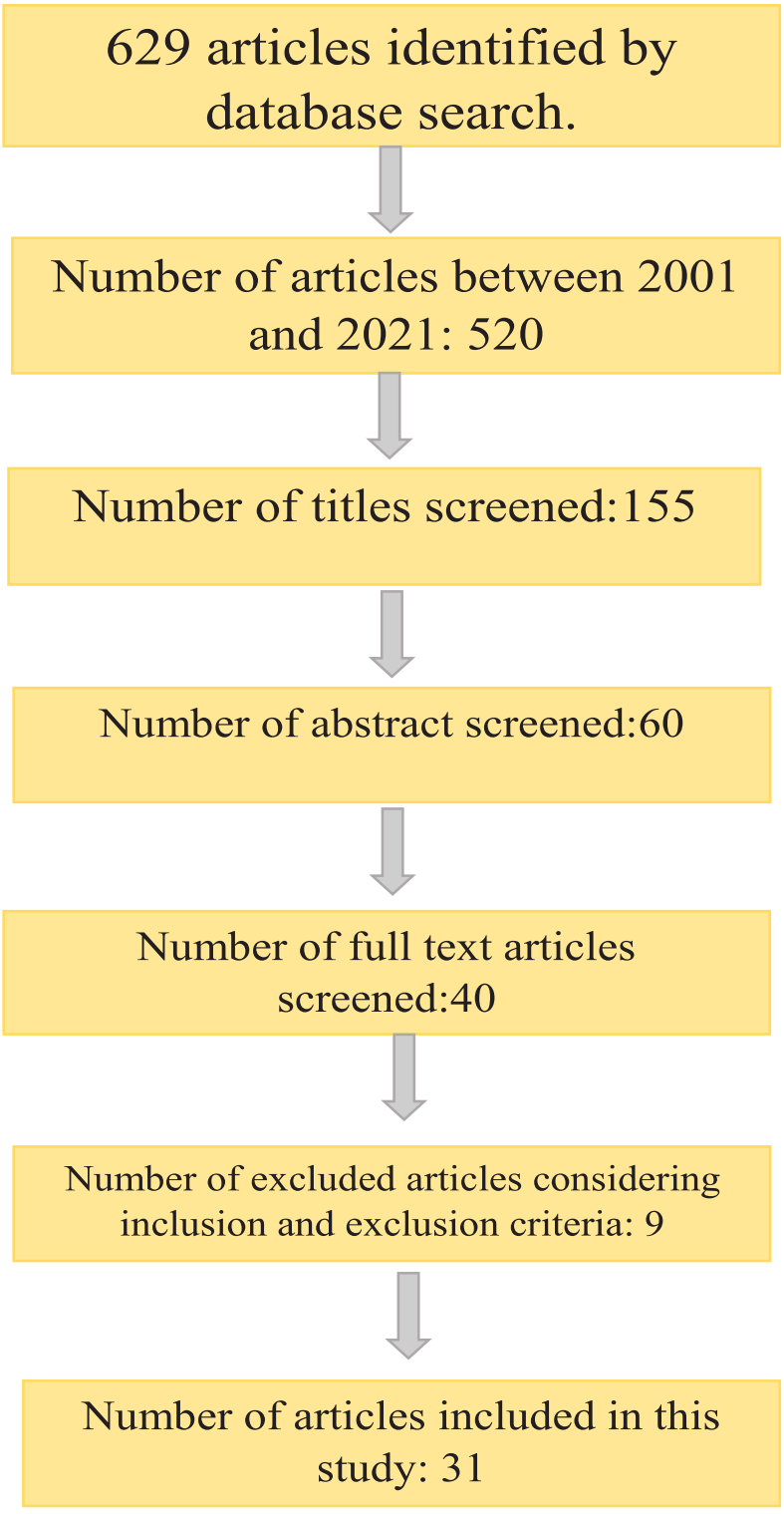


TABLE 1: TABLE OF REASON FOR EXCLUSION OF STUDY

SR NO.	AUTHOR'S NAME	YEAR	REASON OF EXCLUSION
1.	McGLUMPHY ET AL [46]	1992	This study does not fulfil the inclusion criteria i.e., articles between year 2001 to 2021 are included in this study.
2.	SUTTER ET AL [47]	1996	This study does not fulfil the inclusion criteria i.e., articles between year 2001 to 2021 are included in this study.
3.	CHEE ET AL [48]	1998	This study does not fulfil the inclusion criteria i.e., articles between year 2001 to 2021 are included in this study.
4.	POW ET AL [49]	2000	This study does not fulfil the inclusion criteria i.e., articles between year 2001 to 2021 are included in this study.
5.	RAJAN ET AL [50]	2004	This study indicates fabrication of cement retained prosthesis and not the technique to retrieve cement retained prosthesis.
6.	ULUDAG ET AL [51]	2006	This study indicates fabrication of cement retained prosthesis and not the technique to retrieve cement retained prosthesis.
7.	SAMBROOK ET AL [52]	2012	This study focuses on Australian dentists only.
8.	DA ROCHA ET AL [53]	2013	This study focuses on effect of screw access hole on retention of cement retained implant supported fixed dental prosthesis and not the technique to retrieve cement retained implant supported fixed dental prosthesis.
9.	ASLI ET AL [54]	2020	This study focuses on retrieval of implant supported prosthesis and not specifically on retrieval of cement retained implant supported fixed dental prosthesis.

TABLE 2: TABLE OF EVIDENCE

SR. NO.	AUTHOR	YEAR	STUDY DESIGN	EVIDENCE LEVEL
1.	VALBAO ET AL [18]	2001	Technique report	5
2.	DOERR ET EL [19]	2002	Technique report	5
3.	SCHWEDHELM ET AL [20]	2006	Technique report	5
4.	DOHER ET AL [21]	2007	Technique report	5
5.	ICHIKAWA ET AL [22]	2008	Technique report	5
6.	GEVARIS ET AL[23]	2008	Case report	5
7.	FIGUERAS-ALVAREZ ET AL [16]	2010	Technique report	5
8.	PATIL ET AL [24]	2011	Technique report	5
9.	SCHWEITZER ET AL [17]	2011	Technique report	5
10.	WICKS ET AL [25]	2012	Technique report	5

11.	TARLOW ET AL [26]	2012	Technique report	5
12.	LAUTENSACK ET AL [27]	2012	Technique report	5
13.	WADHWANI ET AL [28]	2013	Technique report	5
14.	SCHOENBAUM ET AL [29]	2013	Technique report	5
15.	PARK ET AL [30]	2013	Technique report	5
16.	PATIL ET AL [31]	2013	Technique report	5
17.	BUZAYAN ET AL [32]	2014	Case report	5
18.	FIGUERAS-ALVAREZ ET AL [33]	2014	Technique report	5
19.	KHEUR ET AL [34]	2015	Case report	5
20.	LEE ET AL [35]	2015	Technique report	5
21.	OH ET AL [36]	2015	Technique report	5
22.	KANG ET AL [37]	2015	Technique report	5
23.	RADI ET AL [38]	2016	Technique report	5
24.	LEE ET AL [39]	2016	In-vitro study	Foundational evidence

25.	MAI ET AL [40]	2016	Technique report	5
26.	LEE ET AL [41]	2017	In-vitro study	Foundational evidence
27.	ASIRI ET AL [42]	2017	Case report	5
28.	NESHANDAR ASLI ET AL [43]	2017	In-vitro study	Foundational evidence
29.	CHOI ET AL [44]	2018	In-vitro study	Foundational evidence
30.	MICHALAKIS ET AL [45]	2018	Technique report	5
31.	FARZIN ET AL [1]	2021	In-vitro study	Foundational evidence

TABLE 3 FOR GROUP 1: STUDIES BASED ON IDENTIFICATION MARKERS USED TO RETRIEVE CEMENT RETAINED FIXED IMPLANT PROSTHESIS

SR. NO.	AUTHOR NAME	YEAR	NUMBER OF PATIENTS/ MODEL	NUMBER OF IMPLANTS PLACED	RETRIEVAL METHOD USED	METHODOLOGY	LUTING CEMENT USED	OUTCOME
1.	VALBAO ET AL [18]	2001	1	1	Cross pinning	Cast is made from impression and implant analogue is placed in it. Along with casting of an abutment a screw access hole is placed on the abutment and on the metal coping as well on the palatal surface with the help of bur.	NA	This technique includes a combination of screw- and cement retained implant restoration and hence it facilitates in arch alignment, retention, stability, and retrievability.
2.	SCHWED HELM ET AL [20]	2006		1	External stain	The cast is surveyed along with abutment and the location of screw access channel is determined. An external stain is applied on the prosthesis corresponding to the location of screw access channel.	NA	Advantage of using this technique is that the abutment screw may be easily located, thus minimizing damage to the existing restoration and allowing it to be reused.
3.	ICHIKA WA ET AL [22]	2007		1	(I) Cross pinning (ii) Rotating lever system	(I) Incorporating a small removable side screw on lingual surface of cemented superstructure. Turning this screw clockwise will separate the prosthesis from	NA	Both methods are simple to incorporate and allow enhanced prosthesis retrievability.

			1	1		abutment. (ii)A small oblong dimple is created on the lingual surface of abutment and a corresponding access hole is created in prosthesis. When required an instrument is engaged at this place and rotated to disengage the prosthesis.		
4.	GEVARIS ET AL [41]	2008	1	1	Cross pinning	A cross pin screw is attached to the palatal surface of the restoration. The abutment is customized according to screw size. And after abutment fabrication the screw is tapped into it.	NA	This technique combines the benefit of screw retained and cement retained fixed implant prosthesis.
5.	SCHWEIT ZER ET AL [17]	2011	1	1	Lingual slot.	A lingual slot is created 1 mm coronal to the free gingival margins of the abutment. Slot should be of at least 1mm depth and wider in mesio-distal width than functional end of implant slot driver and is created on the definitive	NA	This technique presented incorporates a design feature that allows for easy and predictable retrieval of cement-retained implant-supported prostheses to facilitate required maintenance and

						restoration's wax pattern.		repair or replacement of the prosthesis by the clinician.
6.	SCHOEN BAUM ET AL [47]	2013	1	1	External stain.	A cast is aligned on the surveyor and the crown is stained using a brush.	NA	By creating and staining a small marking on the occlusal surface of cement-retained implant restorations, the access point to the abutment screw can be clearly identified, ensuring that any future retrieval of the prosthesis is simple and predictable.
7.	CHOI ET AL [44]	2018		N = 60 six types of titanium abutments (10 of each), with two different heights (4 mm and 6 mm) and three different convergence angles (8°, 10°, and 12°). Crowns were made of zirconia and they resembled maxillary first molar.	Lingual slot.	The abutments were fabricated with a Retrievable cement retained slots of 2mm length and 1 mm width. Abutment and crowns were cemented. A custom-made device was used to measure removal torque values.	Dual cure resin cement.	Retrievability of the final Prostheses can be obtained by controlling the convergence Angle of the abutment according to height and by providing R forms during the fabrication of customized abutments.

8.	FARZIN ET AL [1]	2021		N = 33 3 groups (n=11). As the control group, group 1 consisted of conventional cement-retained crowns. Group 2 comprised conventional cement-retained crowns in which a hole of 2 mm diameter was created in the location of the screw. Group 3 consisted of cement-retained crowns in which a ledge of 1 mm thickness and 1.5 mm height was created in the location of the screw access channel.	Screw access holes with a special supportive ledge.	After fabricating the specimens, they were cemented to their abutments and their access openings were filled with composite resin. A compressive load was applied to the specimens using a universal testing machine until they fractured.	Zinc oxide eugenol cement.	Designing a ledge in the zirconia framework around the access hole may increase the fracture resistance of the restoration.

TABLE 4 FOR GROUP 2: STUDIES BASED ON DIGITAL PHOTOGRAPHS USED TO RETRIEVE CEMENT RETAINED FIXED IMPLANT PROSTHESIS

SR. NO.	AUTH OR NAMED	YEAR	NUMBER OF PATIENTS/ MODEL	NUMBER OF IMPLANTS PLACED	RETRIEVAL METHOD USED	METHODOLOGY	LUTING CEMENT USED	OUTCOME
1.	OHER ET AL [21]	2007	1	1	Digital photographs	Once abutment is placed in mouth the position of screw access channel is photographed using a periodontal probe. These photographs are kept as patient records and when patient comes with screw loosening these photographs are used to locate the position of screw access channel.	NA	Digital photographs help to locate the position of screw access channels and it does not require any extra aid for locating SAC.
2.	FIGUERAS-ALVAREZ ET AL [16]	2010	1	2	Digital photographs	On definitive cast 3 points are marked on teeth adjacent to implant site. Now 2 photographs are taken one with prosthesis and one without prosthesis. The photos are resized and cut on photoshop. After that the photos are superimposed and the location of the retaining screw is revealed by imparting some translucency to the	NA	It is a simple method that enables identification of screw access channel with no collaboration from patient and without wasting chair side time. It does not require any physical storage space as well.

					Digital photographs	photograph of the restoration on the abutment.		
3.	PATIL ET AL [31]	2013	1	10	Digital photographs	A thickness gauge is used to determine the centre of abutment and is marked on the prosthesis, if angled abutment is used than second marking on restoration to determine the position of abutment, this prosthesis is placed on the definitive cast and a photograph is taken.	NA	With this technique, no physical storage space is required to preserve the patient records in the form of casts, vacuum formed matrix, or putty index. Neither staining of the ceramic crown nor complex photograph editing is required.
4.	FIGUERAS-ALVAREZ ET AL [33]	2014	1	2	Digital photographs	With the aid of a tripod, make 2 similar photographs of the definitive cast, on which the occlusal surfaces of the 3 teeth closest to the site of the cement-retained restoration has been marked with a felt-tipped pen. One photograph should show the definitive restoration on the abutment, and the other should show the abutment without		This is a simple technique which uses MS PowerPoint which is accessible to everyone and easy to use.

						the restoration. Place both photographs in a Power Point slide. Crop as well as size them identically. Superimpose both the photographs and make the photograph with restoration translucent. Save this slide and this can be used to locate the screw access channel in future when patient visits with screw loosening.		
5	LEE ET AL [35]	2015	1	1	Digital photographs	In this technique a wooden blade is used with its center marked and it is placed on occlusal surface of tooth adjacent to the implant site on a definitive cast. 2 photographs are taken one with abutment and long screw, other with abutment, regular screw and restoration. Superimposition of these two photographs helps to locate screw access channel.	NA	In other studies, relating to digital photographs the location of abutment was determined but not the position of abutment. This technique helps determine position as well as angulation of screw access channels.

6.	OH ET AL [36]	2015	1	1	Digital photographs + magnet	Place as many magnets as possible on abutment screw and then seat the prosthesis over it. Place a magnet over the prosthesis and take a digital photograph.	NA	An inexpensive and straight forward technique which requires no physical records to be preserved or no complex photographic software skills.
7.	MICHALAKIS ET AL [45]	2018	1	1	Digital photographs	Two photographs are taken using magnification of 1:1. One photograph is of abutment without restoration and other one is with the restoration. These images are to be edited on software's like Keynote, Abode, MS PowerPoint, photoshop. The edited images are superimposed and the image with restoration is made translucent to locate position of screw access chambers.	NA	This is a straightforward, inexpensive, and effective method for determining the entry point of the screw-access chamber. The main advantage is of showing the location of the fastening screw in relation to the implant-supported restoration in 3 dimensions.

TABLE 5 FOR GROUP 3: STUDIES BASED ON RADIOGRAPHS AND CUSTOMIZED GUIDE STENTS USED TO RETRIEVE CEMENT RETAINED FIXED IMPLANT PROSTHESIS

SR. NO.					RETRIEVAL METHODOLOGY METHOD USED		LUTING CEMENT USED	OUTCOME
1.	DOERR ET EL [19]	**2002**	**1**	**3**	Customized guide stent.	A vacuum formed stent is made and a hole is drilled at abutment site. A paralleling pin is placed over this stent in a way that it is placed over screw access hole. A small plastic tube is placed over the guide stent after that. This guide stent can help in position as well as location of screw access channel.	NA	It is an easy and cost effective in office approach.
2.	PATIL ET AL [24]		**1**	**2**	IOPA	Intraoral periapical radiograph was taken and linear lines are made on radiograph to locate the position of screw access channel.	NA	This technique helps in retrieval without the need of prior records.
3.					CBCT	A CBCT scan is performed. By activating linear tracers in the software for the sagittal and frontal views that concurrently intersect, using cross reference points,	NA	Use of the CBCT scan adds a further dimension of information that can be used to improve the treatment alternatives.

						with the coronal view. Clinically appraise the intersection of lines from occlusal view and drill a hole as small as possible to prevent much damage to crown.		
4.	TARLOW ET AL [26]	**2012**	**1**	**1**	Customized guide stent.	A vacuum formed guide stent is made over definitive cast. The restoration is removed and the stent is placed over the cast and a hole is drill on site of abutment. This stent will help in future for retrieval of restoration.	NA	It is a simple and practical technique.
5.	LAUTEN SACK ET AL [27]	**2012**	**1**	**2**	Customized guide stent.	A vacuum formed guide stent is made over definitive cast. A hole is drilled along the path of screw access hole. A guide sleeve is attached to stent using auto polymerizing resin.	NA	The location as well as angulation of screw access hole can be determined by using this technique.
6.	WADHW ANI ET AL [28]	**2013**	**1**	**1**	Customized guide stent with precision implant locating device.	Before final cementation of crown, a precision implant locating device (PILD) is made and a hole of diameter 2.1 mm is	NA	This technique is simple, rapid, inexpensive, and gives 3-dimensional information for

						created on it. A guiding rod is inserted into this hole, and it is placed on implant abutment. Impression is made using PVS material and this is stored along with patient records.		guiding directional screw access.
7.	PARK ET AL [30]	**2014**	**1**	**1**	CBCT	Two CBCT scans were performed. First scan is taken with abutment post placed on abutment. Second scan is made after restoration is cemented. These two scans are superimposed and the location of screw access hole is determined.	NA	The 3-dimensional digital record visualizes accurate position and angulation of the screw hole for optimal retrieval procedure.
8.	BUXAYAN ET AL [32]	**2014**	**1**	**1**	IOPA	An intraoral periapical radiograph is taken and a photographic image of this IOPA is taken. The image is enlarged so that the diameter of implant is 4.5 cm. a cylinder of 2.3 cm resembling the abutment diameter is superimposed on the photograph. The position of access	NA	This is a simple technique which does not require any additional equipment's or skills. This is a 2-dimensional technique and hence it does not help in locating the buccolingual positioning of screw access hole.

					Customized guide stent.	hole was decided on patient's prosthesis using a ruler and the access hole was created in patient.		
9.	KHEUR ET AL [34]	**2015**	**1**	**2**	Customized guide stent.	A clear vacuum formed guide stent is made. A drill parallel to the screw access channel is made in this stent. Plastic guide tubes are incorporated on this stent. A parallel pin is used to determine the positional accuracy of guide. A coloured tube is than sealed over this position.	NA	This technique is easy and cost effective in-office approach for the clinicians to gain predictable access to an abutment screw by attaching a plastic tube to the vacuum formed stent fabricated over the implant retained restoration. It also takes out the guess work out of the two-dimensional measures.
10.	KANG ET AL [37]	**2015**	**1**	**1**	Customized guide stent.	A hand piece sleeve of size same as that of handpiece head and 15 mm in length is 3D printed along with a guide sleeve using CAD-CAM technology. A vacuum formed guide template is made which covers adjacent teeth as well. A hole is drilled	NA	The handpiece sleeve facilitates accurate drilling through the restoration and enables cooling water to be delivered to the drilling area. Consequently, this tech nique reduces damage to the

					Customized guide stent.	at the site of abutment in this guide stent. The guide sleeve is placed over guide template and attached using acrylic resin. This template along with the stent can be used whenever necessary.		restoration and abutment.
11.	REDI ET AL [38]	**2016**	**1**	**2**	Customized guide stent.	A piece of suction tip is used as guide sleeve. The suction tip is heated and expanded by using tweezer and are adapted on impression copings. The guide stent is made with clear acrylic resin. This stent is used for creating an access hole in the prosthesis.	NA	This is a straight forward, predictable, cost-effective technique which requires less equipment. The drawback is that it requires storage of patient cast and the occlusal contact will change because of the access hole created.
12.	LEE ET AL [39]	**2016**	**3** Mandibular partially edentulous casts with missing second molars.	N = 54 18 students prepared screw access channels through the crowns and abutments of implants placed at 0-, 15-, and 30-degree angulations in the mandibular	Customized guide stent.	First optical scan was performed with a metal column of 1.5 mm diameter and 20 mm height placed in screw access channel. Second scan was performed under supposition that the abutment screw has loosened. Image superimposition was	NA	A CAD/CAM guide significantly enhanced the accuracy of drilling the screw channel and reduced damage to the crown and abutment, particularly at an implant angulation

				second molar on dental casts. Experimental and control groups differed in the use of a CAD/CAM screw channel drilling guide, and each group was subdivided according to implant angulation.		performed, and guided drill was designed with a guide sleeve. Students of each group made drills using this acrylic guide stent. Periapical radiograph was taken during this process to mimic clinical settings.		of 30 degrees.
13.	MAI ET AL [39]	**2016**	**1**	**1**	Customized guide stent.	First intraoral scanner scanned the cast. Secondly a CBCT scan of cast was performed. First superimposition was between surface image from IOS and reconstruction image from CBCT. Second superimposition was carried out between actual and virtual implant fixtures. The screw drilling guide is fabricated with help of these superimposed image.	NA	This technique is feasible, accurate and efficient for retrieval of cement retained fixed implant prosthesis.
14.	LEE ET AL [41]	**2017**	Partially edentulous mandibular casts with missing first	N = 80 20 dental post graduates performed this procedure on	Customized guide stent.	Guides were fabricated by superimposition of 2 CBCT images obtained by placing		Screw channel drilling guide improves channel formation accuracy and

			premolar and second molar.	phantom heads. 2 groups: control group and experimental group.		metal column in abutment and abutment with prosthesis. The CAD-CAM technology is used to design the guide by using data from merged image. These guides were used by students to make drilling holes.	NA	minimizes prosthetic damage.
15.	ASIRI ET AL [42]	2017	1	**1**	Customized guide stent.	An intraoral CBCT scan is performed. A stone cast model is made which is scanned using CBCT. An implant is selected and placed on cast model according to in vivo situation. A guide with sleeve is prepared using 3D printing. This guide is used to drill the prosthesis.	NA	This technique helps in precisely locating screw access channel without any treatment records or definitive casts.
16.	NESHAN DAR ASLI ET AL [43]	2017	5 clear acrylic resin mandibular casts.	N = 30 Eight 15-degree angled abutments, and 7 25-degree angled abutments. 15 implant abutments were placed straight.	Customized guide stent.	6 osteotomies were performed on each model by a surgeon in the molar, premolar, and incisor regions, 2 implant osteotomies were created by a maxillofacial surgeon on each side. The position of	Interim luting agent	CBCT may be a helpful method for evaluating Implant abutments and SAHs. The success rates of CBCT for defining the location and direction of the SAHs in straight abutments

						screw access hole of the implant abutments, depends on the direction of the inserted implant, could be in the buccal, lingual, mesial, distal, or central portion. A CBCT was performed and the screw access channel was located using rulers, callipers and protractors. The prosthodontist was asked to access the SAH. If it was accessed the result was considered positive and vice versa.		were greater than that in angled forms.

TABLE 6: ASSESSMENT OF RISK OF BIAS OF EACH INCLUDED COHORT STUDY BY NEWCASTLE-OTTAWA SCALE

Study	Selection				Comparability	Outcome			Total Quality Score
	Representativeness of the exposed cohort	Selection of the non-exposed cohort	Ascertainment of exposure	Demonstration that outcome of interest was not present at start of study	Comparability of cohorts on the basis of the design or analysis controlled for confounders	Assessment of outcome	Was follow-up long enough for outcomes to occur	Adequacy of follow-up of cohorts	
LEE ET AL [39]	1	1	0	1	1	1	0	0	5
LEE ET AL [41]	1	1	1	1	1	1	0	0	6
NESHANDAR ASLI ET AL [43]	1	0	0	1	1	1	0	0	4
CHOI ET AL [44]	1	1	0	1	1	1	0	0	5
FARZIN ET AL [1]	1	1	0	1	1	1	0	0	5

TABLE 7 – DETERMINING THE QUALITY OF STUDIES BASED ON NEWCASTLE-OTTAWA SCALE

Study	Selection	Comparability	Outcome	Total Quality Score	Quality of Study
LEE ET AL [39]	3	1	1	**5**	**Fair**
LEE ET AL [41]	4	1	1	**6**	**Fair**
NESHANDAR ASLI ET AL [43]	2	1	1	**4**	**Fair**
CHOI ET AL [44]	3	1	1	**5**	**Fair**
FARZIN ET AL [1]	3	1	1	**5**	**Fair**

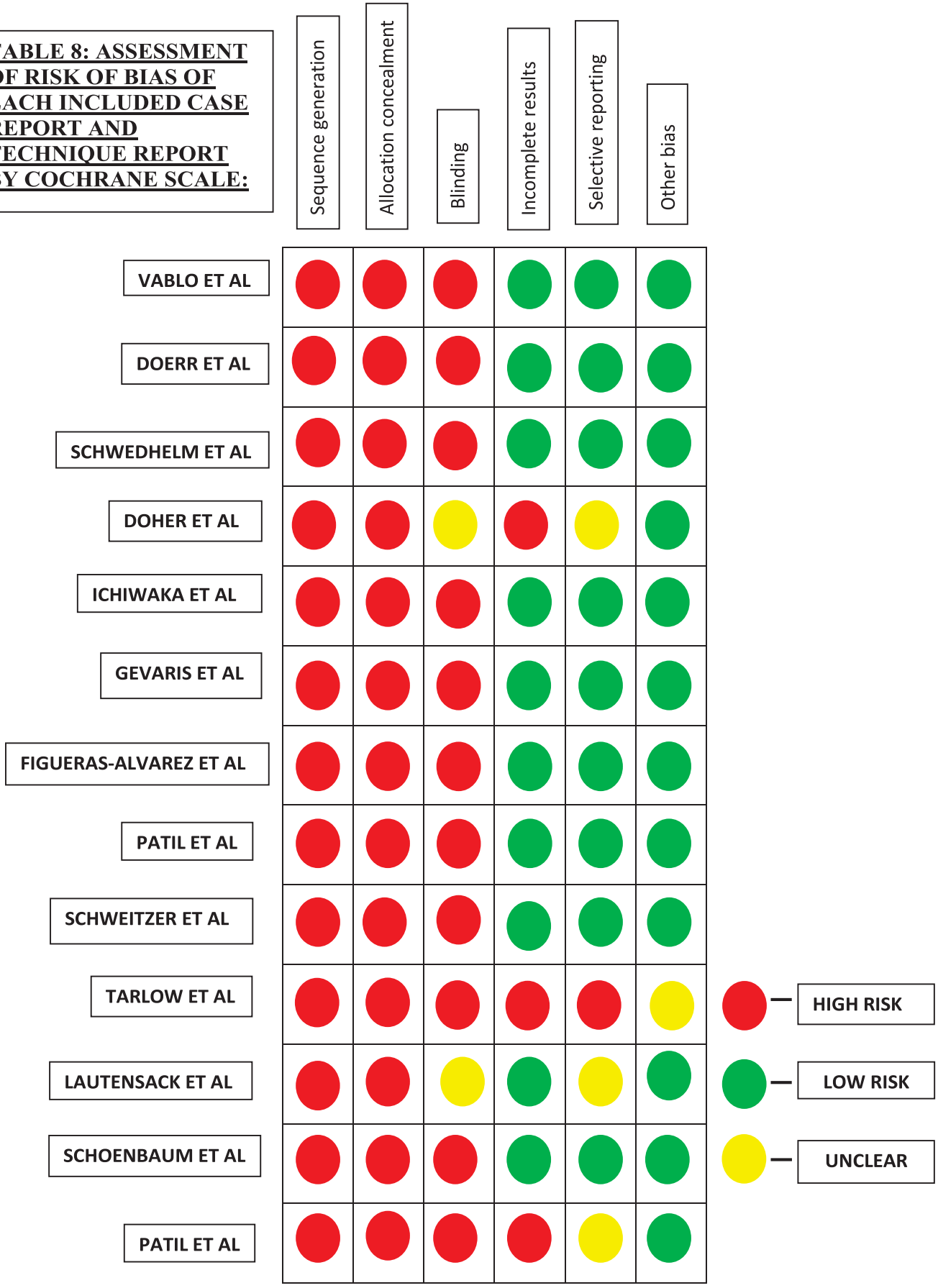
The Newcastle–Ottawa Scale was followed to assess the risk of bias of the prospective studies. The methodological quality was based on selection, comparability, and outcome domain.

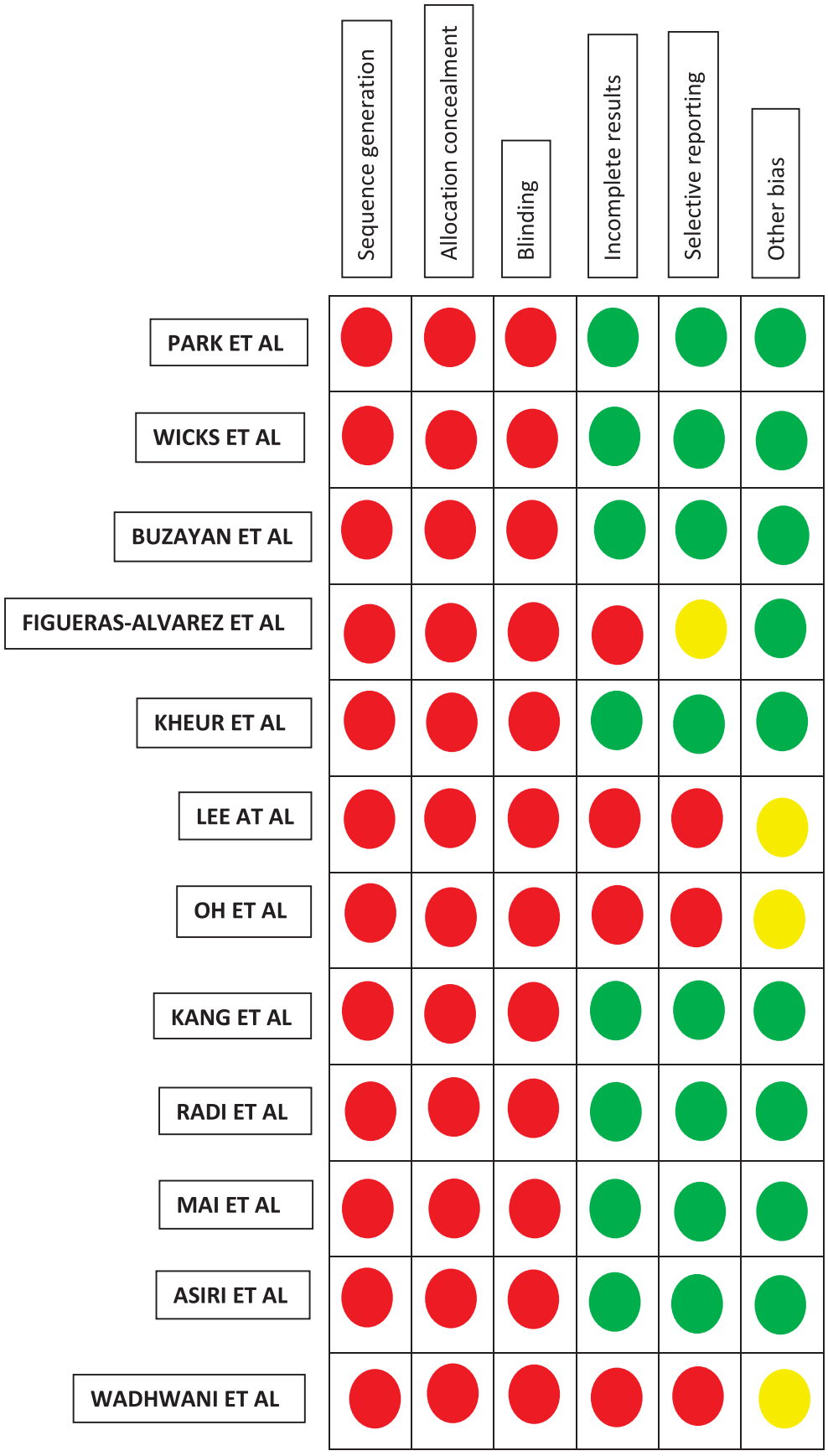
The study was classified to be of good quality if "3 or 4 stars in selection domain," "1 or 2 stars in comparability domain," and "2 or 3 stars in outcome/exposure domain" are obtained.

The study was considered to be of fair quality if it secured "2 stars in selection domain," "1 or 2 stars in comparability domain," and "2 or 3 stars in outcome/exposure domain."

The quality of the study was considered poor when it obtained "0 or 1 star in selection domain," "0 stars in comparability domain," or "0 or 1 star in outcome/exposure domain.

TABLE 8: ASSESSMENT OF RISK OF BIAS OF EACH INCLUDED CASE REPORT AND TECHNIQUE REPORT BY COCHRANE SCALE:




Sequence generation
Allocation concealment
Blinding
Incomplete results
Selective reporting
Other bias
PARK ET AL
WICKS ET AL
BUZAYAN ET AL
FIGUERAS-ALVAREZ ET AL
KHEUR ET AL
LEE AT AL
OH ET AL
KANG ET AL
RADI ET AL
MAI ET AL
ASIRI ET AL
WADHWANI ET AL

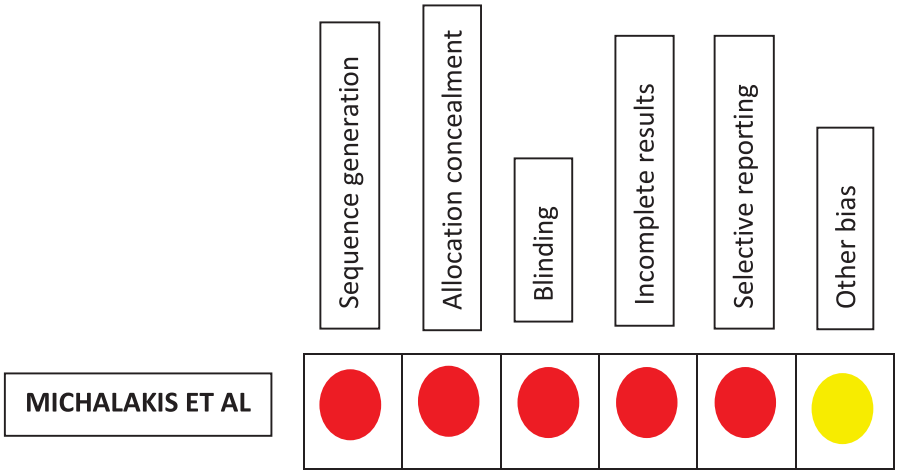
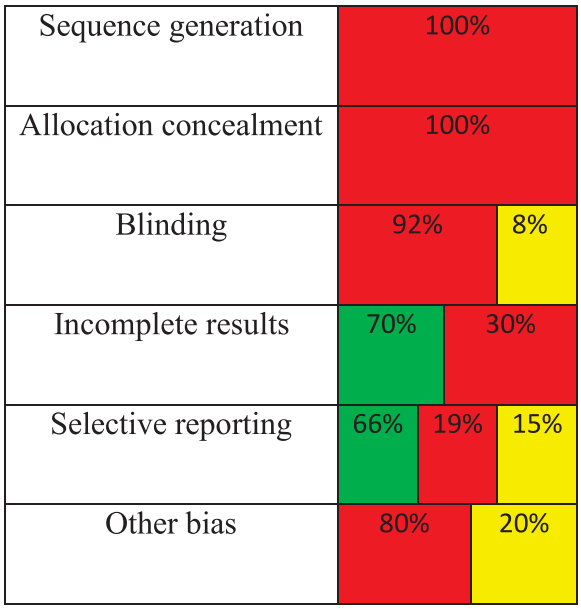


TABLE 9: ASSESSMENT OF RISK OF BIAS OF ALL CASE REPORT OR TECHNIQUE REPORT IN GENERAL BY COCHRANE SCALE



DISCUSSION

A systematic review is a review of a precisely articulated question that attempts to minimize bias by identifying, selecting, critically evaluating, and summarizing relevant research using systematic and explicit methods. They are considered a research activity, despite the fact that the data is derived from primary studies in the field of interest rather than direct experimentation. They differ from other types of reviews in that they follow the standard scientific protocol, making them more comprehensive. They reduce the possibility of bias and provide more reliable results from which to draw conclusions.[55]

Retrieval after implant rehabilitation may be needed in cement retained implant supported fixed dental prosthesis due to biological and technical complications. Screw loosening is considered one of the most common complications in implant supported prosthesis. Retrieval of screw retained prosthesis is easier when compared to cement retained prosthesis. The damage to crown, abutment and implant is possible while retrieving a cement retained prosthesis. [1]

Hence to minimize the damage a screw access hole (SAH) should be created on the prosthesis for retrieval of cement retained implant prosthesis. This technique also reduces the chances of damage to abutment and implant itself. Also refitting and repair of prosthesis is possible using this technique. But the problem here is the location of screw access hole. Hence this systematic review was performed to evaluate the data available on different techniques for ease of retrieval of cement retained implant supported fixed dental prosthesis.

The studies selected to conduct this review were divided into three groups according to the technique used for retrieval of cement retained implant supported fixed dental prosthesis. The first group comprised of identification markers such as cross pinning, lingual slot, external staining, a special ledge along with screw access hole. The cross-pinning technique is basically a combination of screw retained prosthesis and cement retained prosthesis. These designs create an interface that is more capable of dissipating the forces between the implant abutment connections, and the presence of the SAH allows retrievability of the prostheses. The ability to detect the SAH is no different than with any other screw-retained prosthesis. Here, Vablao et al [18], Ichiwaka et al [22], Gevaris et al [23] also concluded that cross pinning is an efficient technique for retrieval of cement retained implant supported fixed dental prosthesis.

The other techniques that are lingual slot, external stain and special ledge along with screw access hole have external contours which promotes plaque accumulation, tongue discomfort, special instruments for lifting of prosthesis. However, they can be used for single or multiple implant prosthesis and straight or angulated abutments.

Studies by Choi et al [44] and Schweitzer et al [17] used lingual slots to retrieve the prosthesis and their conclusion was similar to that obtained in this review. Studies by Schwedhelm et al [20] and Schoenbaum et al [29] were based on external stain. They concluded it to be an efficient technique as it does not require any additional skills or equipment's but it cannot locate the angulation of SAH and these conclusions are in accordance to the results of this review. The study by Farzin[1] et al also provides same results as that of this study.

For location of screw access hole in cement retained implant supported fixed dental prosthesis two dimensional and three-dimensional techniques can be used. Two-dimensional techniques show the location of screw access hole in two planes while three-dimensional techniques show the location of screw access hole in three planes. Two-dimensional techniques include digital photographs, periapical radiographs (IOPA) and arbitrarily made guide stents. The problem with two-dimensional technique is that it needs to be stored and also digital photographic technique requires operator to be skilled but on the contrary, it can be used with single or multiple fixed prosthesis and straight or angulated abutments. [19,26]

Doher et al [21] concluded that digital photographs are less harmful to abutment and also reduces the time of patient visit but is an arbitrary method for location of SAH. While Figueras-Alvarez et al [16,33] in two studies done by him concluded digital photographs are not very efficient for
retrieval of cement retained prosthesis which is in accordance with the results of this study. On the contrary, Michalakis et al [54] concluded digital photographs to be a very efficient technique and recommended the use of this technique over other techniques.

Buzayan et al [32] used an IOPA to determine the position of Screw access hole but the major shortcoming was that he located SAH only in mesiodistal dimension decreasing the efficiency of this technique. These results are in harmony with the results obtained from this review. Yet the screw loosening is first diagnosed mainly by intra oral peri apical radiographs.

Doerr et al [19], Tarlow et al [26], Wadhwani et al [28], Laustensack et al [27], Kheur et al [34] and Radi et al [38] in their studies concluded that guide stents help locate the position of SAH but requires a stent to be made preoperatively. Also, the prosthesis material must be considered while performing a CBCT scan, because elements that are radio dense such as zirconia or gold may not show the depth or the direction of abutment within prosthesis. But lithium disilicate are relatively low in radiodensity, and therefore, the screw access hole may be more easily identified radiographically. CBCT is generally avoided due to radiation exposure and cost. Also, the scatter from high-density materials such as zirconia, gold, or lithium disilicate may limit their use for registering screw access hole. [25,27,38]

Wicks et al [25] and Park et al [30] performed CBCT scan to locate SAH and concluded that CBCT scan can accurately locate the SAH but has to be arbitrarily located in patient's mouth. This conclusion is in accordance with the results obtained from this review.

Vacuum formed clear guide stents with guiding sleeves made using a CBCT scan can be developed into a 3D guide fixed with acrylic resin. For a unique structure, some CAD-CAM techniques include 3D guide printing. Studies by Kang et al [37], Mai et al [40], Lee et al [51], Asiri et al [42] and Neshan Dar Ali [43] et al used CBCT scan to make a customized guide stent to locate SAH. They concluded it to be a very precise method as it gives location as well as angulation of SAH and these results are similar to that obtained from this review.

Although the advantage of 3D techniques over 2D techniques is that they provide information regarding the screw access hole location and angulation, none of the techniques have been verified through clinical studies. Therefore, clinical studies are necessary before developing detailed recommendations. In the absence of these techniques for recording the position of the screw access hole, at least one incisal or occlusal digital photograph recording the access to the screw should be registered. This photograph can be stored in the patient's chart or sent by e-mail to have a permanent record.

CONCLUSION:

Based on the findings of this systematic review, following conclusion can be drawn:

- On the basis of clinical situation any of the described technique can be used for retrieval of cement retained implant supported fixed dental prosthesis.
- The primary disadvantage of most of the Screw access hole registration techniques described is that they only provide a 2D estimated position.
- Although long-term clinical studies are lacking, guides with guiding sleeves and CAD CAM guide stents are effective 3D techniques for registering screw access hole location and angulation.
- The benefits and drawbacks of the techniques described should be considered before implementing any of them in practice.

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