RNI No.: UPENG/2011/41591 | Peer Reviewed Journal | Asia Edition | ISSN : 2278-1161

updent

A Journal of Advanced Dentistry

M-14|ESTD 2010 www.updent.in updent@gmail.com Volume 14 | Issue 01 | January-June 2025

updent
A Journal of Advanced Dentistry

Markers in Dentistry : Advancing Accuracy in Full-Arch Implant Rehabilitation

Implant-supported full-mouth rehabilitation has become a revolutionary treatment modality in the field of prosthodontics, providing edentulous patients with functional, aesthetic, and long-lasting solutions. This procedure involves the placement of dental implants to support fixed prostheses, restoring function and aesthetics in the entire arch. As dental technology evolves, the role of markers has become increasingly pivotal in enhancing the success of full-arch implant rehabilitation.

Digital Workflows and the Role of Markers

The introduction of digital impressions and scanning techniques has transformed the planning and execution of full-arch rehabilitation. A key element in achieving optimal results in these procedures is ensuring precise implant placement and accurate prosthesis fabrication. Markers, both physical and digital, play a crucial role in enhancing the accuracy and reliability of these processes.

A study outlines a fully digital workflow for creating prosthesis prototypes in complete-arch implant rehabilitation. The study highlights the benefits of digital technology, especially the use of integrated markers that aid in accurate implant placement and precise prosthetic design. By replacing traditional impressions with digital scanning, the workflow minimizes errors that typically arise from material distortion or patient movement. The incorporation of markers into the digital scans enhances design accuracy, reduces the likelihood of errors linked to conventional impression methods, and ultimately improves treatment outcomes[1].

Digital vs. Conventional Impressions in Full-Arch Implant Rehabilitation

An essential component of full-mouth implant-supported rehabilitation is the impression-taking procedure. Conventional techniques, such as elastomeric impressions, often face limitations in accuracy, especially in cases involving edentulous arches. In contrast, digital impressions have become increasingly popular due to their higher precision and ability to capture detailed anatomical structures with greater comfort for patients. A comparative study examined the effectiveness of digital versus traditional full-arch implant impressions and found that digital methods, using intraoral scanners, demonstrated greater accuracy. A major benefit of digital scanning is the use of markers, which enhance the precision in recording implant positions and designing prosthetics. The study concluded that digital impressions, especially when supported by markers, were more accurate and efficient than conventional approaches for full-arch implant rehabilitation[2].

Accuracy of Digital Impressions with Auxiliary Geometry

The precision of digital impressions can be significantly improved through the use of auxiliary geometry parts-markers deliberately positioned within the edentulous arch to enhance the detailed capture of anatomical structures. An in vitro study was conducted to assess the accuracy of digital impressions for complete-arch implant-supported prostheses using these auxiliary components. The findings showed that incorporating such markers increased the accuracy of digital scans, particularly in recording the positions of implants and prosthetic elements. The researchers concluded that these markers are essential in refining the precision of digital impressions, contributing to a well-fitting and properly functioning final prosthesis[3].

Improved Digital Impressions for Edentulous Areas

Capturing accurate digital impressions in edentulous patients can be particularly challenging due to the absence of teeth, which normally serve as reference points. A study investigated ways to enhance digital impression accuracy in these cases, focusing on the use of artificial landmarks and markers. The results showed that incorporating markers into the digital workflow significantly increased the precision of impressions in edentulous areas, leading to prostheses that were not only functionally effective but also visually satisfactory[4].

The authors explored digital intraoral scanning techniques for edentulous jaws, highlighting how the use of digital scanners along with markers can enhance the accuracy of impressions for edentulous arches, addressing some of the challenges posed by traditional impression methods. By integrating artificial landmarks or markers into the scanning process, the precision and consistency of the impressions are improved, resulting in prostheses that fit better[5].

Artificial Markers for Accuracy Enhancement

The use of artificial markers such as CT-SPOT 120, Gutta percha, Mini screws, Anchor pins, Ctmark CT23, Radiopaque spheres etc in digital impressions for edentulous areas has been further explored to assess the accuracy of intraoral digital impressions. The study highlighted that the addition of artificial markers helped in better capturing the edentulous arch, improving the precision of the digital model and ensuring a more accurate final prosthetic restoration. By incorporating these markers, clinicians can overcome some of the inherent challenges posed by the lack of anatomical landmarks in edentulous patients, ultimately leading to better prosthetic outcomes[6].

Emerging Marker Technologies for Edentulous Patients

Recent advancements in marker technology have focused on improving the accuracy of digital impressions, particularly in aging societies where edentulous patients are becoming more prevalent. Study has been conducted to investigate how artificial markers could be used to improve the accuracy of digital impressions in edentulous areas. The study emphasized the potential of these markers in enhancing the overall treatment outcomes for aging populations, who often face challenges with traditional impression-taking methods due to age-related factors such as reduced mouth opening and difficulty maintaining impressions. The authors proposed that the future of edentulous patient care lies in the integration of these advanced marker technologies, which will allow for more precise and efficient implant-supported rehabilitation[7].

Practical Implications of Markers in Full-Mouth Rehabilitation

Markers are becoming increasingly integral to the digital workflow in implant-supported full-mouth rehabilitation. They serve not only as aids for capturing accurate impressions but also as guides for implant placement and prosthesis design.

A prospective study comparing digital and conventional full-arch implant impressions revealed that the use of markers in digital impressions improved the overall precision of the treatment process, leading to better-fitting prostheses and a more predictable treatment outcome. The integration of markers into the digital workflow has thus proven to be an essential step in enhancing the accuracy of full-arch implant rehabilitation8.

Conclusion

Markers in dentistry, particularly in implant-supported full-mouth rehabilitation, represent a significant advancement in ensuring the precision and predictability of treatment outcomes. Markers have proven to be indispensable tools in enhancing the accuracy of impression-taking, implant placement, and prosthesis fabrication. As digital technology continues to evolve, the use of markers is expected to play an increasingly prominent role in the field of prosthodontics, offering edentulous patients more reliable, functional, and aesthetically pleasing solutions. With ongoing research and innovation, the integration of markers into the digital workflow holds great promise for the future of full-arch implant rehabilitation.

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Access this article online
Website : www.updent.in
Updent - A Journal of Advanced Dentistry. (2025). Markers in Dentistry : Advancing Accuracy in Full-Arch Implant Rehabilitation. Updent- A Journal of Advanced Dentistry, 14(1), 3–4. https://doi.org/10.5281/zenodo.16556673
Quick Response Code:

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updent
A Journal of Advanced Dentistry
Print ISSN 2278-1161

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Ph.: +91-1342-359-420

PRINTED, PUBLISHED & OWNED BY
Afzal A Zaidi,
'Express House',
967/21-C, Housing Board Colony,
Faridabad-121001
(Haryana) India.

Website & e-mail : http://www.updent.in, updent@gmail.com,

Printed at : Rolleract Press Services C-163, Ground Floor, Naraina Industrial Area, Phase-I, New Delhi-110 028

A Journal of Advanced Dentistry 'Updent' is indexed/listed with Index Copernicus, Google Scholar & Inno Space etc.

The Journal is based on Clinical Dentistry & issues are published Bi-annual in the last week of June, December.

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A Journal of Advanced Dentistry
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Pre-Surgical Orthodontics - A Narrative Review

Received on : 26-05-2025 | Accepted on : 13-6-2025 | Published on : 29 07 2025

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Abstract

Orthodontic treatment plays a vital role in contemporary orthognathic surgery, ensuring proper alignment and functional occlusion post-surgery. Fixed orthodontic appliances are typically required to achieve ideal arch coordination and occlusal interdigitation. Effective treatment planning involves careful analysis of tooth movements in all three planes of space, using comprehensive clinical assessments and diagnostic records. Collaboration between the orthodontist and surgeon is essential for successful outcomes. Thorough documentation of the orthodontic plan is critical and should be readily accessible throughout treatment. This structured approach supports predictable and efficient progress, helpingto achieve both functional and aesthetic goals in orthognathic treatment.

Keywords : Class II Malocclusion, Class III Malocclusion,Envelope of Discrepancy, Open-bite, Pre-surgical Orthodontics, Vertical Maxillary Deficiency, Vertical Maxillary Excess

Introduction

The term Orthognathic is derived from the Greek words "*orthos*," meaning straight, and "*gnathos*," meaning jaw. Orthognathic surgery refers to the surgical correction of facial skeletal components to restore proper anatomical and functional relationships in individuals with dentofacial and skeletal deformities.[1]

A jaw discrepancy is usually involved in a severe malocclusion, and only 3 possible treatments exist:[2]

- **Growth Modification :** In children who are still growing, dentofacial orthopaedics can influence and redirect growth patterns to a certain degree.
- **Orthodontic Camouflage :** Skeletal deformities may be masked through dental compensation, known as orthodontic camouflage, although this often results in extended treatment durations.
- **Orthognathic Surgery :** Once skeletal growth is complete, the most effective approach to correcting dentos-keletal discrepancies is a combination of orthodontic treatment and surgical intervention.

For patients with orthodontic issues so severe that neither growth modification nor camouflage is sufficient, jaw realignment or repositioning of dentoalveolar segments through surgery becomes the only viable option. In such cases, surgery is not a replacement for orthodontic care, but rather must be carefully integrated with orthodontic and other dental treatments to ensure successful and comprehensive outcomes.[3]

Historical Background

A precise chronological account of the development of orthognathic surgery is unattainable, as surgeons in various countries were independently, and at times simultaneously, pioneering different techniques to reposition the maxilla, mandible, and chin.[4]

1. **Simon P. Hullihen**

   The earliest recorded surgical procedure that could be classified as 'orthognathic' was likely carried out by American surgeon Simon P. Hullihen (Figure 1a) in 1849. He documented the case of a 20-year-old female patient, 'Mary S' (Figure 1b), who developed a prognathic mandibular open bite deformity as a result of severe burns to her neck and chest at age 5, leading to scar contractures.[4]

How to Cite This Article : Mishra et al. - Updent - A Journal of Advanced Dentistry. (2025). Pre-Surgical Orthodontics - A Narrative Review. Updent- A Journal of Advanced Dentistry, 14(1), 7–14. https://doi.org/10.5281/zenodo.16556706

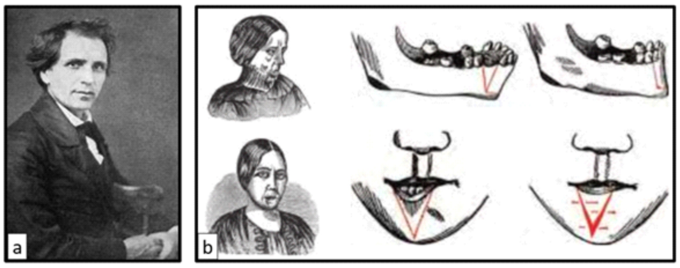


Figure 1: (a) Simon P. Hullihen, (b)'Mary S', aged 20, female patient, first-known surgical correction of a prognathic mandibular open bite deformity developed a prognathic mandibular open bite deformity as a result of severe burns to her neck and chest at age 5, leading to scar contractures.

1. Edward H. Angle

In 1898, James Whipple described a long-term case involving 'Mr K,' noting a pronounced prognathism of the lower jaw and a visible gap between the first and second bicuspids. Two years earlier, in 1896, he had referred the patient to Edward H. Angle (Figure 2), who advised performing a double resection of the lower maxilla to correct the severe protrusion. The patient, however, chose not to proceed with the surgery.[4]

Figure 2: Edward H. Angle

1. Vilray Papin Blair

Vilray Papin Blair (Figure 3a), in 1897, carried out the first 'double resection of the mandible' on the patient who declined Angle's treatment approach. This procedure consisted parallel cuts in the premolar areas and removal of the bone segments using an extraoral approach,resulting in a bilateral ostectomy of the mandibular body, as depicted in Figure 3b. The bony segments were secured with copper wire interosseous ligatures. Four months later, Whipple placed gold crowns on the posterior teeth to 'improve the occlusion.' Angle later commented that a V-shaped section should have been used for postoperative stabilization along with cast gold splints (Figure 3c).[4]

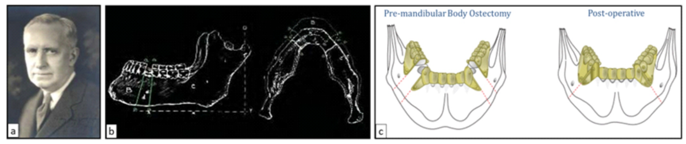


Figure 3:(a) Vilray Papin Blair, (b)Blair's Mandibular Body Ostectomyundertaken in 1897 (c) Cast gold splints for post-operative fixation as suggested by Edward H. Angle.

1. Rodrigues Ottolengui

Rodrigues Ottolengui (Figure 4a), a prominent American dentist and orthodontist, criticized Angle's splint and proposed that a single template splint (Figure 4b) should be used instead. This splint would represent the planned postoperative dental occlusion and after the ostectomy the teeth are cemented to it.[4]

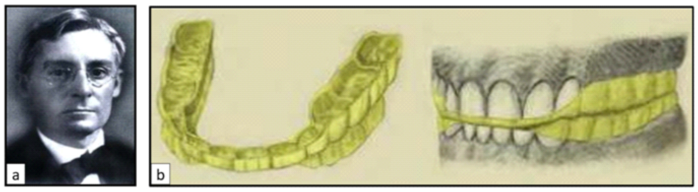


Figure 4: (a) Rodrigues Ottolengui (b)Single Template Splint

1. Max Ballin

Max Ballin (Figure 5a), a surgeon from Detroit (Michigan), suggested:[4]

'I would recommend ... to extract the teeth, necessary to remove for the resection, first, and then wait some months until the extraction wound is completely healed and atrophy of the alveolar process on the place of extraction has taken place. Then the surgeon can proceed, as in our case; that is, excise a piece of the jaw without entering the oral cavity'(Figure 5b)

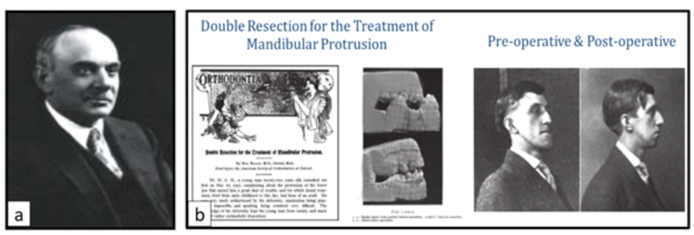


Figure 5:(a) Max Ballin (b)Ballin's paper from 1908

Orthodontic-orthognathic Treatment Objectives

To explain the major objectives to patients considering orthodontic–orthognathic treatment, the acronym FRESH (Figure 6) has proven to be useful as a guide:[5]

F Function
R Reliable, Realistic
E Esthetics, Economic
S Stability, Satisfaction
H Health

Figure 6: Orthodontic-Orthognathic Treatment Objectives acronym as 'FRESH'

1. Function: The goal is to establish optimal gnathologic parameters for the stomatognathic system, such as balanced bilateral posterior occlusal support, to ensure temporomandibular joint (TMJ) stability and health without symptoms, canine rise, and incisal guidance.[5]

2. Reliable: Treatment methods that have been scientifically proven to be highly effective and carry lower risks for achieving skeletal corrections include:[5]

- o The use of micro-screws as anchorage in non-surgical treatments.
- o Jaw surgery for treating sleep apnoea.
- o Rigid fixation techniques.

3. Realistic: A treatment plan designed to maximize the likelihood of fulfilling both the patient's and doctor's expectations.[5]

4. Esthetics: Assessing facial aesthetics involves evaluating both the profile and frontal views to achieve soft tissue harmony and optimal symmetry. Facial balance should be maintained not only at rest but also during speech and facial expressions, particularly when the patient is smiling.[5]

5. Economic: Financial concerns often hinder the ideal combined orthognathic–orthodontic treatment plan due to limited insurance coverage for orthodontic care and reduced benefits for orthognathic surgery.[5]

2. Stability: An essential aspect of successful treatment is achieving jaw and tooth positions that remain reasonably stable over time.[5]

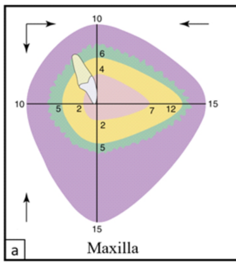
3. Satisfaction: To ensure satisfaction for both the patient and provider, it is important to have open conversations about the potential limitations or drawbacks of the chosen treatment plan. Utilizing visualized treatment goals and computerized simulations can help guide and support both the patient and provider.[5]

4. Health: The aim of treatment plans is to address and improve diseased or nonfunctional aspects while preserving the healthy elements of the case. This involves promoting emotional well-being, supporting the comfort, function, and health of the Temporomandibular Joint (TMJ), and maintaining periodontally healthy tissues.[5]

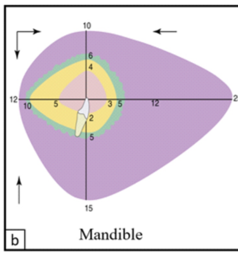
Epker Envelope Of Discrepancy

'Envelope of discrepancy' (Figure 7) given by Proffit and Ackermann graphically illustrates the amount of change possible with various treatment approaches:6

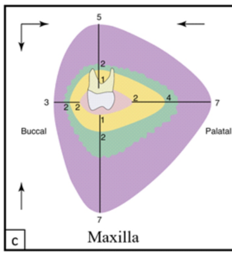
- o **Inner circle:** Limits of orthodontic tooth movement alone.
- o **Middle circle:** Tooth movement combined with growth modification.
- o **Outer circle:** Surgical correction



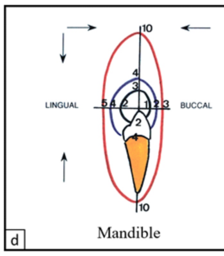
	RETRACTION	PROTRACTION	INTRUSION	EXTRUSION
Only Orthodontic Treatment	7 mm	2 mm	2 mm	4 mm
Orthodontic & Growth Modification	12 mm	5 mm	5 mm	6 mm
Orthognathic Surgery	15 mm	10 mm	15 mm	10 mm



	RETRACTION	PROTRACTION	INTRUSION	EXTRUSION
Only Orthodontic Treatment	3 mm	5 mm	4 mm	2 mm
Orthodontic & Growth Modification	5 mm	10 mm	6 mm	5 mm
Orthognathic Surgery	25 mm	12 mm	10 mm	15 mm



	EXPANSION	CONTRACTION	INTRUSION	EXTRUSION
Only Orthodontic Treatment	2 mm	2 mm	1 mm	1 mm
Orthodontic & Growth Modification	4 mm	2 mm	2 mm	2 mm
Orthognathic Surgery	7 mm	3 mm	7 mm	5 mm



	EXPANSION	CONTRACTION	INTRUSION	EXTRUSION
Only Orthodontic Treatment	2 mm	1 mm	3 mm	2 mm
Orthodontic & Growth Modification	4 mm	2 mm	4 mm	4 mm
Orthognathic Surgery	5 mm	3 mm	10 mm	10 mm

Figure 7: Amount of tooth movement possible – (a) Anterior region of Maxilla[5], (b) Anterior region of Mandible[5], (c) Posterior region of Maxilla[5], and (d) Posterior region of Mandible[7]. The coloured zones illustrate the potential range and direction of tooth movement, as indicated by the arrows in the diagram. The pink zone represents movement achievable with orthodontics alone, the yellow zone includes orthodontics combined with orthopaedics, the green zone involves skeletal anchorage, and the blue zone encompasses any combination of these with orthognathic surgery. The green zone appears "fuzzy" due to limited reliable data, allowing only approximate estimations.

Need For Surgical Orthodontic Treatment

The 'envelope of discrepancy' demonstrates that teeth can be moved more easily in some directions than others at any age, with little change in movement limits over time.[6] Growth modification is effective only during active growth periods. In children, growth modification allows for greater correction than tooth movement alone can provide in adults; for instance, certain conditions like a centimetre of overjet can be managed orthodontically in children but often require surgery in adults. A problem in a child is considered too severe for orthodontic treatment alone if it cannot be corrected by combining growth modification and camouflage. For older individuals, when the jaw discrepancy is too large to be compensated for or masked by tooth movement alone, surgery is the only option to achieve a satisfactory outcome (Figure 8).

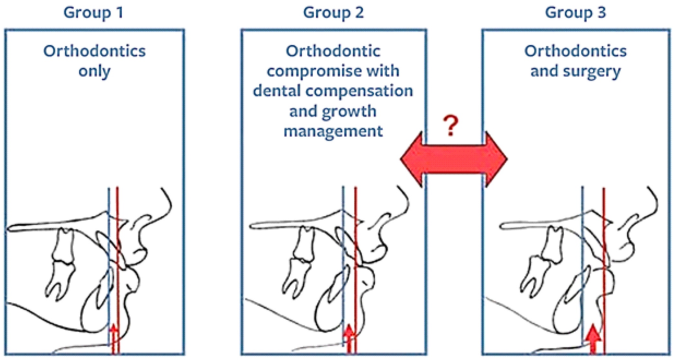


Figure 8: Selecting a treatment – (Group 1) Normal skeletal relationship, (Group 2) Mild to moderate skeletal discrepancy, and (Group 3) Moderate to severe skeletal discrepancy 2

Skeletal Class II Malocclusion: [6]

- 7mm or more of anterior overjet is highly correlated with the presence of Skeletal Class II Malocclusion, which in turn results from mandibular deficiency in most patients.
- Excessive overjet and jaw deformity require surgical correction.

Skeletal Class III Malocclusion: [6]

- Presence of Skeletal Class III Malocclusion can be estimated from reverse overjet.
- Growth modification or orthodontic camouflage is not successful where the mandible is prognathic.
- Orthodontic management of reverse overjet of about 3mm can be achieved, but severe cases require surgical maxillary advancement or mandibular setback or both.

Goals of Pre-surgical Orthodontic Treatment

To ensure that during surgery, there are no obstacles to placing the jaws in their proper positions, the goal of pre-surgical orthodontics is to establish compatible arch forms and align the teeth in each arch. Teeth should be within a half cusp of their final transverse position so that post-surgical occlusion does not lock them into a crossbite.[6]

- **Dental Compensation:** 'Natural compensation' refers to the partial adjustment of anterior tooth axial inclination in the opposite direction to counteract severe skeletal jaw discrepancies (Figure 9a).
- **Reverse Orthodontics:** In preparing for jaw surgery, deliberately making the occlusion worse initially is often necessary (Figure 9b).

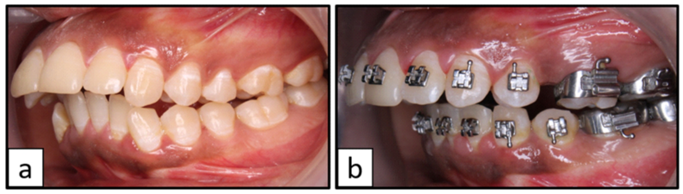


Figure 9: (a) Dental Compensation (b) Reverse Orthodontics

Surgical Treatment Objective (STO)

Epker and Fish proposed the "Two Patient Concept," wherein a mock surgical procedure is conducted on the patient's dental casts, which are subsequently considered as representing a second patient. This approach enables the orthodontist to evaluate the necessity of a pre-surgical orthodontic phase and, if already completed, to determine whether any additional corrections are required prior to surgery or can be effectively addressed during the post-surgical orthodontic phase.[8]

The postsurgical appearance of a patient can be reasonably predicted using cephalometric analysis. This technique, referred to as the 'surgical-treatment objective' (STO) or 'prediction tracing,' provides a two-dimensional visual representation of the expected changes in skeletal, dental, and soft tissue structures resulting from combined orthodontic treatment and orthognathic surgery to correct dentofacial and occlusal abnormalities.[9]

Various methods for STO prediction:[10]

1. **Manual Tracing Method:** Traditional method using acetate tracing paper over a lateral cephalometric radiograph to simulate skeletal, dental, and soft tissue movements manually.
2. **Template Prediction Method:** Uses transparent templates representing surgical movements (e.g., mandibular advancement or maxillary impaction) overlaid on cephalometric tracings to estimate postsurgical outcomes.
3. **Photographic Prediction:** Combines lateral facial photographs with cephalometric tracings to visually estimate soft tissue changes after surgery.
4. **Computer-Assisted Prediction:** Digital software simulates surgical movements and predicts both hard and soft tissue changes with greater accuracy and visual clarity.
5. **Model Mock Surgery (Two Patient Concept):** Involves performing mock surgery on mounted dental

casts to plan and assess the surgical outcome and its orthodontic implications.

Treatment Planning For Surgical-orthodontic Treatment

1. Surgical Changes In Width Of Maxilla:

Surgically, it is possible to narrow or widen the maxilla. Narrowing the maxilla is technically difficult because it is necessary to remove bone to bring the 2 sides closer together, but this movement is entirely feasible (Figure 10a).At the extreme, the maxilla can be widened or narrowed perhaps 15mm, but 10mm of change is a more reasonable expectation. When the maxilla is widened surgically, there is considerable relapse tendency, which is expressed in 2 ways:[6]

a. Skeletal Relapse: Even when a bone graft is used to fill the gap and tooth position is preserved, the two halves of the maxilla tend to relapse and move back together after surgery.

b. Dental Relapse: Tendency of teeth to return to their original positionafter fixation is released.

Combination of these two effects leads to approximately 40% decrease in intermolar width that was established at surgery.

2. Surgical Changes In Width Of Mandible:

Changes in mandibular width are not as easy to make.There are 2 major limitations: (a) Soft tissue envelope and (b) TMJ. It is possible to narrow the mandible anteriorly and to widen or narrow the alveolar process somewhat posteriorly (Figure 10b).However, it is not possible to significantly widen the mandible or the dental arch anteriorly.[6]

3. Surgical Anteroposterior And Vertical Changes Of Maxilla:

Although movements in both directions are possible, they are not equally feasible (Figure 10c).The maxilla can be repositioned superiorly by 10-15mm with excellent stabilityand advancedby 10mm with good stability. The major limitation to moving the maxilla forward is the resistance of soft tissue anterior to it. Primarily,the upper lip makes advancing the maxilla difficult; the tighter the lip greater the resistance.The entire maxillary dentition can be moved backward surgically, but posterior bone interference limits this, and the maximum is only 3-5mm.Instead, the objective can be to retract the protruding anterior portion,and this can be accomplished by sectioning the maxilla and removing bone across the palate.Then the anterior segment can be brought back posteriorly while the posterior segments remain in position or move anteriorly.Moving the entire maxilla down is technically feasible, although an interpositional bone graft is required.This movement is difficult as it is not stable post-surgically, because the maxilla tends to move back up due to the stretch of soft tissue created when the maxilla is repositioned ina downward direction.When the maxilla is moved up, it does not tend to come back down and indeed is remarkably stable in its superior position.[6]

4. Surgical Anteroposterior And Vertical Changes Of Mandible:

The inferior border or chin can be repositioned upward or downward, while the mandible can be advanced or set back. The gonial angle region can be elevated, although lowering it presents more of a challenge. When repositioning the mandible forward or backward, there are three potential options for vertical reorientation:[6]

a. The mandibular plane can increase as the gonial angle moves up and/or the chin moves down.

b. It can remain approximately the same as the mandible is repositioned along the existing mandibular plane.

c. It can decrease as the chin moves up andthe gonial angle moves down.

Mandibular surgery that rotates the mandible down anteriorly and up posteriorly has excellent stability. Surgical movements along the existing mandibular plane, particularly advancements, are not as stable but are still acceptable. Surgery that rotates the mandible up anteriorly and down posteriorly is notoriously unstable and should be avoided whenever possible (Figure 10d).[6]

5. Dental-alveolar Surgery:

Surgical repositioning of dentoalveolar segments can be performed in all three planes of space.There are some limitations on the distance that the segments can be moved and on the size of the segments themselves (Figure 10e).As a general rule, the distance that the dentoalveolar segment can be moved surgically is approximately the same as the distance that teeth could be moved orthodontically.[6]

6. Chin Surgery:

Using an inferior border osteotomy, the chin can be repositioned in all three planes of space. Asymmetries can be corrected by shifting the chin sideways or adjusting its vertical position. A deficient chin can be advanced or moved downward, while an excessive projection can be corrected by repositioning it upward or backward (Figure 9f).[6]

There are two primary methods to alter chin position:

1. Repositioning it through an inferior border osteotomy.
2. Augmenting it with additional materials such as bone, cartilage, or other alloplastic substances.

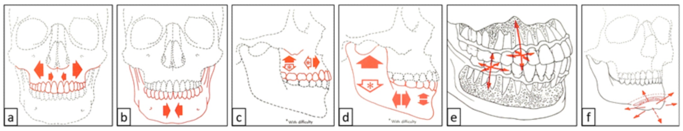


Figure 10: Surgical Changes – (a) Width of Maxilla, (b) Width of Mandible, (c) Anteroposterior and Vertical of Maxilla, (d) Anteroposterior and Vertical of Mandible, (e) Dentoalveolar Surgery,and (f) Chin Surgery[6]

Diagnosis And Treatment Of Specific Dentofacial Deformities

I. Anteroposterior Mandibular Deficiency:

Class II Div 1 Malocclusion[11]

Clinical Characteristics : Profile View	Clinical Characteristics: Frontal View	Dental Characteristics
• Retruded chin • Chin-to-throat length is reduced • Convex profile • Everted lower lip • Short and protrusive upper lip • Deep mentolabial sulcus • Nose appear large due to deficient mandible	• Appearance of double chin • Deep labiomental fold • Everted lower lip	• Increased overjet • Accentuated Curve of Spee • Increased overbite • Tendency for maxillary incisor spacing • Crowding in mandibular incisors

Pre-Surgical Orthodontic Procedure[12]

1. Level and align the maxillary and mandibular arches
2. Establish appropriate anteroposterior and vertical incisor positions
3. Establish arch compatibility-

o Correct inter-canine width.

o Mandibular second molars must be banded.

o Similar maxillary and mandibular archforms should be established.

a. Crowded Cases – Maxillary Arch

· Second premolars should be extracted.

b. Crowded Cases – Mandibular Arch

· In cases with crowding, accentuated Curve of Spee,and need for mandibular incisor retraction, first premolars should be extracted.

· In case of less anteroposterior space requirement, second premolars should be extracted.

c. Non-Crowded Cases

· Minimal crowding and mild spacing, a non-extraction approach is recommended.

· Class III mechanics is mandatory.

2. Class II Div 2 Malocclusion[11]

Clinical Characteristics: Profile View	Clinical Characteristics: Frontal View	Dental Characteristics
• Short lower facial height • Low mandibular plane angle • Lower lip appears deficient • Pronounced chin button • Deep mentolabial sulcus • Mandible appears square	• Face appears short due to decreased vertical height • Deep labiomental fold	• Excessive Curve of Spee • Deep overbite • Maxillary central incisors are retroclined • Maxillary lateral incisors are labially flared

Pre-Surgical Orthodontic Procedure[11]

a. Maxillary Arch

· To achieve sufficient overjet, a proper arch form, and adequate lip support, it is important to labially tip the maxillary incisors.

b. Mandibular Arch

· Curve of Spee should be levelled post-surgically.

· In severe deep-bite cases, it may be difficult to level the Curve of Spee.

· The anterior part of mandible is advanced downward and forward to create Class I Incisor relationship, while lower anterior facial height is increased.

II. Anteroposterior Mandibular Excess:

1. Class III Malocclusion[11]

Clinical Characteristics : Profile View	Clinical Characteristics: Frontal View	Dental Characteristics
• Inferior border of mandible is well-defined • Long chin-throat angle • Lip-chin-throat angle is acute • Protrusive mandible • Reduced labiomental fold	• Chin button is not prominent • Chin is often asymmetrical • Lower third of face appears flat • Reduced labiomental fold	• Dental midline discrepancy • Anterior and posterior crossbites with Class III malocclusion • Mandibular incisors are lingually inclined • Generalized interdental spacing and flared incisors, with anterior open-bite, suggest a large tongue

Pre-Surgical Orthodontic Procedure[2]

1. Eliminate anterior and posterior dental compensation.
2. Establish appropriate anteroposterior and vertical incisor positions.
3. Achieve compatible archforms and inter-canine width.
4. Correct tooth size discrepancy problems.
5. If mandibular asymmetry is present, dental midline should be placed in midline of chin.
6. If chin deformity is present, dental midline change is not necessary as genioplasty will correct the chin position.

a. Maxillary Arch

· After dental decompensation andlevelling, Class II elastics maybe used to advance the mandibular buccal segments and procline the mandibular incisors.

b. Mandibular Arch

· Maxillary incisor region should be applied with high-pull headgear.

· Aids in retraction and prevention of extrusion and proclination of maxillary incisors.

III. Anteroposterior Maxillary Deficiency:

1. Class III Malocclusion[11]

Clinical Characteristics: Profile View	Clinical Characteristics: Frontal View	Dental Characteristics
• Cheeks appear sunken • Upper lip appears flat and reduced in length • Lower lip and chin in balance with nose	• Cheeks appear sunken • Sclera seen inferiorly of the iris of the eye • Short andflat upper lip • Alar base is narrow • Paranasal flattening	• Class III malocclusion • Crowding in maxillary arch • Small or absent maxillary lateral incisors • Normal inclination of mandibular incisors • Narrow maxillary arch with lingual crossbite

Pre-Surgical Orthodontic Procedure[2]

1. Correct existing dental compensations
2. Achieve ideal positioning of incisors
3. Align and level both arches
4. Ensure coordination between maxillary and mandibular arches.

a. Crowded Maxillary Arch

- Significant crowding and maximum retraction are necessary; extraction of first premolars is indicated
- Mild crowding and minimal retraction are necessary; extraction of second premolars is indicated.

b. Crowded Mandibular Arch

- Advancement of mandibular incisors may be limited by thin alveolar bone and/or lack of attached gingiva
- Extraction of second premolar is indicated.

c. Common Extraction Pattern

- Extraction of first premolars in the maxillary arch
- Extraction of first premolars in the maxillary arch and second premolars in the mandibular arch

Iv. Anteroposterior Maxillary Excess:[2]

Clinical Characteristics : Profile View	Clinical Characteristics : Frontal View	Dental Characteristics
• Protrusion of middle third of face • Prominent infra-orbital rims and cheekbones • Short and everted upper lip • Deep labiomental sulcus • Lip incompetence • Acute nasiolabial angle	• Increased lower facial height • Prominent middle third of face • Lip incompetence • Maxillary incisors trap the lower lip • Short and everted upper lip	• Tendency toward open bite • Palatal vault is high-arched • Constricted and narrow maxillary arch

Pre-Surgical Orthodontic Procedure[2]

1. Brackets on teeth adjacent to proposed interdental osteotomies are bonded such that root divergence can be achieved.
2. Maxillary canine brackets can be switched from right to left and vice versa.
3. After surgery is completed, these brackets are replaced with the correct brackets.

v. Vertical Maxillary Deficiency:[2]

Clinical Characteristics : Profile View	Clinical Characteristics: Frontal View	Dental Characteristics
• Reduced height of the lower facial third andthe middle facial third • Acute nasiolabial angle • Chin appears excessive	• Face appears short and square • Reduced maxillary incisors exposure under upper lip • With the mandible closed, skin folds lateral to the oral commissure become apparent with turned down corners of the mouth	• Increased interocclusal freeway space • Class III dental relationship • Mandibular overclosure resulting in bruxism and attrition

Pre-Surgical Orthodontic Procedure[2]

1. Cephalometric radiographs should be taken before treatment, with the lips gently touching and mandible in a resting position.
2. Repositioning of the maxilla in forward and downward direction to increase the vertical height should not exceed the available freeway space.

a. Crowded Arches

- Severe crowding is present, extraction of first premolars is indicated.
- Mild crowding is present, extraction of second premolars is indicated.

b. Maxillary Advancement

- Large maxillary advancement is needed and crowding is present, maxillary first premolars and mandibular second premolars extraction is indicated to create a large crossbite.

c. Transverse Maxillary Deficiency

- Correct it Surgically

VI. Vertical Maxillary Excess:[13]

Clinical Characteristics : Profile View	Clinical Characteristics: Frontal View	Dental Characteristics
• Increased mandibular plane angle • Mandible rotated downward and backward • Increased interlabial distance • Increased maxillary incisor exposure • Increased lower facial height	• Lower facial height increased • Decreased upper facial height to total facial height • Increased anterior facial height • Increased interlabial distance • Increased maxillary incisor exposure • Gummy smile	• High-arched palate • V-shaped maxillary arch • Tendency for anterior open bite present • Maxillary teeth are in a palatal crossbite • Over-eruption of mandibular incisors resulting in increased Curve of Spee • Mandibular incisors are upright and crowded

Pre-Surgical Orthodontic Procedure[2]

a. Mandibular Arch

- Level, align, close all spaces, and achieve good arch form.
- Depending on the case, extractions along with Class II or Class III mechanics will be necessary.

b. Maxillary Arch

1. Brackets on teeth adjacent to proposed interdental osteotomies are bonded such that root divergencecan be achieved.
2. Maxillary canine brackets can be switched from right to left andvice versa.
3. After surgery is completed, these brackets are replaced with the correct brackets.

III. Open Bite Deformities:

1. Class I Open Bite[2]

Clinical Characteristics
• Posterior vertical maxillary excess • Mandible rotated clockwise • Increased interlabial gap • Increased maxillary incisor exposure • Often, transverse maxillary deficiency • Could be Skeletal Class I due to rotation from Class III

Pre-Surgical Orthodontic Procedure

a. Segmental Arch Mechanics
- Dual occlusal plane of maxilla.
- Avoid orthodontic extrusion of anterior teeth.

b. Continuous Arch Mechanics

- Single occlusal plane of maxilla

c. Extraction Vs Nonextraction

- Influenced by 2 factors:
  - o Crowding
  - o Anteroposterior position of mandibular incisors.

2. Class II Open Bite[2]

Clinical Characteristics
• Increased lower facial height • Recessive chin • Vertical maxillary excess • Increased interlabial gap • Skeletal Class II relationship • Could be Skeletal Class II due to rotation from Class I • Increased mandibular plane angle • Transverse maxillary deficiency (posterior crossbite) • Increased maxillary incisor exposure under the upper lip

Pre-Surgical Orthodontic Procedure

1. Level and align the maxillary and mandibular teeth on the basal bone.
2. Achieve arch coordination ofthe maxillary and mandibular arches.
3. Expand buccal segments only where teeth are palatally inclined to the basal bone.
4. In case of segmental osteotomy, deviate the roots at the intended osteotomy areas.

3. Class III Open Bite[2]

Clinical Characteristics
• Mandibular anteroposterior excess, with backward rotation of mandible • Maxillary vertical excess – more posterior than anterior • Transverse maxillary deficiency • Posterior crossbites • Class III malocclusion • Often, reverse Curve of Spee • Increased mandibular plane angle

Pre-Surgical Orthodontic Procedure[12]

1. Eliminate dental compensation.
2. Level and align the maxillary arch in segments and align the mandibular arch.
3. In case of segmental osteotomy, deviate the roots at the intended osteotomy areas.

Wire Sequence

WIRE (Dimension in mils)	PROPERTIES
16 NiTi (austenite/superelastic)	Outstanding load-deflection characteristics
16 NiTi (martensite)	Obsolete for initial alignment, but still valuable as an intermediate wire
17.5 twist steel	Economical with good properties
19.5 coaxial steel	Properties similar to 17.5 twist steel, but higher cost
14 steel with loops	Excellent properties, but requires time for fabrication

Table 1: Properties of wires used during the Pre-surgical Orthodontic Stage.[6]

0.018" slot	0.022" slot
16 NiTi (austenite) or 14 steel loops (asymmetric crowding)	17.5 twist steel or 16 NiTi (austenite) (severe crowding)
16 steel	16 steel, 18 steel
17x25 TMA	21x25 TMA
17x25 steel	21x25 steel

Table 2: Wire sequence in 0.018" and 0.022" slot brackets.[6]

Time Estimates For Surgical-Orthodontic Treatment

Stage of Treatment	Time Required	Variations In Treatment Time
1. Presurgical orthodontics	2 to 12 months	Varies with the difficulty of alignment
2. Surgery/Hospitalization	2 to 6 days	Typically, 3 to 4 days
3. Under surgeon's care before beginning postsurgical orthodontics	3 to 8 weeks	Reduced with rigid fixation (3 to 5 weeks) as compared with maxillomandibular fixation (5 to 8 weeks)
4. Postsurgical orthodontics	3 to 6 months	Over 6 months indicates a problem or inadequate preparation

Table 3: Time estimates for Surgical-Orthodontic Treatment.[6]

Conclusion

Presurgical orthodontics aims to align the teeth with the basal bone, ensure compatibility between the arches, and position the incisors correctly in both the anteroposterior and vertical dimensions. This stage plays a vital role, as poor preparation of tooth alignment and arch form can compromise the efficiency of orthognathic surgery and lengthen the post-surgical phase. Conversely, extending the duration of presurgical orthodontics may unnecessarily increase overall treatment time without offering substantial advantages to the patient.

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updent A Journal of Advanced Dentistry

A Journal of Advanced Dentistry
Open Access Full Text Article

3D Printing Technology and Its Use In Paediatric Dentistry For The Fabrication of Space Maintainers - A review

Received on : 26-05-2025 | Accepted on : 13-6-2025 | Published on : 29 07 2025

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Abstract

3D printing is an additive manufacturing process wherein objects are fabricated layer by layer from digital designs. In recent years, this technology has brought significant advancements to pediatric dentistry. As global technological progress accelerates, 3D printing is poised to become an essential tool in dental practice due to its precision, efficiency, and reduced need for physical contact - an important consideration in ensuring safety for both practitioners and patients. One of the emerging applications in pediatric dentistry is the fabrication of space maintainers using 3D printing. These digitally fabricated appliances, also referred to as 3D-printed space maintainers, digitainers, or digital space maintainers, are rapidly replacing conventional methods and materials such as traditional band and wires, Ribbond®, and EverStick® systems.

Introduction

Dental caries remains a prevalent public health concern and is a leading cause of premature loss of primary teeth. This early tooth loss can interfere with the normal eruption sequence of permanent teeth, often resulting in space loss, malocclusion, or arch length discrepancies1-2.

To counteract these issues, the maintenance of the edentulous space is critical to prevent complications such as crowding, ectopic eruption, and centerline shifts[3]. The American Academy of Pediatric Dentistry (AAPD) defines space maintenance as the process of preserving the current dentition and preventing loss of arch dimension[4]. Initially introduced by JC Brauer in 1941, space maintainers are appliances designed to hold the space of prematurely lost teeth for their permanent successors[5].

Despite their long-standing use, conventional space maintainers come with limitations such as complex impression techniques, high lab costs, patient discomfort, and construction inconsistencies. These challenges have encouraged the development of alternatives like fiber-reinforced composites and prefabricated devices, which offer reduced chair-time and better patient compliance but still suffer from technical limitations such as poor bonding and material shrinkage[5].

The introduction of digital dentistry and 3D printing technologies has marked a significant advancement in this field. Starting in the 1990s and gaining momentum in the early 2000s, these technologies enable more precise, efficient, and patient-friendly fabrication of dental appliances6. The process begins with scanning the oral anatomy, generating a 3D model saved in STL format, which is then used by 3D printers to build appliances layer by layer[7].

3D printing offers several advantages over traditional methods-faster production, higher precision, and improved patient experience. As Thomas Edison once said, "If there is a way to do it better - find it." In this spirit, research continues to enhance and adapt 3D printing for pediatric dental applications, especially in the development of space maintainers, signifying a promising future for digital workflows in pediatric care.

History

3D printing, or additive manufacturing, enables the layer-by-layer creation of three-dimensional structures and has significantly transformed manufacturing and healthcare.

How to Cite This Article : Chadha et al. - Updent - A Journal of Advanced Dentistry. (2025). 3D Printing Technology and Its Use In Paediatric Dentistry For The Fabrication of Space Maintainers - A Review. Updent- A Journal of Advanced Dentistry, 14(1), 15–18. https://doi.org/10.5281/zenodo.16556955

While its commercial applications began in the 1980s, conceptual foundations were laid earlier. Writers such as Murray Leinster (1945) and Raymond F. Jones (1950) anticipated technologies similar to additive manufacturing in science fiction narratives. During the 1970s, François Duret pioneered digital dental impressions, and David E.H. Jones speculated on layered object formation in academic contexts, setting the stage for technological breakthroughs in the following decade.

The 1980s marked the emergence of practical 3D printing technologies. Hideo Kodama filed early patents on rapid prototyping, followed by U.S. contributions from Bill Masters and Alan Herbert. A major development came in 1986 when Chuck Hull introduced stereolithography (SLA) and the STL file format. Simultaneously, Scott Crump invented fused deposition modeling (FDM), leading to the founding of Stratasys8-9.

In the 1990s, various deposition methods such as Selective Laser Melting (SLM) and PolyJet printing expanded the scope of 3D printing. Emanuel Sachs coined the term "3D Printing" in 19929. The 2000s saw democratization of the technology with the expiration of key patents, giving rise to open-source initiatives like RepRap (2004) and consumer-oriented companies such as MakerBot (2009). CAD/CAM systems, notably CEREC, allowed for the in-office production of ceramic restorations in dentistry10-12.

Advancements in pediatric dentistry have paralleled these trends. In 2017, zirconia-based space maintainers were successfully fabricated using CAD/CAM, demonstrating excellent mechanical strength and esthetics13. Polyetheretherketone (PEEK) has also shown promise for space maintainers due to its high biocompatibility and strength14. Additive manufacturing techniques like metal sintering and resin-based printing have enabled the production of customized band-loop space maintainers[15]. More recently, digital workflows using PMMA have been employed to fabricate esthetic fixed space maintainers[16].

Material science has also advanced, notably with the development of high-throughput combinatorial printing (HTCP) by Zhang, which allows on-the-fly material customization during the printing process, enhancing microscale control[17].

I. Digital Impressions And Intraoral Scanners In Dentistry

Digital impressions in dentistry are created using intraoral scanners, which capture 3D data of the oral cavity. Compared to traditional methods, they offer improved diagnostic accuracy, faster workflow, better patient comfort, and enhanced appliance fabrication efficiency[18]

a. Intraoral Scanners

Intraoral scanners (IOS) are handheld devices that scan dental arches by projecting light, which is analyzed to generate 3D digital models. These models are usually saved in STL (Standard Tessellation Language) format and used for treatment planning, appliance design, and digital workflows[19].

b. Scanning Techniques

- Passive Scanning: Uses ambient light and relies on surface texture.
- Active Scanning: Projects structured lights (e.g., white, red, blue) to calculate distances via triangulation or pattern projection20.

c. Scanner Systems

- Open Systems : Generate files compatible with various CAD/CAM software and devices[21].
- Closed Systems : Use proprietary formats limited to specific software and hardware[22].

d. Scanner Components

Each IOS typically includes:

1. Software for data handling
2. Monitor for scan review
3. Handheld wand for intraoral data capture[22]

e. Imaging Mechanisms

Intraoral scanners use three main technologies

1. Confocal Laser Scanning (e.g., TRIOS, iTero): Uses focused laser beams to capture high-precision images[23-24].
2. Triangulation (e.g., CEREC): Calculates surface geometry using angles and distances[23-24].
3. Active Wavefront Sampling (e.g., Lava COS, True Definition): Captures motion-based 3D images with multiple CMOS sensors[23-24].
4. Stereophotogrammetry: Reconstructs 3D images using multiple 2D views and software[25].

II. Storage Of Scanned Data In 3D Printing

a. STL File Format

The STL (Stereolithography) file format is the most widely used standard for 3D printing. Developed in the 1980s by Chuck Hull at 3D Systems, it allows 3D slicers to translate digital models into instructions for 3D printers[26]. STL encodes only the surface geometry of a 3D object using tessellation-a process in which surfaces are tiled with triangles, known as facets, ensuring no gaps or overlaps.

b. Encoding Methods

STL files store data in two formats

- ASCII encoding: Human-readable text format.
- Binary encoding: Compact and faster to process.

Both formats store:

- The 3D coordinates of each triangle's three vertices.
- The unit normal vector indicating the triangle's outward direction.

c. Special Rules in STL Specification

1. VertexRule: Each triangle must share two vertices with adjacent triangles. This ensures the mesh is continuous and watertight.
2. Orientation Rule:

Each triangle's orientation is defined by:

- An outward-pointing normal vector.
- Vertices listed in counterclockwise order when viewed from outside, following the right-hand rule.This redundancy helps detect inconsistencies or corrupted meshes.

3. All-Positive Octant Rule: All vertex coordinates should be positive, confining the model to the positive octant of the Cartesian coordinate system. This simplification helps reduce data complexity and file size.

4. Triangle Sorting Rule: While not mandatory, it's recommended to sort triangles by increasing z-values to optimize slicing performance.

III. Designing of The Appliances

CAD-CAM stands for Computer-Aided Design and Computer-Aided Manufacturing, respectively. These technologies are often integrated into a unified software platform to facilitate the design and production of prototypes and final products[27].

CAD Process (Computer-Aided Design)

CAD involves using computer software to create, modify, analyze, and optimize product designs. It supports tasks ranging from conceptual sketches to final modeling and ergonomic assessments. CAD is essential in engineering, architecture, and dentistry for its ability to generate accurate digital models, both in 2D and 3D.

Key Features of CAD Software:

- 2D and 3D Modeling - Enables detailed geometric design.
- Visualization - Allows designers to inspect models from multiple perspectives.
- Simulation - Assesses design performance in virtual environments.
- Collaboration - Supports multi-user access and real-time design sharing.

CAM Process (Computer-Aided Manufacturing)

CAM refers to the use of software to control machine tools and manufacturing equipment. It translates CAD-generated geometry into machine-readable instructions. CAM software helps plan and automate toolpaths, optimizing manufacturing workflows.

Key Features of CAM Software

- Toolpath Generation - Converts digital models into physical instructions.
- Machine Control - Directs CNC machines during production.
- Optimization - Enhances efficiency by reducing material waste.
- Integration – Works in tandem with CAD platforms for seamless transitions from design to production.

CAD and CAM systems are interdependent: CAD defines the part geometry, while CAM interprets and manufactures it. CAD is typically operated by designers or engineers, whereas CAM is used by machinists or technicians.

In dentistry, one of the earliest and most influential CAD-CAM systems is CEREC, introduced by Mörmann and Brandestini. It enables in-office fabrication of restorations, such as crowns, within a single patient visit—revolutionizing chairside dental workflows[27].

III. Printing of The Designed Appliance

The 3D printing process for space maintainers begins after the design is finalized using CAD-CAM software. Considering the need for non-toxic, biocompatible, and inert materials, the current range of 3D printers used in dental applications is somewhat limited in terms of compatible materials-particularly metals and ceramics - due to variability in print direction and accuracy[28].

- Metal Space Maintainers

Metals such as cobalt-chromium, stainless steel, nickel alloys, and titanium are widely used in dentistry for strengthening restorations and creating frameworks for space maintainers. Among 3D printing techniques, Selective Laser Sintering (SLS) is most commonly used for fabricating metal-based dental appliances[7].

Fabrication of Titanium-Based Space Maintainers via Micro Laser Sintering

Once the appliance is designed digitally, a thin layer of titanium powder is spread over a build platform inside the 3D printer. The powder is preheated to just below its melting point, and a high-precision laser selectively fuses the powder particles together by scanning a cross-section of the model. This process is repeated layer-by-layer until the full appliance is formed7.

Post-processing involves:

- Powder removal
- Media blasting/tumbling
- Optional coatings (e.g., spray painting, lacquering, electroplating)

Advantages

- Biocompatible and strong
- Ideal for long-lasting restorations

Disadvantages

- Non-aesthetic metallic color
- Radio-opaque (visible on X-rays)
- Potential for allergic reactions[29]

Metal-Free Space Maintainers

These include polymers and zirconia-based materials, preferred for their aesthetics, biocompatibility, and reduced allergenicity[30].

1. **PEEK (Polyetheretherketone)**

   PEEK belongs to the high-performance PAEK (Polyaryletherketone) family. It is a semi-crystalline thermoplastic with outstanding mechanical properties, chemical resistance, and high-temperature stability. PEEK is increasingly used in dental prosthetics due to its favorable aesthetics and biocompatibility[31-32].

Advantages

- Biocompatible and ideal for metal-allergic patients
- Aesthetically pleasing
- Suitable for both fixed and removable appliances

Disadvantages

- Radiolucent (invisible on X-rays)
- Lower strength compared to metal maintainers33

2. **Trilor®**

   Trilor is a fiber-reinforced techno-polymer developed by BiolorenSrl. It consists of thermosetting resin reinforced with multidirectional fiberglass. Its compatibility with CAD/CAM systems and excellent mechanical properties make it suitable for dental use[34].

Advantages

- Lightweight, aesthetic, and durable
- Good flexural strength
- Easy to clean

Disadvantages

- Increased risk of dislodgement or fracture under high stress

3. **BruxZir® (Zirconia-Based Material)**

BruxZir is a monolithic zirconia material, widely used for its strength and durability. Fabrication involves Digital Light Processing (DLP), a form of vat polymerization where a resin is cured layer-by-layer by a digital light projector[35].

Advantages

- Very high flexural strength (up to 1,465 MPa)
- Excellent fracture toughness and wear resistance
- Aesthetically superior and available in multiple shades

Disadvantages

- Brittle; prone to dislodgement/fracture under stress

IV. Post-processing, Finishing, And Polishing

All 3D-printed appliances require post-processing to remove residual powder (in SLS/SLM) and improve surface finish. Finishing processes may include:

- Polishing
- Coloring
- Surface coating[36]

Conclusion

Delivering dental care to pediatric patients in a minimally invasive and comfortable manner is a key objective in modern dentistry. 3D-printed space maintainers represent a revolutionary step toward achieving this goal. With digital impressions, CAD/CAM workflow, and rapid additive manufacturing, space maintainers can now be fabricated with exceptional precision and patient comfort.

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A Journal of Advanced Dentistry
Open Access Full Text Article

A Review on Non-Benzodiazepines as Oral Sedative Agents : A Safer Alternative for Clinical and Paediatric Use

Received on : 26-05-2025 | Accepted on : 13-6-2025 | Published on : 29 07 2025

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Abstract

Non-benzodiazepines, often referred to as "Z-drugs," have gained prominence as safer and more targeted alternatives to traditional benzodiazepines in the management of anxiety and sleep disorders. This review explores their pharmacological profile, mechanism of action, and clinical relevance. Structurally distinct from benzodiazepines, non-benzodiazepines act as positive allosteric modulators of the GABA-A receptor, with selective binding to the alpha-1 subunit. This receptor specificity produces effective sedative action while minimizing common benzodiazepine-associated side effects such as psychomotor impairment, memory disruption, and alteration of sleep architecture. Agents such as zolpidem, zaleplon, zopiclone, and eszopiclone vary in their pharmacokinetics and duration of action, making them suitable for individualized treatment strategies. Based on duration, non-benzodiazepines can be classified as short-, intermediate-, or long-acting. This review highlights the therapeutic potential and safety profile of non-benzodiazepines, emphasizing their role as first-line agents in the treatment of insomnia and related conditions. Their clinical utility, combined with a lower risk of dependence and adverse effects, supports their growing use in modern pharmacotherapy.

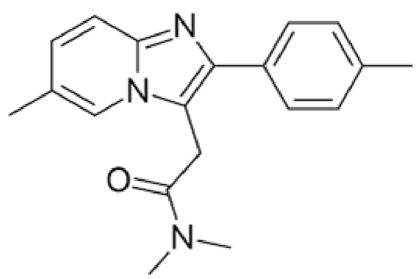
Keywords - Non-Benzodiazepine, Zolpidam, Zaleplon, Zopiclone, Eszopiclone

Introduction

Oral sedative medications in the non-benzodiazepine category have garnered growing interest as effective alternatives to traditional benzodiazepine-based anxiolytics and hypnotics. These agents offer a more targeted and refined approach to managing anxiety and sleep disorders1, largely due to their improved safety profile and selective mechanism of action. Structurally distinct from benzodiazepines, non-benzodiazepines act primarily on the alpha-1 subunit of the GABA-A receptor, producing sedation while minimizing common adverse effects such as psychomotor impairment, memory disruption, and significant disturbances in sleep architecture. This selective receptor affinity contributes to a more favourable side effect profile, making them especially appealing for use in settings where patient safety and rapid recovery are important. Importantly, their short duration of action and reduced risk of residual sedation make this class of drugs potentially useful for minor sedation needs in paediatric dentistry, where brief and well-tolerated sedation is often required. This review explores various oral sedative agents within the non-benzodiazepine group, highlighting their pharmacodynamics, pharmacokinetics, and clinical relevance in sedation protocols.

Discussion

Structure



Non – Benzodiazipine

Pharmacodynamics

Nonbenzodiazepine pharmacodynamics are similar to benzodiazepine drugs, acting as GABA-A receptor positive allosteric modulators of the benzodiazepine site, and therefore

How to Cite This Article : Samanta et al. - Updent - A Journal of Advanced Dentistry. (2025). A Review on Non-Benzodiazepines as Oral Sedative Agents : A Safer Alternative for Clinical and Paediatric Use. Updent- A Journal of Advanced Dentistry, 14(1), 19–23. https://doi.org/10.5281/zenodo.16557003

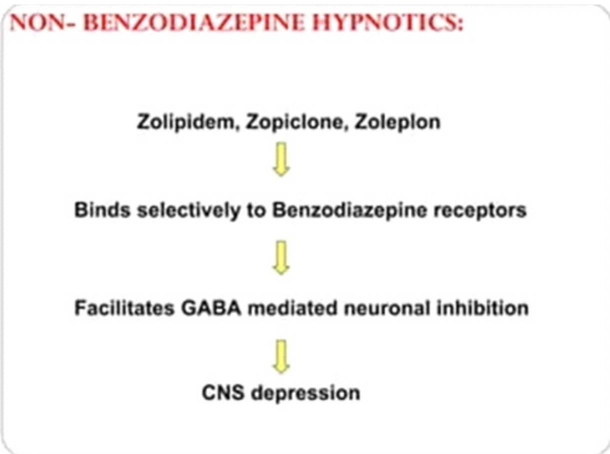
exhibit similar benefits, side effects, and risks.[2]

Pharmacokinetics

The nonbenzodiazepine hypnotics, such as zolpidem, zaleplon, and eszopiclone, facili-tate GABAA transmission by preferential binding to the 1a receptor subunits, therefore they are devoid of the significant muscle rela-xant, anxiolytic, and anticonvulsant activities of traditional benzodiazepines[3].

Mechanisum of Action

Nonbenzodiazepines are a relatively newer class of hypn-otics. Also known as the "Z" drugs, this class includes zolpidem, zopiclone, zaleplon, and eszopiclone. The elimination half-lives and duration of action of nonbenzodiazepine "Z" drugs range from short-acting zaleplon to the zolpidem, to intermediate acting eszopiclone.2 (Flow chart 1)



Flow chart 1- Mechanism of action of non-benzodiazepine

Classification of Non-benzodiazepine

According to duration of action[4]

1. Short acting non-benzodiazepine
   Zolpidem
   Zaleplon
2. Intermediate acting non-benzodiazepine
   Eszopiclone
   Ramelteon
3. Long acting non-benzodiazepine
   Zopiclone
   Zolpidem

Zolpidem belongs to a class of medications called sedative-hypnotics. It works by slowing activity in the brain to allow sleep.5

Mechanism of Action

It interacts with a GABA-BZ receptor complex and shares various pharmacological properties with the benzodiazepine class of drugs Label. Subunit binding of the GABAA receptor chloride channel macromolecular complex is thought to lead to the sedative, anticonvulsant, anxiolytic, and myorelaxant drug effects of zolpidem. (Fig 1)

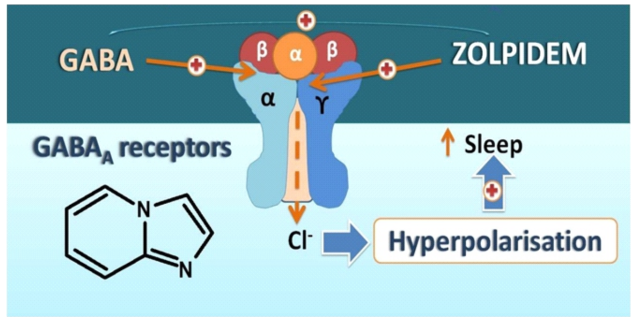


Fig 1 - Mechanism of action of Zolpidem

Clinical Significance

Anxiolytic effect - zolpidem is unrelated structurally to benzo-diazepines, it is a strong sedative with only mild anxiolytic, myorelaxant, and anticonvulsant properties.[6]

Treatment of insomnia - It improves measures of sleep latency and sleep duration and reduces the number of awakenings in patients with transient insomnia.[7]

Antipsychotic effect - Zolpidem produced some antipsychotic-like effects at doses, which produced no catalepsy and did not inhibit spontaneous locomotor activity

Dosage

Adults – 7.5 ml/mg once a day (only 1 dose a night as needed)

Suggested oral dose: 0.05–0.1 mg/kg, Maximum single dose: 5 mg

Contraindication

Zolpidem is only contraindicated in patients with a known allergy to the drug or inactive ingredients in the formula.

Zaleplon

Zaleplon is a non-benzodiazepine hypnotic medication used for the short-term treatment of insomnia, particularly for patients who have difficulty falling asleep. It works by enhancing the effects of gamma-aminobutyric acid (GABA) in the brain, promoting sleep.[8]

Mechanism of Action

Like benzodiazepines, they increase GABA-mediated Cl

- influx into the cell, which inhibits neurotransmission. Zale-plon, zolpidem and zopiclone bind to the α1-subunit in the GABAA receptor, and zopiclone also binds to the α2-subunit.[9] (Fig 2)

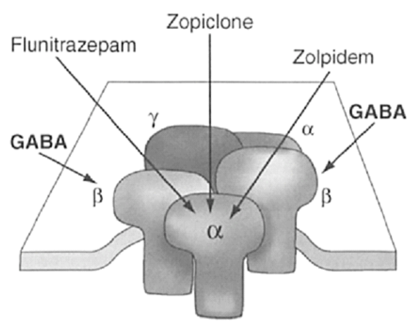


Fig 2 – Mechanism of action of Zaleplon

Clinical Significance

- Treatment of insomnia - Zaleplon is used on a short-term basis to treat insomnia (difficulty falling asleep). It does not help you to stay asleep longer or decrease the number of times that you awaken during the night.
- Anxiolytic effect - Studies are going on which suggest that zaleplon may have weak anxiolytic activity.[10]

Dosage

Adults – 5 or 10 ml/mg once a day.[10]

Suggested Paediatric oral dose: 0.1–0.2 mg/kg, Maximum single dose: 5 mg

Contraindication

Coadministration with alcohol or sedative hypnotics are contraindicated because of additive CNS depression.

Eszopiclone

Eszopiclone is a pharmaceutical agent primarily prescribed for the short-term treatment of insomnia. As a non-benzodiazepine sedative-hypnotic, eszopiclone is designed to promote sleep by targeting specific receptors in the brain, offering an alternative to traditional sleep aids.

Mechanism of Action

The precise mechanism of action of eszopiclone as a hypnotic is unknown, but its effect is believed to result from its interaction with GABA receptor complexes at binding domains located close to or allosterically coupled to benzodiazepine receptors.11(Fig - 3)

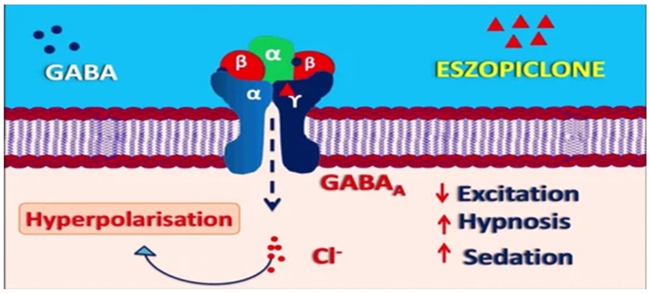


Fig 3 – Mechanism of action of Eszopiclone

Clinical Significance

Eszopiclone is used to treat insomnia (trouble sleeping). It belongs to the group of medicines called central nervous system (CNS) depressants, which slow down the nervous system. Eszopiclone helps you get to sleep faster and sleep throughout the night.[12]

Helps in treatment of anxiety management. It slows down body and brain's functions such as breathing and heartbeat. These medications can be prescribed for severe anxiety management.[13]

Dosage

Adults - Initially 1ml/mg at bedtime.

Dosing can be raised to 2mg or 3mg if clinically indicated.

Suggested Paediatric oral dose: 0.1–0.2 mg/kg. (Not as such recommended)

Adverse Effects

- Bad, unusual, or unpleasant (after) taste
- Change in taste
- Dizziness
- Heartburn
- Iindigestion
- Sstomach discomfort, upset, or pain

Contraindication

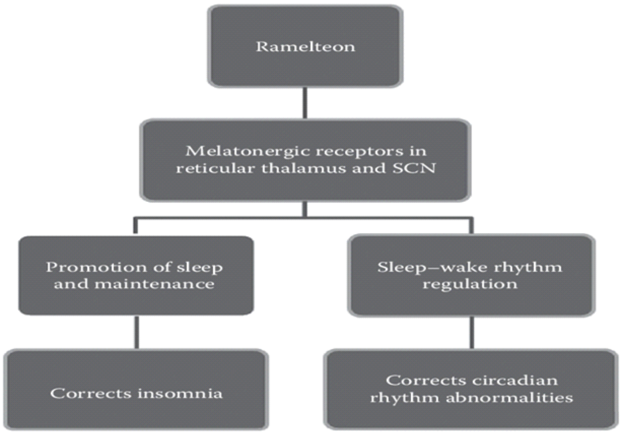
Coadministration with alcohol or sedative hypnotics are contraindicated because of additive CNS depression.

Ramelteon

Ramelteon is a melatonin receptor agonist that has garnered attention for its role in regulating sleep-wake cycles. This medication offers a unique approach in treating insomnia by specifically targeting melatonin receptors in the brain.[14]

Mechanism of Action

Ramelteon is a hypnotic with a novel mechanism of action and is the only melatonin agonist currently indicated for the treatment of insomnia. This drug acts at the MT1 and MT2 receptors to promote sleep and exert an effect on circadian rhythms.14 (Flow chart – 2)



Flow chart 2 – Mechanism of action of Ramelteon

Clinical Significance

- Treatment of insomnia - It is used to treat insomnia (trouble in sleeping). Ramelteon helps to sleep faster and sleep throughout the night.[15]
- As anxiolytic agent - It is effective in the treatment of generalized anxiety disorder (GAD).
- As antidepressant - Ramelteon is also effective in reducing certain amount of depression.

Dosage

Adults – 8mg at bedtime.

Paediatric oral dose:0.05–0.1 mg/kg(Not Routinely Recommended)

Adverse Effects

- Body aches or pain
- Change in taste
- Difficulty in breathing

- Discouragement
- Ear congestion
- Feeling sad or empty

Contraindication

- Coadministration with alcohol or sedative hypnotics are contraindicated because of additive CNS depression.
- Fluvoxamine will increase the level or effect of ramelteon by affecting hepatic enzyme.

Zopiclone

Zopiclone is a non-benzodiazepine hypnotic agent used primarily for the short-term treatment of insomnia. It functions by enhancing the activity of gamma-aminobutyric acid (GABA) in the central nervous system, promoting sedation and helping to initiate and maintain sleep. Zopiclone is known for its rapid onset of action and relatively short half-life, which reduces the risk of residual drowsiness the following day.

Mechanism of Action

Zolpidem has strong hypnotic properties with weak anxiolytic, myorelaxant, and anticonvulsant properties. It binds to binary $\alpha\beta$ GABA receptors. (Flow chart - 3)

Zopiclone

↓

Binds Selectively to BZD site on GABA-A receptors

↓

Facilitate GABA-mediated neuronal inhibition

↓

CNS depression

Flow chart 3 – Mechanism of action of Zopiclone

Clinical Significance

- Insomnia Treatment: Zopiclone is effective in treating various forms of insomnia, including difficulty falling asleep, frequent nocturnal awakenings, and early morning awakenings.
- Rapid Onset: Zopiclone has a quick onset of action, usually within 30 minutes, making it suitable for patients who need fast relief from insomnia.
- Reduced Next-Day Residual Effects: Due to its relatively short half-life (about 5 hours), zopiclone tends to cause fewer next-day residual effects compared to some other hypnotics, which helps maintain daytime alertness.
- Alternative to Benzodiazepines: Zopiclone offers an alternative to benzodiazepines for insomnia treatment, providing similar efficacy with a potentially lower risk of dependency.
- Anxiolytic and Muscle Relaxant Effects: Besides its hypnotic properties, zopiclone also has mild anxiolytic and muscle relaxant effects, which can be beneficial for patients with concurrent anxiety.

Indication

- Primary Insomnia: Used to treat short-term and chronic insomnia characterized by difficulties in falling asleep, frequent nocturnal awakenings, or early morning awakenings.16
- Situational Insomnia: Prescribed for insomnia related to specific situations such as hospitalization, travel (jet lag), or acute stress.
- Secondary Insomnia: Can be used as an adjunct treatment for insomnia associated with psychiatric disorders (e.g., depression, anxiety) and medical conditions (e.g., chronic pain).
- Pre-Surgical Sedation: Sometimes used for its sedative properties to help patients relax before undergoing surgical procedures or diagnostic tests.
- Sleep Maintenance: Helps patients who have trouble maintaining sleep throughout the night, reducing nocturnal awakenings.
- Elderly Patients: Often prescribed for elderly patients who experience sleep disturbances.

Adverse Effects

General adverse effects:

- Drowsiness
- Dizziness
- Headache
- Gastrointestinal disturbances (nausea, diarrhoea)
- Complex behaviours such as sleepwalking, sleep-driving, and other activities performed while not fully awake, often with no memory of the event.
- Memory problems and anterograde amnesia.
- Rebound insomnia upon discontinuation after prolonged use.

Psychiatric Effects

- Potential for mood changes, including depression and anxiety.
- Risk of hallucinations and confusion, particularly at higher doses or in sensitive individuals.[17]

Dosage

- Typically, 5 to 10 mg for adults taken immediately before bedtime.
- Lower doses (5 mg) recommended for elderly or debilitated patients.
- Paediatric dose - 0.1–0.2 mg/kg orally, maximum single dose not exceeding 3.75 mg (Not Routinely Recommended)

Administration

- Should be taken on an empty stomach for quicker onset of action.
- Should not be taken unless the patient can dedicate a full 7-8 hours to sleep to reduce the risk of next-day impairment.

Contraindications

- Hypersensitivity to zolpidem or any component of the formulation.
- Severe hepatic impairment (due to increased risk of

encephalopathy).

Conclusion

Non-benzodiazepine drugs offer a promising option for oral sedation in managing anxiety, particularly in dental settings where patient cooperation is essential. Their targeted action on the GABA-A receptor provides effective anxiolysis with minimal side effects such as memory impairment or motor dysfunction. These agents, including zolpidem and zaleplon, are well-suited for short procedures and have shown potential for safe and predictable use in dentistry4, making them valuable tools for enhancing patient comfort and treatment success.

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Mixed Dentition Space Analysis In Orthodontics: A Narrative Review

Received on : 26-05-2025 | Accepted on : 13-6-2025 | Published on : 29 07 2025

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Abstract

Space analysis plays a vital role in when mixed dentition is present in early diagnosis of orthodontic and planning of treatment by evaluating the relationship between unerupted permanent teeth size and available arch space. This review provides a comprehensive overview of the various space analysis techniques employed during the mixed dentition phase, encompassing both conventional and digital methodologies. A detailed classification framework is presented based on objectives, methodology, purpose, evaluated parameters, and the use of digital tools. Key predictive methods such as direct radiographic measurements, statistical prediction equations, and their combinations are discussed. Prominent techniques including the Probability Method of Moyers and analysis of Tanaka-Johnston are critically examined, with attention to their clinical applications and limitations. The influence of racial, ethnic, and gender variations on tooth size prediction is also addressed, alongside the impact of different predictor tooth selections on the accuracy of estimations. Furthermore, the integration of digital technologies in space analysis is explored, highlighting their potential to enhance diagnostic precision and efficiency in contemporary orthodontic practice.

Keywords - Mixed dentition, Prediction table, Space analysis

Introduction

A thorough diagnosis along with comprehensive planning of treatment are fundamental of aneffective orthodontic care.[1] Among the diagnostic tools available, Study Model Analysis (SMA) holds a central role, particularly during the mixed dentition phase, by providing a three-dimensional evaluation of dental relationships and malocclusion patterns.[2] One of the most critical components of SMA is space analysis, which involves assessing arch length and tooth size discrepancy (TALD), tooth size prediction, and the proportional relationships between teeth - key factors that guide early orthodontic intervention.[3]

Space analysis in mixed dentition, helps clinicians to evaluate the size and orientation of unerupted permanent teeth in relation to the available space in arch. It is crucial for identifying potential crowding or spacing issues prior the permanent dentition eruption. By estimating future tooth positions and space requirements, orthodontists can make informed decisions regarding interceptive treatments such as space maintenance, expansion, interproximal reduction, or even extractions, if necessary.

An effective space analysis in this stage aids in planning tooth movement while considering both functional and aesthetic goals. It allows for early correction of developing malocclusions and helps ensure proper alignment, overjet, and overbite relationships.[4] Additionally, the analysis incorporates an understanding of individual anatomical variations, including arch length, tooth size, width, and skeletal growth patterns - factors that are particularly dynamic during the mixed dentition period.

Dental malocclusions during this stage often result from discrepancies between the size of erupting permanents and available space in the dental arches. Addressing these discrepancies early supports better treatment outcomes and minimizes the need for more complex interventions later. A wide range of established techniques exists in the literature for analyzing space in the mixed dentition,

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How to Cite This Article : Singh et al. - Updent - A Journal of Advanced Dentistry. (2025). Mixed Dentition Space Analysis In Orthodontics: A Narrative Review. Updent- A Journal of Advanced Dentistry, 14(1), 24–27.
https://doi.org/10.5281/zenodo.16557009

including radiographic assessments, prediction equations, and digital methodologies. These tools serve as essential diagnostic aids, enabling orthodontists to evaluate developing occlusions, anticipate future dental alignment challenges, and craft individualized, growth-conscious treatment plans.

Space Analysis In Mixed Dentition

The phase of mixed dentition, occurring between six to twelve years, is crucial period in dental development, characterized by the simultaneous presence of both dentition that is deciduous and permanent. In this transitional period, orthodontists can effectively predict future dental change and assess the likelihood of spacing or crowding issues within the dental arch.[5] Mixed Dentition Space Analysis is technique used by orthodontists to check the space necessary for permanent teeth which is unerupted before their emergence in the dental arch.[6] In space analysis of mixed dentition, predicting the width of unerupted permanent premolars and canines mesiodistally stands as a key component in evaluating dental arch space and planning for optimal tooth alignment. The process of mesiodistal width prediction of unerupted canines and premolars involves various methods, including dental models, radiographic analysis, and clinical examination.

1. **Direct Radiographic Measurement**

   The permanent premolars and canines (both first and second) width from dental radiographsis directly measured, including cephalometric and periapical images.[7,8] Numerous studies have proposed techniques to enhance the precision of estimating the size of unerupted teeth through the utilization of dental radiographs.

2. **Use Equation of Prediction and/ or Table**

   These methods estimate the size of unerupted premolars and canines based on the known widths of erupted teeth, typically the mandibular incisors.[9,10]Among the most frequently utilized methods are probability tables of Moyer's and the equations of regression developed by Tanaka and Johnston.

   a. **Moyers Probability Analysis**

   One of the most widely used non-radiographic techniques, this method utilizes probability charts developed from a large population database. By measuring the addition of the mandibular four incisors, clinicians can estimate the mesiodistal widths of the unerupted premolars and canines with a chosen level of statistical confidence (e.g., 75%, 85%).[10]

This method is widely preferred for mixed dentition due to several advantages:

1. It exhibits less known systematic error.
2. Can be utilized by both novices and experts with equal reliability.
3. Less consumption of time.
4. It does not necessitate any special equipment and/or radiographic exposure.
5. It is applicable in lower and upper dental arches both.
6. While ideally done on casts, it can be reasonably performed in the mouth.

Method of Moyer's is frequently applied by numerous populations.[11,12] Ackerman and Profit also found the Moyers method relevant[13]

b. **Method of Tanaka and Johnston**

It is used to predict the size of unerupted premolars and canines without the need for radiographs. It helps orthodontists in planning space management, extractions, or other treatments.

Key Feature : The method relies on the addition of the mesiodistal widths of the four permanent incisors of mandibular, which are two central incisors and two lateral incisors. These teeth erupt early and are easy to measure clinically.[9]

The Prediction Equations : Once you measure the width of the four mandibular incisors, you apply the following equations:

For Mandibular Arch (Each Quadrant):

Predicted width of one mandibular canine + premolars = (total of mandibular incisors ÷ 2) + 10.5 mm

For Maxillary Arch (Each Quadrant)

Predicted width of one maxillary canine + premolars = (total of mandibular incisors ÷ 2) + 11.0 mm So, if the total of the four mandibular incisors is 24 mm:

Predicted width for one side in the lower jaw = (24 ÷ 2) + 10.5 = 22.5 mm

Predicted width for one side in the upper jaw = (24 ÷ 2) + 11.0 = 23.0 mm

To get the total for both quadrants (right and left), just multiply by 2:

Mandible total : 22.5 mm × 2 = 45.0 mm

Maxilla total : 23.0 mm × 2 = 46.0 mm

Advantages : Simple and quick: Only a caliper and a calculator are needed.

Non-invasive : No radiographs required.

Reasonably accurate for most patients.

Applicable to both males and females, and to both dental arches.

Limitations : May not be accurate in cases of ethnic variation, tooth size anomalies, or dental crowding.

It is a statistical estimation and not a precise prediction.

Accuracy may be lower in populations different from the one it was originally developed on (Caucasian children in the U.S.).

3. **Combination of Radiographic measurement and Prediction Equation**

   This method is a more advanced and often more accurate technique for predicting the mesiodistal width (side-to-side width) of unerupted premolars and canines, especially compared with purely clinical or non-radiographic approaches (like Tanaka and Johnston).

   This Method Combines Direct measurement from dental radiographs (X-rays) — specifically the first and second premolars that may be visible but not erupted. And clinical measurement of erupted mandibular incisors (central + lateral) — just like in simpler methods. Together, these measurements are used in a regression equation to estimate the full size of the premolars and canines.[7,14-16]

Historical Development of This Method

a. Hixon and Oldfather (1958)

They were the first to suggest using radiographic measurements to estimate the size of unerupted mandibular canines and premolars. They created regression equations – mathematical formulas based on observed data to make these predictions.[16]

a. Stahle (1959)

He improved the method by adding the size of the mandibular incisors (central and lateral). This addition made the prediction more accurate.[17]

b. Staley and Kerber (1980)

They refined the method further and developed better prediction equations. Also, they Created graphs to help estimate the mesiodistal widths more visually and easily. Their version is considered a more clinically practical tool and is commonly referenced.[18]

Prediction Equation or Table Vs Radiographic

In orthodontics, there are main two approaches to predict the unerupted teeth size (especially premolars and canines):

a. Radiographic Prediction Method

PROS : Uses X-rays to directly measure the unerupted teeth size and can give individual specific information if done correctly.

CONS : Requires high-quality radiographic equipment and technique because poor X-rays can lead to inaccurate measurements. Also, radiographs are 2D, but teeth are 3D so if a tooth is rotated inside the bone (before eruption), its width can appear smaller or larger than it actually is.[19]

Radiation exposure is involved, which is a concern especially in children.

Radiographs can be accurate but are dependent on technique and equipment, and they carry some health risks.

B. Prediction Equations And Tables (non-radiographic Methods):

Instead of using X-rays, these methods estimate the size of unerupted teeth depend on already erupted teeth size -usually the mandibular incisors. Common Method used is Moyer's Probability Tables which uses statistical tables based on population data and gives a predicted range (with certain probabilities, e.g., 75% or 85% confidence).[7-10]

Ethnic and Racial Difference in Tooth Size

Studies have shown that tooth size differ among different ethnic and racial groups. These variations are influenced by a mix of genetic factors (inherited traits), epigenetic factors (how genes are expressed, which can be affected by things like nutrition or health) and environmental factors (such as diet, climate, or cultural habits).[20,21]

Many of the commonly used tooth size prediction methods like:

Moyer's Probability Tables

Tanaka and Johnston's Regression Equations

Which were developed based on studies done in North American Caucasian children. As a result, these methods are tailored to average tooth sizes and patterns found in that specific group. They not always accurate when applied to children from different ethnic or racial backgrounds, such as African, Asian, Hispanic, Indigenous populations.

Difference of Gender in Tooth Size

Although commonly used tooth size prediction methods - such as those by Moyer and Tanaka & Johnston - have been widely applied in clinical settings, they were not originally designed to differentiate between males and females. This is a significant limitation because numerous studies have consistently shown that size of tooth varies by gender, in which males generally have bigger teeth than females, especially in terms of width mesiodistally (the width of the tooth from front to back along the dental arch).[22] This biological difference, known as sexual dimorphism, is particularly important when predicting the size of unerupted per-manent premolars and canines in planning of orthodontic treatment.

Due to this well-documented variation, many researchers argue that gender should be considered as a key factor in tooth size prediction. Ignoring gender can lead to inaccurate estimations over estimating sizes in females or underestimating them in males which may result in inappropriate clinical decisions. Therefore, it is recommended that separate prediction tables and regression equations be developed for females and male.[22,23] This would enhance the precision of mixed dentition analyses and lead to better orthodontic outcomes by accounting for the natural variation in tooth size between the genders.

1. Mixture of Group of Teeth Used as Predictor

In orthodontics, predicting the size of unerupted permanent canines and premolars during the mixed dentition stage is essential for planning treatments like braces or extractions. To do this, researchers and clinicians use the mesiodistal widths (the front-to-back width along the arch) of already erupted teeth as predictors.

a. Traditional Predictor: addition of Four Incisors of Mandible

The most commonly used predictor is the combined width of the four permanent incisors of mandible. This method has been accepted widely and used in developing regression equations for estimating the size of unerupted premolars and canines across various populations.

Many researchers have supported this approach because these teeth erupt early and are easy to measure and they show a fairly consistent size pattern within populations. However, recent studies suggest that relying solely on these four incisors might not always provide the most accurate predictions, especially across diverse ethnic groups.[19,24,25]

b. Alternative and Combined Predictors

To improve accuracy, researchers have explored other combinations of erupted teeth - beyond just the four mandibular incisors - as predictors. These combinations often include molars or maxillary incisors, based on population-specific characteristics.

For examples : In Brazilian population, the best predictor was found to be the total of permanent incisors of mandible and first molar of mandible. This combination gave better estimates of unerupted canine and premolar sizes.[26]

In Spanish and Egyptian populations, the most accurate predictor was the combined width of the central incisor of maxilla and mandibular first molar. This combination worked better than using mandibular incisors alone.[27]

In Peruvian population (Bernabé and Flores-Mir, 2005) A more accurate prediction was achieved using the addition of central incisors of maxillary and mandibular plus the maxillary first molar.[28]

In Syrian, Croatian, and Italian populations the mixture of incisors of mandible and maxillary first molar was found the most reliable predictor. This combination has been supported by multiple studies in these regions.[29-31]

Mixed Dentition Space Analysis Using Digital Models

In orthodontics space analysis in mixed dentition is done commonly using conventional plaster models. Digital models which are created with the help of intraoral scanner are not widely used in clinical setting. Okamoto et al. in his preliminary study evaluated that how well digital models can perform in the mixed dentition analysis compared to conventional plaster models.[32] They measured the space which is needed for permanent premolars and canines teeth and also, they measured the arch length discrepancy.

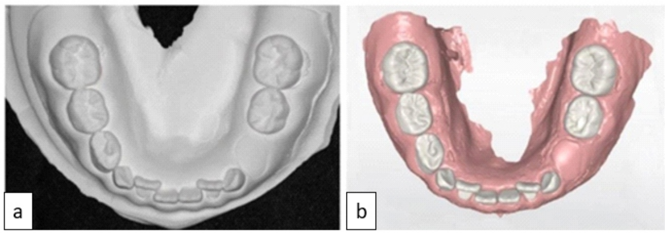

Figure.1 : (a) Plaster model is made from an impression of the reference model using alginate impression material. (b)Digital model is obtained from an optical impression of the reference model using an intraoral scanner.

(Picture courtesy : Okamoto A, Karibe H, Tanaka S, Kawakami T, Shinya A. Reliability of mixed dentition space analysis using a digital model obtained from an optical impression: a preliminary study. BMC Res Notes. 2024 Jan 3;17(1):12)

The biggest difference among the digital and plaster model results was in the right side arch length discrepancy: Digital vs plaster showed a difference of -0.49 mm. However, this difference is very small and considered not significant clinically (in real practice, such a small difference wouldn't affect treatment decisions). Hence, concluded that the digital models are just as accurate as traditional plaster models for mixed dentition space analysis.[32]

Conclusion

Space analysis during the mixed dentition phase is a cornerstone of early diagnosis of orthodontic and planning of treatment. Accurately predicting the mesiodistal width of unerupted permanent canines and premolars is essential to anticipate and manage potential space discrepancies in the dental arch. Various techniques - ranging from direct radiographic measurements to statistical prediction equations and their combinations - offer clinicians valuable tools for evaluating developing dentition. While widely used methods like Probability Tables of Moyer's and the equations of Tanaka-Johnston remain clinically relevant due to their simplicity and non-invasive nature

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A Journal of Advanced Dentistry
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Management of Resorbed Mandibular Ridge with Neutral Zone Technique : A Case Report

Received on: 14- 05- 2025; Accepted on: 13-06-2025; Published on : 29 07 2025

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Abstract

Resorption of the mandibular ridge in patients is a problem for prosthodontic rehabilitation. The fundamental process of denture stability and support is defined by the continuous reduction of the denture foundation. The prognosis of these individuals can be markedly improved by using the neutral zone technique to create a denture that is sculpted by muscle function and blends in with the surrounding oral structures. The area of the oral cavity known as the neutral zone is where, when the mouth is in its normal functioning state, the forces exerted by the tongue pressing outward are balanced by the cheeks and lips pressing inward. Therefore, it is possible to establish a medically ideal tooth arrangement and harmonious denture shapes to maximize patients' prosthesis stability, comfort, and function. This case report details the use of the neutral zone impression technique in the rehabilitation of a patient with a significantly resorbed mandibular ridge.

Keywords : Atrophic mandibular ridge, neutral zone technique, resorbed ridge, tissue conditioner, monoplane teeth

Introduction

The term "neutral zone" refers to a prospective denture region where forces from the tongue that are directed outward are offset by forces that are directed inward and come from the cheeks and lips.[1] The complexity of complete denture situations rises in direct proportion to the population's increased life expectancy. For a prosthodontist, the unstable mandibular full denture presents a basic but difficult situation. Due to the mandibular denture's covered surface area being roughly half that of the maxillary arch, retention and stability issues are more noticeable there than in the maxillary denture.[2] The condition known as residual ridge resorption (RRR) is multifactorial in origin, progressive, chronic, irreversible, and incapacitating.[3] It is a physiological process that is unavoidable.[4] Patients with non-retentive and unstable mandibular dentures benefit from the neutral zone approach. The neutral zone is the region where, during functional movements, the forces of the lips and cheeks acting inward balance the outward forces exerted by the tongue. Where there is a strongly atrophic ridge, the neutral zone procedure is a method for fabricating lower full dentures.[5] The goal of this method is to create a denture that complements the surrounding oral musculature and is sculpted by muscle function. The positioning of the teeth is done in the neutral zone so that the pressures applied by the lips and cheeks balance out the forces applied by the tongue. The neutral zone has been recorded using a variety of agents, including impression compounds, tissue conditioners, waxes, and impression plaster.[6] This medical method made use of tissue conditioner material to record the neutral zone.

Case Report

A male patient, age 68, brought a complaint to the Department of Prosthodontics and Crown & Bridge regarding worn-out, ill-fitting dentures and wants a replacement. The patient had shown good medical fit and was not taking any medications. Upon clinical examination, the mandibular residual ridge was unfavourable due to a high degree of resorption (Fig. 1b), while the maxillary ridge was found to be well-formed and rounded (Fig. 1a). For the previous ten years, the patient wore a complete denture. To increase the lower denture's stability and retention, the

How to cite this article : Rathee et al. - Updent - A Journal of Advanced Dentistry. (2025). Management of Resorbed Mandibular Ridge with Neutral Zone Technique : A Case Report. Updent- A Journal of Advanced Dentistry, 14(1), 28–30. https://doi.org/10.5281/zenodo.16557117

patient's treatment plan called for building a mandibular denture utilizing the traditional neutral zone procedure.

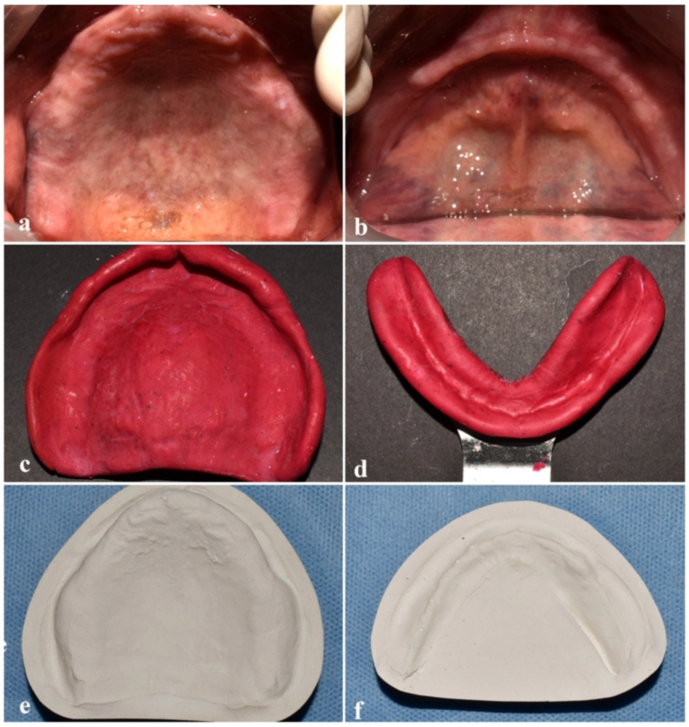

Figure 1. (a) Pre-rehabilitative maxillary occlusal view (b) pre-rehabilitative mandibular occlusal view (c) Primary maxillary arch impression (d) Primary mandibular arch impression (e) Primary maxillary cast (f) primary mandibular cast.

Procedure

The preliminary impression was made using impression compound (Fig. 1c and 1d) (MDM Y- Dent's) in an edentulous tray and the primary cast was poured in dental plaster(Fig. 1e and 1f). Custom trays were fabricated using DPI (Dental Products of India) - RR cold cure acrylic material. The border moulding was done conventionally for the maxillary arch (Fig. 2a). and using all green technique for the mandibular arch (Fig. 2b) followed by the secondary impression with light body elastomeric impression material (Fig. 2c). Master casts were fabricated. Tentative jaw relation was recorded using occlusal rims made from modelling wax (Fig. 2e) and this record was mounted on a three-pin articulator (Fig. 2d). Using self-cure acrylic resin (Fig. 2f), three acrylic pillars were created in the vicinity of the first molars after the lower occlusal rim was removed. A thick mix of tissue conditioner material (Visco-gel, Dentsply Ltd., Weybridge, Uk) was applied on the lower denture up to the height of acrylic pillars while the upper occlusal rim was placed in the mouth(Fig. 2g). The patient was instructed to talk, swallow, lick, and purse his lips, and drink some water several times so that the lingual and buccal surfaces of the impression were moulded correctly (Fig. 2d). After five to ten minutes, the set impression of the neutral zone was taken out of the mouth and placed back on the articulator (Fig. 2h). The recorded neutral zone's silicone index was created (Fig. 2i).

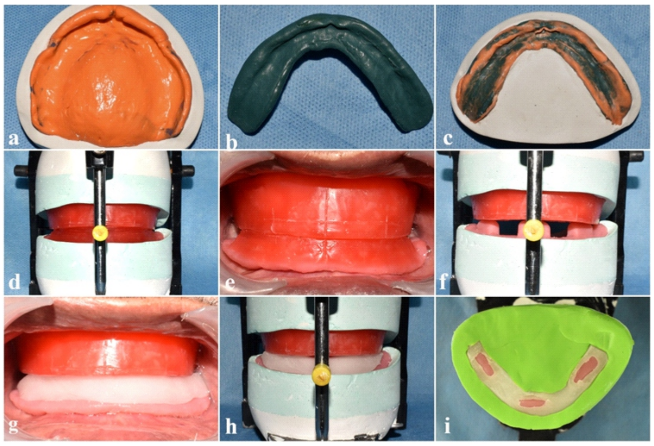

Figure 2. (a) Maxillary final impression using light body silicone (b) All green technique to record atrophic mandibular ridge (b) secondary impression. (d) tentative jaw relation (e) recording jaw relation. (f) Acrylic rest at level of occlusal rim (g) neutral zone recorded with tissue conditioner material (h) articulated occlusal rims (i) silicone index.

The tissue conditioner material was removed from the denture base, the parts of the silicone index were reassembled and wax was poured into the neutral zone area (Fig. 3a). Lower teeth arrangement was done first in the recorded neutral zone (Fig. 3b). A denture try-in was done (Fig. 3c). Finally, the trial dentures were cured and polished conventionally (Fig. 3d). Finished final prosthesis (Fig. 3e). The patient was kept on a regular 3 monthly follow-up. The patient found the denture satisfactory.

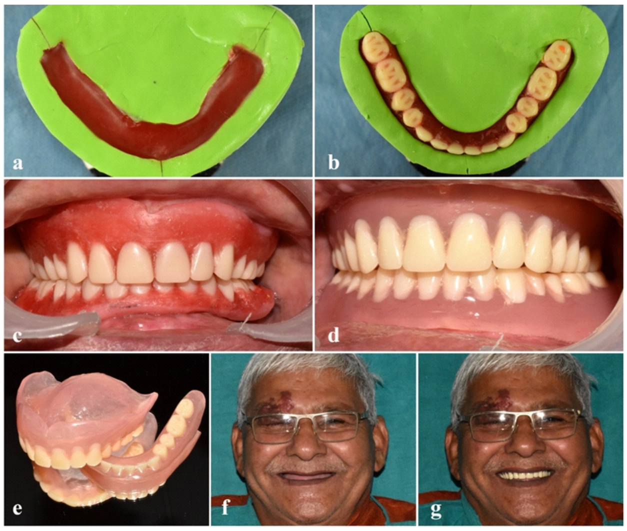

Figure 3. (a) Tissue conditioner replaced with modelling wax (b) mandibular teeth arrangement in neutral zone(c) denture try-in (d) denture insertion (e)Final prosthesis (f) Extraoral pre-operative view (g) Extraoral post-operative view.

Discussion

If the mandible is moderately or severely resorbed, it is frequently difficult to stabilize and make a lower full denture comfortable.[7] The incapacity of the remaining ridge and the tissues that cover it to withstand masticatory forces is one of the primary functional challenges with the atrophic mandible.[8] In these situations, the placement of the artificial teeth and the way the polished surface of the denture interacts with the surrounding tissues are critical to the outcome of the treatment.[10] There have been several reported methods for forming the neutral zone's shape that rely on oral function. According to the Eurocentric idea, posterior mandibular denture teeth should be positioned to take up as much of the denture foundation as feasible without interfering with normal tongue function.[11]The placement of prosthetic teeth within the neutral zone serves two crucial purposes: (1) it prevents prosthetic teeth from interfering with normal muscle function; and (2) it exerts a force against the entire set of dentures, helping to stabilize and retain them rather than causing denture displacement. Numerous studies have contrasted conventionally constructed dentures with dentures made using the neutral zone approach. Neutral zone dentures were found to be functionally more stable than traditional dentures.[9] To record the neutral zone, a variety of materials can be utilized, including silicone, admix material, green stick compound, and zinc oxide eugenol. This instance involved the usage of tissue conditioner material with acrylic pillars, which has the benefit of maintaining vertical dimension. Acrylic pillars can easily be substituted with wire loops. Tissue conditioner use has the following benefits, among others: If the material added in the first application is insufficient to record the neutral zone, it can be added to the same material. It is also (1) mucostatic, (2) odourless and tasteless, (3) and (4) extended setting time that allows for proper performance of all functional movements. The pricey tissue conditioners are the sole drawback.

Conclusion

It can be difficult for a prosthodontist to treat mandibular ridges that are moderately to severely resorbed. When the neutral zone approach is applied, patient comfort, satisfaction, speech, and stability all improve. The article discusses the clinical importance of the neutral zone for the positioning of prosthetic teeth and the shaping of polished denture surfaces.

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Dentists on the Frontline : Preventing Hepatitis Transmission in Oral Healthcare

Received on: 25- 05- 2025; Accepted on: 04-06-2025; Published on : 29 07 2025

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Abstract

Liver disease encompasses a broad spectrum of conditions that impair liver function, including infections, alcohol misuse, drug toxicity, and autoimmune disorders. Hepatitis, a major cause of liver inflammation, has significant global health implications. The five primary hepatitis viruses (A, B, C, D, and E) vary in transmission, pathogenesis, and clinical outcomes. Hepatitis A (HAV), an RNA virus, spreads primarily via the fecal-oral route and is prevalent in regions with poor sanitation. It causes acute liver inflammation but does not lead to chronic disease. Clinical features include fever, jaundice, and abdominal discomfort, with diagnosis confirmed through serologic testing for IgM anti-HAV. Management is supportive, and prevention relies on sanitation and vaccination. Hepatitis B (HBV), a DNA virus, is transmitted through blood and body fluids, including vertical and sexual transmission. HBV poses a high risk of chronic infection, leading to cirrhosis and hepatocellular carcinoma. Clinical manifestations range from asymptomatic infection to severe liver disease. Vaccination is the cornerstone of HBV prevention. In dental practice, strict infection control protocols and vaccination of healthcare workers are essential to reduce transmission risks. Post-exposure prophylaxis and appropriate patient management further mitigate the spread of infection in healthcare settings.

Keyword - Dentist, Hepatitis, Liver disease, Oral manifestation.

Introduction

The liver performs a multitude of roles in preserving health and balance. It produces the majority of necessary serum proteins, including albumin, transporter proteins, blood coagulation factors V, VII, IX, and X, prothrombin, and fibrinogen, [in addition to numerous hormone and growth factors], generates bile and its transporters (cholesterol, lecithin, phospholipids, and bile acids), regulates nutrients (glucose, glycogen, lipids, cholesterol, and amino acids), and metabolizes and conjugates lipophilic compounds (bilirubin, cations, and drugs) to aid in their excretion in bile or urine. The metabolism of medicines, lipids, proteins, bilirubin, and hormones is all altered by liver disease.[1]

Types of Liver Disease[2]

Liver disease generally refers to conditions that damage liver. They can develop for many reasons, including:

- Damage from viruses. e.g-Hepatitis
- Alcohol overuse. e.g- Alcohol-related cirrhosis
- Medication misuse.e.g-Drug- induce hepatitis
- Exposure to toxins. e.g- Toxic hepatitis,
- Autoimmune conditions that block the liver's ability to function properly

Experts have identified more than 100 different types of liver disease.

Hepatitis

The inflammation of the liver is known as hepatitis. The illness may resolve on its own or may worsen and lead to liver cancer, cirrhosis, or fibrosis (scarring). Although hepatitis viruses are the most frequent cause of hepatitis worldwide, autoimmune disorders, alcohol, narcotics, and other toxic chemicals can also result in hepatitis.

The five primary forms of hepatitis viruses are A, B, C, D, and E. Because of the burden of disease and mortality they inflict, as well as the possibility of outbreaks and epidemic spread, these five categories are the most concerning. Specifically, types B and C cause

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Website : www.updent.in
Quick Response Code:

How to cite this article : Datta et al. - Updent - A Journal of Advanced Dentistry. (2025). Dentists on the Frontline : Preventing Hepatitis Transmission in Oral Healthcare. Updent- A Journal of Advanced Dentistry, 14(1), 31–35. https:// doi.org/ 10.5281/ zenodo. 16557304

chronic illness in hundreds of millions of people and are the main cause of cancer and liver cirrhosis together. Viral Hepatitis is one of the major global public health issues, and every year millions of individuals suffer from it. Viral Hepatitis caused 1.34 million fatalities worldwide in 2015, with the majority of viral Hepatitis deaths owing to chronic liver disease or primary liver cancer .

Most cases of hepatitis A and E are brought on by consuming tainted food or water. Parenteral contact with contaminated bodily fluids typically results in the development of hepatitis B, C, and D. Receiving contaminated blood or blood products, invasive medical procedures utilizing contaminated equipment, and sexual contact are common ways for these viruses to spread. Hepatitis B can also spread from mother to kid, from family member to child, and during childbirth.[3]

Hepatitis A

Hepatitis A is the most commonly reported type of hepatitis in United States.It is caused by hepatitis A virus (HAV) ,which is a small, undeveloped and symmetrical RNA virus. Incubation period for hepatitis A virus is between 3 to 5 weeks with a mean of 28 days. Virus replicate in liver and large quantities are shed in feces up to 1 week prior to onset of symptoms. Unlike hepatitis B and C, hepatitis A does not cause chronic liver disease but it can cause debilitating symptoms and rarely fulminant hepatitis (acute liver failure), which is often fatal.

Epidemiology

Infection is common in low- and middle-income countries with poor sanitary conditions and hygienic practices, and most children (90%) have been infected with the hepatitis A virus before the age of 10 years, most often without symptoms. In middle-income countries and regions where sanitary conditions are variable, children often escape infection in early childhood and reach adulthood without immunity. Infection rates are low in high-income countries with good sanitary and hygienic conditions.[3]

The WHO estimates that approximately 1.5 million people are infected with HAV each year. With the implementation of vaccination, the incidence of HAV in the United States has significantly decreased. The incidence of acute HAV infection has decreased by 92% from 12 cases per 100,000 in 1995 to 1 case per 100,000 in 2007.[4]

WHO estimates that in 2016, 7134 persons died from hepatitis A worldwide (accounting for 0.5% of the mortality due to viral hepatitis).[5]

Transmission of HAV

Hepatitis A generally spread through fecal oral route (when an unaffected person eats or drinks food contaminated by fecal material of infected person).Blood transfusion is a very rare cause of hepatitis A.[5]

Risk factors for HAV include

- Institutionalization
- Close personal contact
- Travel to a foreign country
- Occupation
- Parenteral drug abuse
- Homosexuality

Pathogenesis

HAV, first identified in 1973 by Feinstone et al., is classified in the family Picornaviridae and genus Hepatovirus. It is a positive-sense, single-stranded RNA virus which replicates primarily within hepatocytes. Animal studies showing HAV antigen in the epithelial cells of intestinal crypts and cells of the lamina propria in the small intestine suggest replication might also occur at these sites. Once ingested orally, the virus is taken up from the gastrointestinal tract and the HAV particles are carried to the basolateral membrane of the hepatocyte via the portal circulation. The hepatocellular injury in acute HAV infection is mediated by various immune mechanisms. It has been shown that patients with acute HAV infection have the virus-specific T-cell mediated release of cytotoxic interferon-gamma. Additionally, recent mice-models have demonstrated HAV-induced hepatocellular apoptosis and inflammation associated with the innate immune response.The humoral immune response is responsible for the diagnostic serologic assays. Following replication in the liver, HAV is excreted in bile and released into the stool. The concentration of the virus is highest in the stool during the 2 weeks before the onset of jaundice, at which point the individual is most infectious. Most people are no longer infectious 1 week after jaundice appears at which time stool shedding and viremia are decreased.[5]

Clinical Sign And Symptoms

1. The clinical manifestations of HAV infection range from asymptomatic infection to acute liver failure, but it does not progress to chronic hepatitis.
2. Development of symptomatic hepatitis is associated with patient age. Relatively few children under 6 years of age (<30%) manifest hepatitis symptoms, whereas the majority of adults (>70%) develop symptoms that persist for 2–8 weeks.
3. The onset of hepatitis A is often abrupt with fever (18%–75%), malaise (52%–91%), nausea or vomiting (26%–87%), abdominal discomfort (37%–65%), and then dark urine (28%–94%) and jaundice. When the patient seeks medical advice, the fever has usually disappeared. On physical examination, hepatomegaly (78%) and jaundice (40%–80%) are frequently detected.[6]
4. Less commonly, pruritus, diarrhea, arthralgia, or skin rash develop.

Diagnosis

1. **Serologic testing :** Acute hepatitis A is diagnosed by serologic testing to detect HAV-specific immunoglobulin (IgM) antibodies in the blood.
2. **Reverse transcriptase-polymerase chain reaction :** This is include to detect the viral RNA. Immunoglobulin G (IgG) anti-HAV emerges soon after infection and remains present for the person's lifetime.
3. **Complete blood count :** Blood work will reveal a mild lymphocytosis and normal prothrombin time. If the prothrombin time is elevated, it should raise suspicion of severe liver damage including risk for encephalopathy.
4. **Liver function test :** Hepatitis A is associated with an elevation in aspartate aminotransferase, which returns to normal in 4-6 months. Bilirubin levels are also elevated and if they persist one should suspect cholestatic liver disease.[4]

Management

1. No specific treatment is needed for most patients with acute, uncomplicated HAV infection beyond supportive care. Complete recovery from symptoms may take several weeks to months. In the rare case of fulminant hepatitis from HAV infection, liver transplantation may be a life-saving measure. Extra hepatic complications are managed routinely.
2. According to the WHO, the most effective way to prevent HAV infection is to improve sanitation, food safety, and immunization practices. In the United States, vaccination against hepatitis A is available as inactivated, single-antigen vaccines (HAVRIX and VAQTA) or in combination with hepatitis B (TWINRIX). The Centers for Disease Control and Prevention recommends vaccination for children 12 months or older, travelers to endemic countries, gays, illegal drug users, individuals with occupational risk exposure, persons with clotting factor disorders or chronic liver disease. Standard adult dosing recommends administration of two doses of the vaccine 6 to 12 months apart. These vaccines are highly efficacious were seroconversion rates approaching 100%.
3. Until more recently, immunoglobulin was the only treatment for post-exposure prophylaxis again HAV. However, animal studies and clinical trials demonstrated the efficacy of post-exposure immunization with an inactivated HAV vaccine has led the CDC to recommend the vaccine instead of immunoglobulin for exposure to HAV in healthy individuals aged 1 to 40 years. For individuals 41 years and older, immunoglobulin administration is preferred due to the risk of more severe clinical presentation and limited evidence of vaccine efficacy in this age group. Children less than 12 months, individuals with chronic liver disease, and immunocompromised persons should also receive immunoglobulin.[5]

Hepatitis B

Hepatitis B is a major global health problem. Hepatitis B is an infection of the liver caused by the hepatitis B virus(HBV). The infection can be acute (short and severe) or chronic (long term). Hepatitis B can cause a chronic infection and puts people at high risk of death from cirrhosis and liver cancer.[7]

Epidemiology

The burden of infection is highest in the WHO Western Pacific Region and the WHO African Region, where 116 million and 81 million people, respectively, are chronically infected.[7] Sixty million people are infected in the WHO Eastern Mediterranean Region, 18 million in the WHO South-East Asia Region, 14 million in the WHO European Region and 5 million in the WHO Region of the Americas.[8]

In India, HBsAg prevalence among general population ranges from 2% to 8%, placing India in intermediate HBV endemicity zone and the number of HBV carriers is estimated to be 50 million, forming the second largest global pool of chronic HBV infections.

Structure of Hepatitis B ViruS(HBV)

HBV is a DNA virus belonging to the family Hepadnaviridae. It is a complex 42 nm double-shelled particle. The outer surface or envelop of the virus contains hepatits B surface antigen (HbsAg). It encloses an inner icosahedral 27 nm nucleocapsid (core), which contains hepatitis B core antigen (HbcAg). Inside the core, there is a circular double-stranded DNA and a DNA polymerase[9]. (Fig:1)

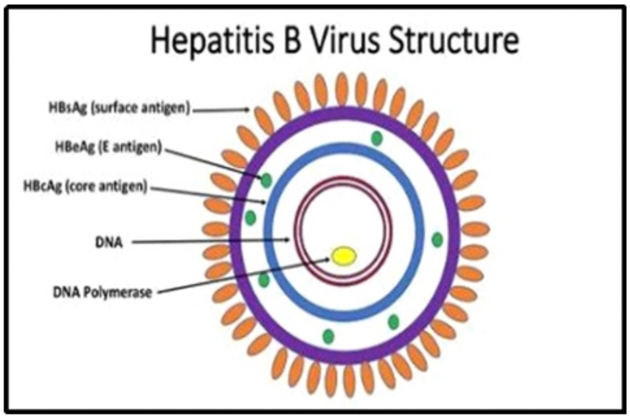

Fig1-Hepatitis B virus structure

Transmission of HBV

Various modes of transmission for chronic HBV (Hepatitis B Virus) infections are:

1. **Mother-to-Child Transmission (Vertical Transmission) :** Most chronic HBV infections in children are acquired through mother-to-child transmission during childbirth or early childhood. This mode of transmission is particularly common in high-prevalence settings where infant vaccination, especially birth-dose vaccination, may be suboptimal.
2. **Sexual Transmission :** HBV can also be transmitted sexually, especially among men who have sex with men (MSM) and individuals engaging in unprotected sex with multiple partners. In the US, nearly 50% of acute HBV infections are associated with sexual activity.
3. **Horizontal Transmission in Early Childhood :** Up to a third of new HBV infections in children could occur through horizontal transmission in early childhood. This includes transmission between children, within households, or within families. This mode of transmission is particularly significant in sub-Saharan Africa and among unvaccinated children who migrate to other regions.[8]
4. **Medical Procedures :** Transmission can also occur through poor infection control and injection safety practices during medical, surgical, and dental procedures.
5. **Traditional Practices :** Certain traditional practices, such as scarification or circumcision, may also contribute to HBV transmission if proper infection control measures are not observed.

Pathogenesis

Pathophysiology involves knowing how the virus enters the body, replicates, and triggers immune responses that lead to liver damage.

1. **Viral Entry and Replication**
   - Hepatitis B virus (HBV) enters the body through contact with infected blood or bodily fluids. This can happen through sexual contact, sharing needles, or from an infected mother to her baby during childbirth.
   - Once in the bloodstream, HBV targets liver cells, known as hepatocytes. It binds to specific receptors on the surface of hepatocytes and enters them.
   - Inside the hepatocytes, HBV releases its DNA, which is then transported to the nucleus of the cell. Here, the viral

DNA is integrated into the host cell's DNA, becoming a part of the hepatocyte's genetic material.

- The integrated viral DNA serves as a template for the production of new viral particles. These particles are assembled in the cytoplasm of the hepatocyte and then released into the bloodstream.

2. **Immune Response**
   - The body's immune system recognizes the presence of HBV and mounts a response to eliminate the virus. This involves both innate and adaptive immune mechanisms.
   - Innate immune cells, such as natural killer cells and macrophages, are activated to destroy infected hepatocytes and inhibit viral replication.
   - Adaptive immune responses, involving T cells and B cells, are also activated. Cytotoxic T lymphocytes (CTLs) target and kill infected hepatocytes, while B cells produce antibodies against HBV antigens.
   - However, HBV has developed strategies to evade the immune system, such as by downregulating antigen expression and altering the presentation of viral antigens to T cells.
3. **Liver Damage**
   - The immune response against HBV, particularly the cytotoxic activity of CTLs, can cause inflammation and damage to hepatocytes.
   - Chronic inflammation and hepatocyte damage lead to the development of liver fibrosis, where scar tissue replaces normal liver tissue. Over time, this can progress to cirrhosis, a condition characte-rized by severe scarring and loss of liver function.
   - In some cases, chronic hepatitis B infection can also increase the risk of developing hepatocellular carcinoma (liver cancer).[8]

Clinical Sign And Symptoms

1. Around 30-50% of adults and children develop clinical illness typical of hepatitis B after initial exposure to HBV. The incubation period for hepatitis B usually ranges from 60 to 150 days.[10]
2. Early symptoms that occur before jaundice include constitutional symptoms like malaise, fatigue, and anorexia for a period of 1-2 weeks.
3. In the acute phase, the typical clinical signs and symptoms include nausea, vomiting, abdominal pain, and jaundice. In some cases, skin rashes, joint pain, and arthritis may occur.
4. Acute hepatitis B progresses to chronic HBV infection in 30-90% of people infected as infants or young children and during adolescence or adulthood around <5% of people infected may develop chronic infection. Chronic infection with HBV results in chronic liver disease, including liver cirrhosis and hepatocellular carcinoma.[8]

Oral Manifestation

1. Intraorally, the greatest concentration of hepatitis B infection is the gingival sulcus. In addition, periodontal disease, severity of bleeding, and bad oral hygiene were associated with the risk of HBV.
2. In patients with liver disease, the resultant impaired hemostasis can be manifested in the mouth as petechiaes or excessive gingival bleeding with minor trauma. This is especially suggestive if it occurs in the absence of inflammation.[11]

Prevention And Management Of Hepatitis In Dental Clinic [10,12]

1. **Immunization**

   To decrease the burden of hepatitis in dental health care workers, it is recom-mended that the dental professionals should receive immunization against hepatitis virus and should use individual protective equipments such as gloves, head caps, masks,etc.Despite the availability and recommendations on hepatitis B vaccination, the vaccination rate among dental professionals has remained consistently low in developing countries.

   It has been found that 5–10% of normal subjects do not produce the anti-hepatitis B surface antibody (anti-HBs) after receiving a standard course of HBV vaccine. Thus, a post-vaccination testing, 1–3 months following the third dose of vaccine, is recommended for health care workers who have contact with blood.
2. **Exposure that might place a dentist at risk of hepatitis infection includes the following:**
   - Percutaneous injuries (needlestick or cut with a sharp object).
   - Contact with potentially infectious blood, tissues, or other body fluids.
   - Mucus membranes of the eye, nose, or mouth or non-intact skin (exposed skin that is chapped, abraded, or afflicted with dermatitis).
3. **Guidelines for treating hepatitis patients**
   - No dental treatment other than urgent care should be rendered for a patient with acute viral hepatitis
   - Hepatitis B is of primary concern to the dentist. Individuals still carry the virus up to 3 months after the symptoms have disappeared, so any patient with a recent history of hepatitis B should be treated for dental emergency problems only
   - For patient with a past history of hepatitis, consult the physician to determine the type of hepatitis, course and length of the disease, mode of transmission, and any chronic liver disease or viral carrier state
   - For recovered HAV or HEV, perform routine periodontal care
   - For recovered HBV and HDV, consult with the physician and order HBsAg and HBs laboratory tests. If HBsAg and anti-HBs tests are nega-tive but HBV is suspected, order another HBs determination .Patients who are HBsAg positive are probably infective (chronic carriers); the degree of infectivity is measured by an HBsAg determination .Patients who are anti-HBs positive may be treated routinely. Patients who are HBsAg negative may be treated routinely.
4. **Precautions for treating active hepatitis,positive-HBsAg (HBV carrier) status, or positive HCV status:**

- Consult the patient's physician regarding status
- If bleeding is likely during or after treatment, measure prothrombin time (PT) and bleeding time. Hepatitis may alter coagulation; change treatment accordingly
- All personnel in clinical contact with the patient should use full barrier technique, including masks, gloves, glasses or eye shields, and disposable gowns
- Use as many disposable covers as possible, covering light handles, drawer handles, and bracket trays. Headrest covers should also be used
- All disposable items (e.g., gauze, floss, saliva ejectors, masks, gowns, gloves) should be placed in a lined wastebasket. After treatment, these items and all disposable covers should be bagged, labeled, and disposed of, following proper guidelines for bio-hazardous waste
- Aseptic techniques should be followed at all times. Minimize aerosol produ-ction by not using ultrasonic instrumentation, air syringe, or high-speed handpieces. Remember that saliva contains a distillate of the virus. Pre-rinsing with chlorhexidine gluconate for 30 s is highly recom-mended
- When the procedure is complete, all equipments should be scrubbed and sterilized. If an item cannot be sterilized or disposed of, it should not be used
- All working surfaces and environmental surfaces should be wiped with 2% activated glutaraldehyde (Cidex).

5. **Work practice controls are an important adjunct for preventing blood exposures. They are as follows:**
   - Using a one-handed scoop technique, a mechanical device designed for holding the needle cap to facilitate one-handed recapping, or an engineered sharp injury protection device (e.g., needles with re-sheathing mechanisms) for recapping needles between uses and before disposal
   - Not bending or breaking needles before disposal Avoid passing a syringe with an unsheathed needle
   - Removing burs before disassembling the handpiece from the dental unit
   - Using instruments rather than fingers to grasp needles, retract tissue, and load/unload needles and scalpels.
   - Placing used disposable syringes and needles, scalpel blades, and other sharp items in appro-priate puncture-resistant containers located as close as feasible to where the items were used
   - Giving verbal announcements when passing sharps
6. **Post-exposure prophylaxis**

1. Control monitoring- If any of medical staff was exposed to hepatitis, it would be necessary to do control testing for HBV, including mandatory counseling. This considers the following:
   - Testing for anti-HBs antibodies 1–2 months after the last dose of vaccine [anti-HBs antibodies cannot be tested 6–8 weeks after the administration of anti-HBs immunoglobulin (HBIG) because of the possibility for false-positive results]
   - Advising the exposed person not to donate blood, plasma, organs, tissue, sperm, and to abstain from risky behavior
   - Offering the psychological counseling if needed.
2. Control testing and advising after exposure to HCV include the following
   - Repeat the test for anti-HCV antibodies and ALT at the earliest 4–6 months after exposure.
   - Do the test for HCV RNA for 4–6 weeks for early diagnosis (caution due to the possibility of obtaining false-positive results).
   - During the testing period, the exposed person must not donate blood, plasma, organs, tissue, or sperm .
   - Exposed person should abstain from changes in sexual activity, pregn-ancy, breastfeeding, or professional activities
   - Counseling Services should be Offered.

Conclusion

Hepatitis, particularly types A and B, presents significant health challenges worldwide, especially in regions with limited healthcare resources. HAV, while generally self-limiting, can lead to serious complications in vulnerable populations, and HBV poses long-term risks due to its chronic nature and potential for oncog-enic progression. Dental practitioners play a vital role in recognizing the implicat-ions of hepatitis on oral health and ensuring a safe clinical environment through immunization, infection control protocols, and post-exposure management. With proper education, preventive practices, and collaboration with medical professi-onals, the dental healthcare system can significantly reduce the risk of hepatitis transmission and contribute to overall public health safety.

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A Journal of Advanced Dentistry
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The Surgical Odyssey of Impacted Canines : A Case Report Exploration

Received on: 25- 05- 2025; Accepted on: 04-06-2025; Published on : 29 07 2025

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Abstract

Impacted canines, particularly in the mandibular region, present a significant challenge in oral and maxillofacial surgery due to their complex anatomy and close association with vital structures. This case report explores the surgical management of bilaterally impacted mandibular canines, highlighting the diagnostic considerations, surgical approach, and postoperative outcomes. This study underscores the importance of meticulous planning and interdisciplinary collaboration in managing such cases[1].

Keywords : Impacted canines, mandibular canines, oral surgery, CBCT, surgical management, case report

Case Report

A 22-year-old male patient presented with the complaint of unerupted canines in the mandibular region[2]. Clinical examination revealed the absence of mandibular canines 33 and 43. The patient reported no significant medical history or previous trauma[3].

Diagnostic Imaging

Cone Beam Computed Tomography (CBCT) was utilized to assess the position and orientation of the impacted canines. The coronal, sagittal, and axial sections of the CBCT revealed that the roots of the canines were in close approximation with the inferior alveolar nerve (IAN) and overlapped the pterygoid loop of the inferior alveolar canal.

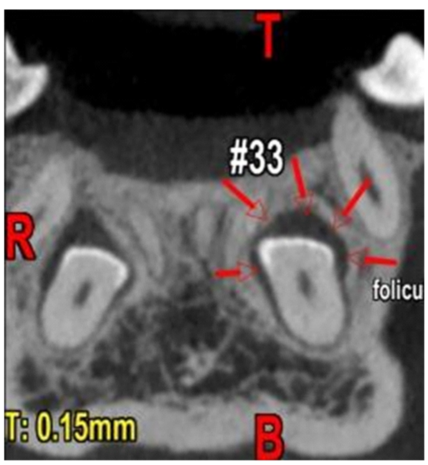

Figure 1: Coronal section of CBCT indicating impacted 33 and 43.

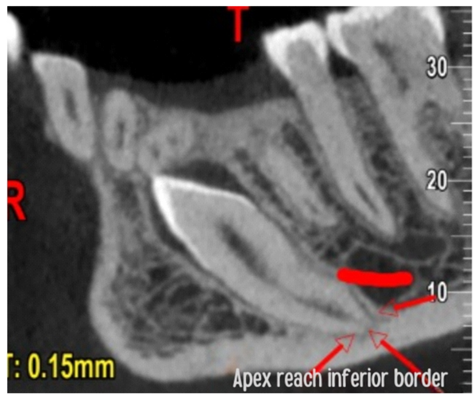

Figure 2: Sagittal section showing close approximation of root with IAN

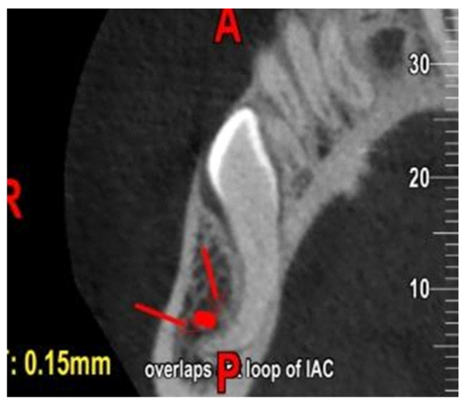

Figure 3: Axial section showing looping of the IAN with apical 3rd of the root.

How to cite this article : Akmal et al. - Updent - A Journal of Advanced Dentistry. (2025). The Surgical Odyssey of Impacted Canines : A Case Report Exploration. Updent- A Journal of Advanced Dentistry, 14(1), 36–38. https://doi.org/10.5281/zenodo.16557557

Figure 4: 3D CBCT scan showing bilateral impacted mandibular canines.

Surgical Approach

Under general anesthesia, a crevicular incision with bilateral vertical releasing incisi-ons from teeth 32 to 42 was made[6]. A full-thic-kness mucoperiosteal flap was raised to exp-ose the underlying bone[2]. Bone guttering was performed to expose the crowns of the impac-ted canines[8]. Careful dissection was carried out to avoid damage to the IAN[9]. The impac-ted canines were then surgically extracted[10].

Fig 5: Crevicular incision with bilateral vertical releasing incisions from 32 to 42.

Fig 6 : Full thickness mucoperiosteal flap raised.

Fig 7: Exposure of bone after reflecting full thickness perisoteal flap.

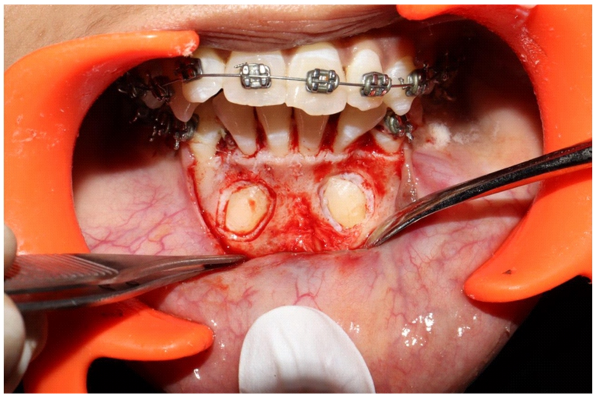

Fig 8 : Exposure of crowns of bilateral impacted canines following bone guttering.

Postoperative Care

Postoperative instructions included maintaining oral hygiene, avoiding strenuous activities, and adhering to a soft diet[11]. The patient was prescribed antibiotics and analgesics to manage pain and prevent infection[12]. Follow-up visits were scheduled to monitor healing and assess for any complications[13].

Conclusion

The successful management of bilaterally impacted mandib-ular canines requires a thorough understanding of the anatomy and careful surgical planning[14]. CBCT imaging plays a crucial role in preoperative assessment, aiding in the precise localization of impacted teeth and their relation to vital structures[15]. Interdiscipl-inary collaboration and meticulous surgical technique are para-mount in achieving favorable outcomes[16].

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A Journal of Advanced Dentistry
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Maxillary Sinus Augmentation in Implant Dentistry : A Comprehensive Review

Received on: 25- 05- 2025; Accepted on: 04 06 2025; Published on : 29 07 2025

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Abstract

Maxillary sinus augmentation is a cornerstone procedure in implant dentistry, especially for managing the atrophic posterior maxilla. This review explores the evolution of sinus lift techniques, anatomical and surgical considerations, graft materials, and post-operative management. Advancements such as piezoelectric surgery, antral-balloon-assisted elevation, and minimally invasive approaches have significantly improved outcomes. The article underscores the importance of individualized treatment planning and evidence-based approaches in ensuring long-term implant success.

Keywords : Direct sinus lift, maxillary atrophy, osseointegration, dental implants, congen-ital defects, surgical techniques, bone grafting.

Introduction

Over the last three decades, implantdirected maxillary reconstruction has increasingly relied on sinus augmentation grafting to overcome the anatomical limitations of the posterior maxilla. The region's challenges-low bone density, sinus pneumatization, and post-extraction alveolar bone loss-result in limited bone volume for implant placement[1],[2]. The spongy nature of maxillary bone makes it one of the least dense bones in the oral cavity. Following tooth loss-particularly due to periodontal disease alveolar ridge resorption accelerates in the absence of functional stimulation. This may lead to a bone reduction of 40–60% within three years[3], significantly impacting prosthetic rehabilitation. The maxillary sinus, with an average volume of 12.5 mL, lies bordered by the orbital floor superiorly and the posterior maxillary alveolus inferiorly. The Schneiderian membrane a bilaminar mucoperiosteal layer - is vital during sinus lift procedures[1]. The main goal of sinus augmentation is to increase vertical bone height for predictable implant osseointegration[3]. While the lateral window technique remains the gold standard, innovations like the transcrestal approach, balloon assisted elevation, and piezoelectric instrumentation offer minimally invasive alternatives with improved safety and recovery[4]. Understanding maxillary sinus anatomy, including the location of septa and neurova-scular bundles, is essential for successful outcomes[1], [5]. Despite significant advances, ongoing research is required to improve graft materials, minimize surgical trauma, and enhance predictability. The integration of minimally invasive protocols and personalized planning is key to the success of implants in the atrophic posterior maxilla.

Historical Background

Sinus lift surgery dates back to the 1970s when Dr. Hilt Tatum6 introduced augmentation techniques using autogenous rib grafts. Later, he modified the Caldwell-Luc procedure by creating a lateral window, allowing Schneiderian membrane elevation and grafting. In 1994, Dr. Summer[7] proposed the internal (crestal) approach using osteotomes. By 1996, Dr. Junji Chen introduced the hydraulic sinus condensing method, employing hydraulic pressure to lift the sinus floor[8]. These innovations significantly reduced morbidity and expanded the treatment scope for patients with posterior maxillary atrophy, setting the foundation for today's advanced sinus augmentation protocols.

Methods

A comprehensive electronic search was conducted using the PubMed database to identify relevant studies published up to the year 2019. The search utilized the keywords: Maxillary sinus, direct sinus lift, bone graft-

How to cite this article : Singh et al. - Updent - A Journal of Advanced Dentistry. (2025). Maxillary Sinus Augmentation in Implant Dentistry : A Comprehensive Review. Updent- A Journal of Advanced Dentistry, 14(1), 39–43. https://doi.org/10.5281/zenodo.16557826

ing, complications related to direct sinus lift. The aim was to include both prospective and retrospective follow-up studies on the placement of direct sinus lift. Studies with a follow-up period of less than Six months and case reports lacking adequate follow-up were excluded. The selected articles were then organized in chronological order to facilitate a clearer understanding of the progression and evolution of Direct sinus lift techniques.

Anatomical and Surgical Considerations

The adult maxillary sinus is a pyramidal, air-filled cavity measuring up to 45 mm in height and 15 cm^3 in volume. Its floor lies approximately 1 cm below the nasal cavity and is closely related to the roots of maxillary premolars and molars. Internally, it is lined with pseudostratified ciliated columnar epithelium, which plays a key role in mucociliary clearance.[9] Drainage occurs through the osteomeatal unit (OMU), and disruption due to anatomical variants like septa or accessory ostia may predispose to sinusitis. The sinus has six walls, each with vital anatomical landmarks such as the infraorbital canal (superior wall), the pterygopalatine fossa (posterior), and the maxillary alveolus (inferior).[10] Accessory ostia (in 40% of individuals) and Underwood septa (in 58%) can complicate sinus surgeries. Understanding these structures is essential for accurate surgical planning.[10]

Blood Supply and Innervation

The sinus receives blood primarily from the posterior superior alveolar artery (PSAA) and infraorbital artery, forming an anastomotic network within the lateral wall. Injury to these vessels during surgery can cause hemorrhage or graft failure.11 Venous drainage is via the facial vein and pterygoid venous plexus (fig.1).

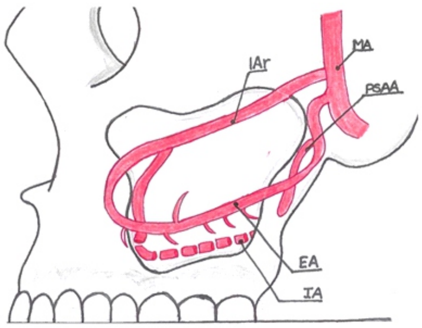

Fig.1- Vascular system that innervates the maxillary sinus vestibular wall. The infraorbital artery and the posterior superior alveolar artery form an intraosseous anastomosis (dotted line). (IA: Intraosseous anastomosis, EA: Extraosseous anastomosis, IAR: Infraorbital artery, MA: Maxillary artery. PSAA: posterior superior alveolar artery).

Innervation is from the maxillary division (V2) of the trigeminal nerve, with contributions from the superior alveolar nerves and pterygopalatine ganglion. Lymphatic drainage is directed to the submandibular, retropharyngeal, and deep cervical nodes.[10]

Preoperative Evaluation

A comprehensive preoperative evaluation is essential before initiating surgical intervention. This should begin with a detailed medical history and physical examination, focusing on factors that may influence surgical outcomes. Important considerations include recent upper respiratory infections, chronic sinus condit-ions, sinus or facial pain, otitis media, previous nasal or sinus surgeries, and any prior attempts at maxillary reconstruction. Additionally, documenting the patient's smoking history is essential, as it may affect healing and graft success. A preoperative computed tomography (CT) scan is highly recommended to assess available bone volume, detect any existing sinus pathology, and identify anatomical variations such as bony septae that may impact the surgical approach.

Surgical Technique: Lateral Window Approach

The lateral window approach, first described by Dr. Hilt Tatum, 6 remains the gold standard for maxillary sinus augment-ation. It allows extensive vertical bone augmentation - up to 12 mm - through a direct view of the Schneiderian membrane.

Anesthesia and Flap Design

Local anesthesia is typically administered using 2% lignocaine with 1:200,000 epinephrine or 4% articaine. Incisions may be midcrestal or palatal, depending on keratinized tissue and bone availability. A vertical releasing incision is added to enable full flap reflection. Sulcular or submarginal incisions may also be utilized when harvesting bone from the tuberosity region.[10]

Antrostomy Creation

The antrostomy is an oval or rectangular bony window (fig.2) created using rotary instruments or piezoelectric tips. The inferior horizontal cut is positioned 2–3 mm above the sinus floor. Variations include:

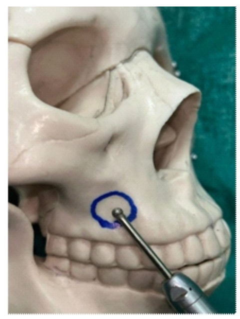

Fig.2. Antrostomy carried out using rotary instruments.

- **Top-Hinge Trapdoor Technique :** In this technique, a rectangular osteotomy is created in the lateral sinus wall using round burs or piezoelectric tips, forming a U-shaped trapdoor. The inferior cut is made 2–3 mm above the sinus floor, while the superior cut is partially drilled to preserve bone thickness. The bony plate is then carefully fractured inward and repositioned medially, remaining attached to the Schneiderian membrane. This repositioned cortical plate serves as the superior border of the new sinus compartment, ensuring stability without exceeding the sinus width (fig.3).

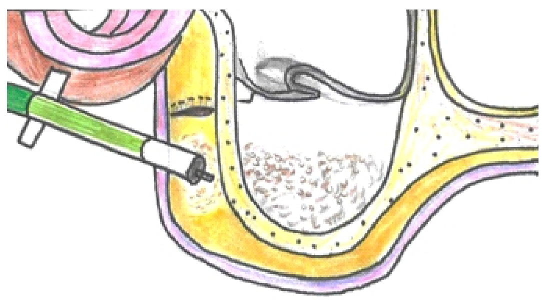

Fig.3. Top-hinge trapdoor SFE.

- Repositioned Bony Window:This technique is typically used for thick lateral sinus walls and aims to preserve the buccal plate. A rectangular osteotomy is made using mechanical or piezoelectric tools, and the lateral window is carefully removed with a periosteal elevator. The bony window is separated from the sinus membrane, stored in saline, and later repositioned over the graft material without rigid fixation after membrane elevation.
- **Complete Osteotomy :** In this technique, the buccal bone plate is completely removed to create an access window. If the bone is thick, it is thinned using a round bur, piezo tip, or bone scraper until the bluish hue of the sinus membrane is visible. To minimize the risk of membrane perforation, the window is then refined using a diamond-coated bur or a smoothing piezoelectric tip.[11]

Membrane Elevation

Using blunt elevators or piezoelectric inserts, the Schneide-rian membrane is carefully dissected and elevated. Perforation risk is minimized by starting at the sinus floor and moving anteriorly and medially. In cases of thin membranes, a collagen membrane may be used for reinforcement.[10]

According to volumetric studies, around 5.46 cm^3 of graft material is needed for 15 mm augmentation, and 3.5 cm^3 suffices for three implants of 13 mm length.[11]

Implant Site Preparation

Ideally, a minimum of 3–4 mm of residual crestal bone is needed for primary stability. Implants can be placed simulta-neously if sufficient bone is present; otherwise, a staged approach is recommended.

Graft Placement and Closure

Autografts or substitute materials are packed along the sinus walls to encourage revascularization. Overfilling is avoided to reduce complications. The flap is repositioned and sutured to ensure tension-free closure.[12]

Balloon-Assisted Sinus Elevation (BASE)

A minimally invasive alternative, balloon-assisted sinus elev-ation (BASE) uses hydraulic pressure to lift the membrane. After crestal incision and buccal window formation, a balloon catheter is inserted and inflated with saline, gently elevating the mem-brane. This reduces trauma and allows simultaneous graft and implant placement.[13]

Piezoelectric Surgery in Sinus Augmentation

Piezoelectric instruments use ultrasonic vibrations to cut bone while sparing soft tissues. Introduced by Horton et al., this technique minimizes the risk of Schneiderian membrane perfora-tion and preserves vascular structures.

Vercellotti et al. observed a 5% perforation rate with piezosu-rgery. Diamond-coated and ball-tip inserts are particularly useful for membrane detachment. Though technically demanding, this approach enhances safety and predictability.[14]

Graft Materials

Bone grafts are commonly utilized to stimulate bone regener-ation, and maxillary sinus augmentation can be achieved using various materials, including autografts, allografts, xenografts, alloplastic substitutes, and growth factors. Autogenous bonegraft considered the gold standard due to osteogenic, osteoinductive, and osteoconductive properties. Common donor sites include the iliac crest and intraoral regions. Autogenous chips promote neov-ascularization within a week due to bone morphogenic proteins (BMPs)[13]. Allografts sourced from a donor of the same species, possess osteoconductive and osteoinductive properties but lack osteogenic potential. Demineralized Freeze-Dried Bone Allografts (DFDBA) contain BMPs, promote bone formation, and are gradually resorbed.[10] Xenografts derived from bovine sources and used for their osteoconductive properties, though resorption may be slow.Synthetic substitutes materials like - tricalcium phosphate and hydroxyapatite are used for volume maintenance and structural support. The success of grafting is influenced by porosity, biocompatibility, and surface chemistry.

Postoperative Care

Proper post-op care is crucial for healing and graft success:

- Avoid nose blowing, using straws, or applying pressure to the sinus.
- Apply cold compresses for the first 24 hours.
- Maintain a soft diet; removable prostheses should not contact the surgical site.
- Use chlorhexidine or saline rinses after 24 hours.
- Sneeze with an open mouth and avoid bending over.
- Analgesics and antibiotics are prescribed as necessary.[10]

Complications and Management of Sinus Lift Surgery

Sinus lift procedures may present with intraoperative, early postoperative, and delayed complications. Membrane perfora-tion is the most common intraoperative issue, manageable with collagen membranes. Graft material loss may result from incre-ased sinus pressure due to sneezing or inflammation. Bleeding from the lateral wall vessels can be controlled using bone wax or electrocautery. Postoperative complications include wound dehiscence, oral fistula formation, acute graft infections (5% incidence), and rare hematomas. Proper flap design, antibiotic use, and surgical technique reduce risks. Delayed complications like chronic sinusitis can occur from odontogenic infections, jeopardizing implant success if left untreated.[15]

Discussion

Implant placement in the posterior maxilla is often complic-ated by limited vertical bone height due to alveolar resorption and sinus pneumatization[2]. Maxillary sinus augmentation, particul-arly through the lateral window approach, has become the stand-ard of care for creating adequate bone volume to support osseoi-ntegrated implants.[15] The lateral window technique allows for substantial bone height gain (up to 12 mm) and direct visualiz-ation of the Schneiderian membrane. Despite its advantages, this method is invasive and carries risks like membrane perforation and sinusitis.4To minimize these complications, less invasive options such as the transcrestal (osteotome) technique have been introduced . While these offer reduced morbidity, their use is limited to patients with a minimum residual bone height of 6–7 mm.[15] Antral balloon-assisted sinus elevation (AMBE) has shown promising results, enabling controlled membrane eleva-tion with reduced risk of perforation. Soltan and Smiler (2005) emphasized its value in narrow ridges, making it a suitable choice for simultaneous implant placement.[13] Piezoelectric surgery has transformed the way sinus lifts are performed. Vercellotti et al. (2001) reported a reduced membrane perforation rate (5%) using piezoelectric devices.[14] These instruments selectively cut minera-lized bone while preserving soft tissue integrity, enhancing surgical safety. Torrella et al. (1998)

also highlighted the precis-ion and reduced complication rate with ultrasonic devices, although they require longer operating times and technical expertise.[16] These benefits make piezoelectric surgery particula-rly valuable in anatomically challenging cases. Preserving the Schneiderian membrane is a critical determinant of sinus lift success. Perforations increase the risk of postoperative infections and implant failure.[4] Preoperative cone-beam computed tomogr-aphy (CBCT) scans are invaluable for identifying sinus septa (seen in up to 37% of patients) and the proximity of the infraor-bital nerve.[17] In some cases, sinus elevation can be avoided altog-ether. Tilted implants, as described by Aparicio et al. (2001), achieved a 95.2% implant survival rate and a 100% prosthetic survival rate over five years.[18] Zygomatic implants also offer a reliable solution for severely atrophic maxillae, with success rates as high as 97% (Candel-Martí et al., 2012)[19].The choice of graft material profoundly impacts healing and implant success. Autogenous grafts remain the gold standard due to their osteo-genic capacity, but their use is limited by donor site morbidity.[20] The Safescraper is one intraoral tool that facilitates safe autograft harvesting.Allografts and xenografts serve as viable alternatives with varying degrees of osteoconductive and osteoinductive potential. DFDBA, enriched with BMPs, supports bone regene-ration, especially when used in well-vascularized environments (Goldberg & Stevenson, 1987)[21].Aro et al. (1981)[22] compared ultrasonic and oscillating instruments, noting that while early bone healing was slower with piezoelectric tools, long-term histological results were comparable. These findings justify the use of ultrasonic techniques for their tissue-sparing benefits. Residual bone height is a key predictor of implant success. Al-Dajani (2014) found that implants placed in bone with less than 5 mm height showed lower survival rates . This underscores the necessity of thorough radiographic and clinical planning. Brigna-rdello-Petersen et al. (2014) promoted evidence-based dentistry (EBD), advocating for treatment planning based on high-quality research and individualized patient care.233 In a retrospective study, Balaji (2013) demonstrated that the direct sinus augmenta-tion technique resulted in a mean bone height gain of 6.19 mm, supporting its use in severely atrophic ridges.[2] The study also emphasized the importance of alveolar width in choosing implant diameter.

Conclusion

Maxillary sinus augmentation is a vital surgical technique that has evolved significantly over the years. From its origins in the 1970s to today's minimally invasive and technology-assisted procedures, the sinus lift has enabled the reliable placement of implants in the challenging posterior maxilla. The lateral window technique, though invasive, remains the most versatile and widely used method for substantial bone gain. Alternatives like the transcrestal and balloon-assisted approaches cater to patients with moderate residual bone, offering reduced morbidity. Techn-ological innovations such as piezoelectric surgery and improved biomaterials have enhanced safety, reduced complications, and improved long-term outcomes. The selection of graft material, patient-specific anatomy, and adherence to postoperative care protocols are all crucial for success. As maxillofacial surgeons, it is our responsibility to stay abreast of these advancements and apply them with precision and personalized planning. With the aid of CBCT imaging, careful anatomical evaluation, and evid-ence-based decision-making, we can ensure optimal functional and esthetic outcomes for our patients.

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A Journal of Advanced Dentistry
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Supracrestal Tissue Attachment : A Modern Take on the Classic Biologic Width Concept

Received on: 25- 05- 2025; Accepted on: 04-06-2025; Published on : 29 07 2025

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Abstract

The concept of biologic width, now redefined as supracrestal tissue attachment (STA), plays a pivotal role in maintaining periodontal health and ensuring the longevity of restorative treatments. The term STA emerged from the 2017 World Workshop on the Classification of Periodontal and Peri-implant Diseases and Conditions, superseding the traditional terminology. STA encompasses the junctional epithelium and supracrestal connective tissue, forming a critical barrier that protects the underlying alveolar bone from microbial invasion and trauma. The historical evolution of biologic width, originating with the foundational work of Cohen and Gargiulo, underscores its importance in restorative dentistry, particularly in the placement of subgingival margins. Disruption or violation of this dimension can lead to inflammation, attachment loss, and alveolar bone resorption, necessitating precise diagnostic and treatment strategies. Clinical evaluation methods, including bone sounding and radiographic techniques, are essential for assessing STA and preventing restorative margins from encroaching upon this delicate space. Future research aims to enhance our understanding of STA dynamics around implants and natural teeth, contributing to improved periodontal and restorative outcomes.

Key Words : Supracrestal Tissue Attachment, Biologic Width, Periodontal Health, Restorative Dentistry, Gingival Margins

Introduction

Supracrestal tissue attachment (STA)1 is a relatively new term that was introduced in 2017 following the World Workshop on the Classification of Periodontal and Peri-implant Diseases and Conditions, co-sponsored by the American Academy of Periodontology (AAP) and the European Federation of Periodontology (EFP), which included expert participants from all over the world. It has replaced the term biological width, and refers to the junctional epithelium and supracrestal connective tissue.

Biological width: what is it? The human body is susceptible to invasion by a wide range of germs, diseases, and foreign particles. Ectodermal tissue helps guard against disease-causing organisms. The biological width (BW)that is derived from the ectoderm refers to the innate protective barrier that forms around the alveolus, protecting it from infections and diseases.[2]

Over the years, different authors have defined the BW differently,

Authors	Year	Definition
Ingber J et al. & Amiri-Jezeh M et al.	1977 & 2006	"The junctional epithelium and supracrestal connective tissue attachment surrounding every tooth."
Nevin et al.	1984	"The sum of the combined supracrestal fibers, the junctional epithelium, and the sulcus."
Khuller N et al. & Nugala B et al. (most accepted)	2009 & 2012	"The dimension of the soft tissue, which is attached to the portion of the tooth coronal to the crest of the alveolar bone."
World Workshop on the Classification of Periodontal and Peri-Implant Disease and Conditions	2018	"Commonly used clinical term to describe the apico-coronal variable dimensions of the supracrestal attached tissues."

Table 1: Definitions of biologic width by different authors.3,4,5,6,7,8

History of Biological Width

Cohen coined the term "biological width" in 1962 to refer to the biological attachment of the soft tissues to the tooth's root. This attachment includes both connective tissue and junctional epithelium, and it is the distance between the alveolar bone crest and the base of the gingival sulcus.[9]

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Website : www.updent.in
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How to Cite This Article : Bansal et al. - Updent - A Journal of Advanced Dentistry. (2025). Supracrestal Tissue Attachment : A Modern Take on the Classic Biologic Width Concept. Updent- A Journal of Advanced Dentistry, 14(1), 44–50. https: // doi.org/ 10.5281 /zenodo. 16557991

This term was coined following the work by Gargiulo et al in 1961, in which the width is referred to as the dentogingival junction.[10] The dentogingival junction consists of two parts: connective tissue attachment and epithelial attachment.

In 2017, the World Workshop on the Classification of Periodontal and Peri-implant Diseases and Conditions changed the word 'biological width' to'supracrestal tissue attachment' (STA), which refers to the junctional epithelium and supracrestal connective tissue. The workshop was co-sponsored by the American Academy of Periodontology (AAP) and the European Federation of Periodontology (EFP), with expert attendees from all around the world.[1]

Anatomy of Biological Width

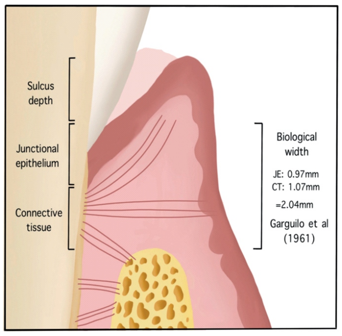


Figure 1. Diagram illustrating the dimensions based on the research of Garguilo et al.[10]

The term "biological width" originates from Gargiulo et al.'s 1961 study,10 which analyzed the dentogingival complex in 287 human cadaver teeth. The research revealed proportional relationships between the alveolar crest, connective tissue attachment, epithelial attachment, and sulcus depth. The average measurements were 0.69 mm for sulcus depth, 0.97 mm for epithelial attachment, and 1.07 mm for connective tissue attachment, totaling 2.04 mm for biological width. However, biological width varies individually, with Vacek et al. (1994)11 reporting a range of 0.75 mm to 4 mm.

Importance or Significance of STA

STA is a type of human tissue barrier that protects against infection and foreign materials by responding dynamically to keep a consistent distance.[5] If this distance is crossed, a cellular reaction will occur to restore the proper distance between the restoration's edge and the bone crest.

The supracrestal tissue attachment (STA) is crucial in restorative dentistry, especially for subgingival margins. Dentists must avoid disrupting the junctional epithelium or connective tissue during preparation and impression recording. Since distinguishing the junctional and sulcular epithelium is challenging, subgingival margins should extend only 0.5-1.0 mm below the gingival level.[5]

In natural dentition, tooth shape influences gingival morphology. Tooth forms include triangular, ovoid, square, long narrow, and short wide. Triangular teeth have incisal proximal contacts and require more tissue height, increasing the risk of "black hole disease." In contrast, square teeth have longer proximal contacts and less papillary tissue, reducing this risk.[12]

Dimensions of Periodontium

Maynard and Wilson[13] classified the periodontium into three dimensions: superficial physiologic gingiva, which surrounds the teeth in its free and attached state. The crevicular dimension refers to the distance between the junctional epithelium and the gingival edge. Subcrevicular physiology refers to the biological width of the connective tissue connection and junctional epithelium.

Supracrestal Tissue Violation

Inflammation, pocket formation, osseous resorption, irreversible loss of periodontal attachment, and in rare cases, root resorption can result from supracrestal tissue violation. Patients with a thin gingival tissue biotype (gingival thickness <1.5 mm) are more likely to have recession, while those with a thick gingival biotype (gingival thickness >2 mm) are more likely to experience inflammation and periodontal pocketing.

STA Clinical Evaluation

Using a periodontal probe, BW is measured in clinic settings. It is determined that there is a violation of BW when the distance is smaller than 2 mm at one or more sites. For accurate gauging, measurements should be made on multiple teeth with healthy gingiva to reduce the possibility of site and individual variances.[7,14]

Evaluation of STA Violation

Clinical Method[15]

It is a strong sign that the margin extends into the attachment and that a biologic width violation has taken place if the patient feels discomfort in their tissue while the restoration margin levels are being measured with a periodontal probe.

The signs of biologic width violation are:

- Chronic progressive gingival inflammation around the restoration.
- Bleeding on probing.
- Localized gingival hyperplasia with minimal bone loss.
- Gingival recession.
- Pocket formation.
- Clinical attachment loss.
- Alveolar bone loss.
- Gingival hyperplasia (most frequently found in altered passive eruption and subgingivally placed restoration margins).

Bone Sounding/Transgingival Probing[16]

Biologic width is measured by probing to the bone level under local anesthesia ("sounding to bone") and subtracting the sulcus depth from the total measurement. A distance of less than 2 mm at any site indicates a biologic width violation.

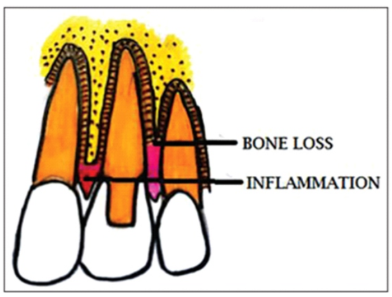


Figure 2: Signs of biologic width violation - inflammation and bone loss.[15]

Radiographic evaluation[17]

- Radiographs can detect interproximal biologic width violations but are unreliable for mesiofacial and distofacial line angles due to tooth overlap.
- The parallel profile technique offers precise measurements of the dentogingival unit's length and thickness.

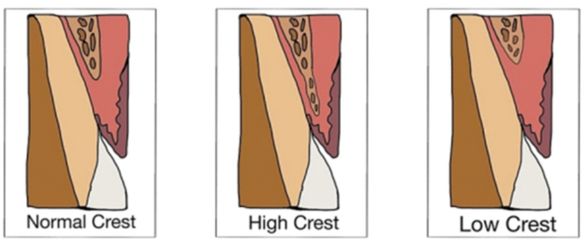
Categories/profiles of Biologic Width

Kois[18,19] proposed three categories of biologic width based on the total dimension of attachment and the sulcus depth following bone sounding measurements:

- Normal crest.
- Low crest.
- High crest.

	Normal Crest	High crest	Low crest
Mid-facial measurement	3 mm	<3 mm	>3 mm
Proximal measurement	3 – 4.5 mm	<3 mm	>4.5 mm

Fig 3 : Transgingival Probing/Bonesounding[16]



Normal Crest Patient (85%)[20]

Gingival tissue remains stable long-term. A crown margin should be placed at least 2.5 mm from the alveolar bone. A 0.5 mm subgingival crown margin is well-tolerated and stable in these patients. patient.

High crest patient (2%)[20]

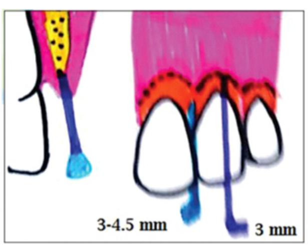
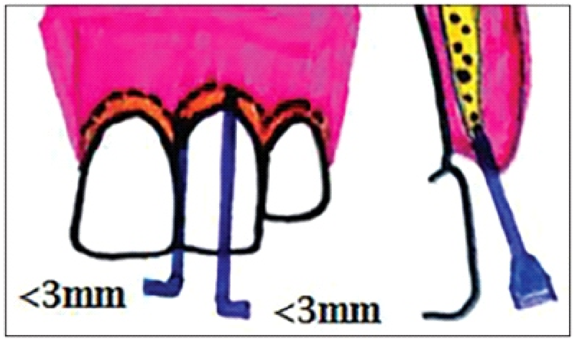


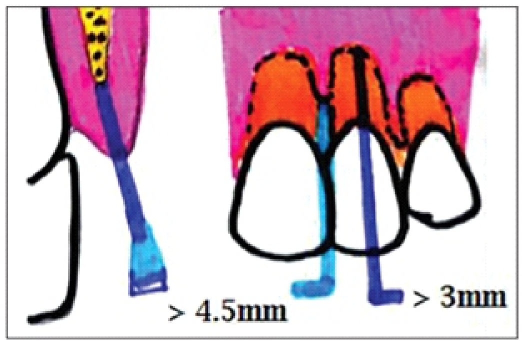
Figure 4: Categories of biologic width.[18]



Typically found near edentulous areas, where placing an intracrevicular margin is not possible due to proximity to the alveolar bone, leading to biologic width impingement and chronic inflammation.

Low Crest Patient (13%)[20]

These patients are more prone to recession from intracrevicular crown margins, as retraction cord placement often injures the attachment apparatus. Healing may return tissue to a normal crest position, causing recession. Low crest patients vary in response; those with a shallow sulcus and stable attachment are less prone to recession, while those with a deeper sulcus and narrower attachment are more susceptible to it.



Margin Placement

Ingber et al. (1977)[21] Ingber et al. (1977) proposed that a minimum of 3 mm should be maintained between the restorative margin and the alveolar crest to ensure proper healing and restoration of the tooth.

Maynard and Wilson (1979)[22] Maynard and Wilson (1979) classified the periodontium into three functional zones that influence restorative decisions:

- Superficial physiologic: The free and attached gingiva around the tooth.
- Crevicular physiologic: The gingival area extending from the gingival margin to the junctional epithelium.
- Subcrevicular physiologic: Equivalent to the biologic width (as described by Gargiulo et al., 1961), including the junctional epithelium and connective tissue attachment.

Nevins and Skurow (1984)[23] Nevins and Skurow (1984) highlighted the need to protect the junctional epithelium and connective tissue when preparing and recording impressions for subgingival margins. They advised limiting the subgingival margin extension to 0.5-1.0 mm, as it is difficult for clinicians to precisely distinguish where the sulcular epithelium ends and the junctional epithelium begins. A minimum distance of 3.0 mm from the alveolar crest to the crown margin is essential.

Margin placement - Rules24

1. If the sulcus probes 1.5 mm or less, the restorative margin could be placed 0.5 mm below the gingival tissue crest.
2. If the sulcus probes >1.5 mm, the restorative margin can be placed in half the depth of the sulcus.
3. If the sulcus is >2 mm, gingivectomy could be performed to lengthen the tooth, and create a 1.5 mm sulcus.

Then the patient can be treated as per rule [1].

Supragingival margin[25]

- Supragingival margins have minimal impact on the periodontium.
- Traditionally used in non-esthetic areas due to the stark contrast in color and opacity between restorative materials and the tooth.
- With the development of translucent restorative materials, adhesive dentistry, and resin cements, placing supragingival margins in esthetic areas has become feasible.

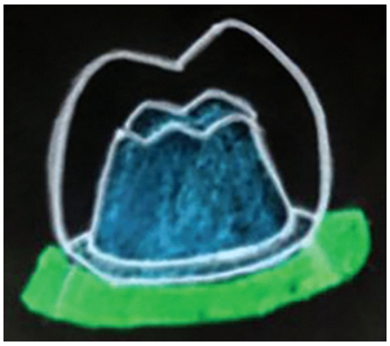


Figure 5 : Supra Gingival Margin[25]

Advantages

1. Tooth preparation and margin finishing are simpler.
2. Impressions can be easily removed past the finish line without tearing or distortion, making supragingival margins ideal for duplication.
3. Supragingival margins cause the least irritation to the periodontal tissue.

Equigingival Margin[20]

Equigingival margins were once avoided due to concerns about plaque accumulation, gingival inflammation, and unsightly margins from minor recession. However, these concerns are no longer valid, as modern restorations can blend esthetically with the tooth and be easily finished for a smooth, polished gingival margin.

Subgingival Margin[26]

- ·Restoration margins are often placed below the gingival crest to address caries, tooth deficiencies, or mask the tooth/restoration interface.
- ·If the margin is too deep, it can irritate the gingival attachment, causing chronic inflammation and cleaning difficulties.
- ·The body attempts to create space between the alveolar bone and margin for tissue reattachment, leading to gingival recession and bone loss.
- This is more common in areas with thin alveolar bone.
- Thin, scalloped gingiva is more prone to recession than flat, fibrous tissue.
- With deep margin placement, bone levels often remain unchanged, but gingival inflammation persists around the restoration.

When placing the margin subgingivally, consider the following factors

- Correct crown contour in the gingival third.
- Proper polishing.
- The margins are rounded.
- A sufficient zone of connected gingiva.
- There is no infringement of biological width.

Biological Width Around Implants

- Two-piece implants have a wider biological width than single-piece implants and natural teeth.
- The existence and location of a microgap alter the soft tissue and bone levels.
- Connective tissue around implants is more stable than the epithelial dimension.[27]
- Biological width is a physiological reaction in the oral cavity that does not depend on loading quantity or quality.[28]
- One-piece implants and natural teeth have more stable connective tissue dimensions. However, the junctional epithelium is constantly threatened by microbial growth and pathogenic microbial products.
- The biological width around the implant undergoes structural and histologic alterations similar to those seen around the tooth, regardless of tissue type.[29]

Diagnostics And Planning

- Localized gingival recession or bone loss with good hygiene may indicate an overextended restoration impinging on STA.
- STA should be considered during restorative planning to prevent damage.
- Maintain 3 mm between the restoration margin and alveolar bone to avoid STA impingement (1 mm connective tissue, 1 mm junctional epithelium, 1 mm sulcus).[11,30]
- Individual STA variations may require more than 3 mm.
- Subgingival margins should extend only 0.5–1.0 mm to avoid damaging the junctional epithelium.
- Crown margins impinging on STA cause localized inflammation, distinguishable from gingivitis, often unrelated to plaque.
- Correction may involve improving hygiene, crown lengthening, or crown replacement.

Correction of Violation of STA

- **Risk Factors :** Restorations near the alveolar crest (cracks or caries) risk encroaching on biological width.
- **Aesthetic Considerations :** Subgingival placement of restoration margins may violate biological width.

- **Variation :** Biological width differs between individuals and sites within the same patient.
- **Assessment :** Each site must be evaluated to avoid anatomical disruption.
- **Goal :** Respect anatomical integrity during restorative procedures.

Figure 7 : A clinical photograph to demonstrate gingival inflammation caused by the crowns on UR1 and UR2 impinging on the biological width.[1]

Surgical Crown Lengthening

Crown lengthening treatment is tailored to each patient, taking into account the connection between the crown and root of the alveolar bones.

Surgical crown lengthening	Orthodontic procedures
Gingivectomy: External bevel or internal bevel gingivectomy	Can be slow, rapid, forced tooth eruption with or without fibrotomy, supracrestal fibrotomy, and root planing (OEFRP)
Apical repositioned flap (ARF) surgery: with or without osseous reduction	

Table 2 : Methods of biological width correction.[32]

Indications	Contraindications	Complications
Deficient clinical crown for retention because of deep and extensively large caries lesions, cemental/subgingival/root caries, or any type of tooth fracture, root perforation, or resorption within the cervical 1/3rd of the root in the teeth with suitable periodontal attachments	Deep carious or fractured tooth requiring an excessive amount of bone removal	Poor esthetics due to the presence of black triangles
Short or insufficient clinical crowns	Unjustified compromise of esthetics and/or of adjacent alveolar bone support	Root hypersensitivity
Excessive, unequal, and/or unesthetic gingival levels with respect to esthetics	Teeth that cannot be restored	Root resorption
Tooth with an imprudent amount of incisal or occlusal wear	Tooth depicting increased risk of furcation involvement	Transient tooth mobility
Teeth exhibiting weak interocclusal space for proper restorative procedures because of supraeruption		
Teeth exhibiting weak interocclusal space for proper restorative procedures because of supraeruption		
Tooth in need of hemisection or root resection		

Table 3 : Indications, contraindications, and complications of surgical crown lengthening.[7,33]

Methods for Surgical Crown Lengthening

Techniques for Correcting Biological Width Violation

1. **External Bevel Gingivectomy**[34]
   - Reduces excessive pocket depth and exposes coronal tooth structure.
   - Suitable when attached gingiva is abundant, with no bone involvement.
2. **Internal Bevel Gingivectomy**[6]
   - Reduces deep pockets and exposes coronal tooth structure.
   - Indicated even in the absence of sufficient attached gingiva.
   - Internally beveled flap exposes alveolar bone, addressing osseous irregularities if necessary.
3. **Apical Repositioned Flap (ARF) Surgery**[35]
   - Ideal for crown lengthening across multiple teeth in a quadrant.
   - Not recommended for single-tooth procedures, especially in esthetic zones.
4. **ARF Without Osseous Reduction**[35]
   - Suitable when biological width exceeds 3 mm with adequate attached gingiva.
5. **ARF With Osseous Reduction**[35]
   - Indicated for biological width <3 mm and insufficient attached gingiva.
   - Osteotomy and osteoplasty expose sufficient tooth structure, ensuring proper gingival contour.
   - At least 4 mm of sound tooth structure must be exposed to account for coronal soft tissue regrowth, leaving 1-2 mm of supragingival tooth structure.

Note : Although Gargiulo et al.[10] established a supracrestal tissue attachment of 2 mm, clinical measurement during crown margin preparation remains challenging.

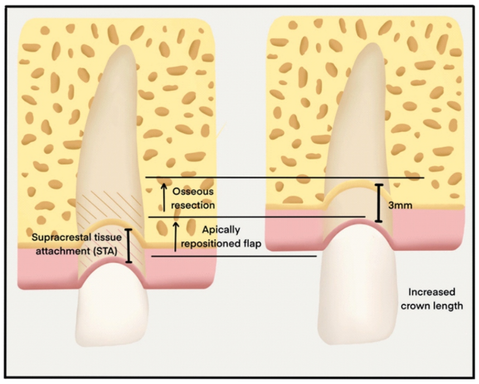


Figure 9:37 Series of clinical photographs to demonstrate the crown lengthening procedure (APF with osseous reduction) on a patient with tooth surface loss. (a) Probe markings. (b) UR1 and UL1 incisions. (c) Flap raised. (d) Stent in situ before bone removal). (e) Stent in situ following bone removal demonstrating 3 mm of osseous reduction. (f) Simple interrupted intra-papillary sutures.

Implants

1. **STA Differences in Implants**
   - Implants exhibit a supracrestal tissue attachment (STA), but this is primarily based on animal studies (e.g., dogs), as proposed by Misch et al.[36]
   - Unlike natural teeth, implants integrate through osseointegration, resulting in ankylosis and minimal or no connective tissue fiber attachment.
2. **Connective Tissue Characteristics**[1]
   - In implants, connective tissue comprises primarily parallel and circular fiber groups, lacking the perpendicular fiber attachment seen in natural teeth.
   - The implant is sealed by epithelial hemi-desmosomes, contributing to its stability.
3. **Structural Differences**[1]
   - Absence of periodontal ligament (PDL) reduces the implant's capacity to absorb and distribute occlusal forces.
   - The tissue surrounding implants is hypovascular and hypocellular, with increased collagen content compared to the natural tooth environment.
4. **Biological Width and Variation**
   - Misch et al.[38] measured an average biological width of 3.08 mm around implants.
   - Herman et al.[39] noted that biological width may vary depending on implant type (e.g., one-piece vs. two-piece, submerged vs. non-submerged).
5. **Clinical Implications**[1]
   - Reduced vascularity and lack of connective tissue attachment contribute to thicker STA around implants.
   - This structural difference can result in deeper clinical probing depths and less predictable bleeding on probing, making peri-implant health assessments more challenging.

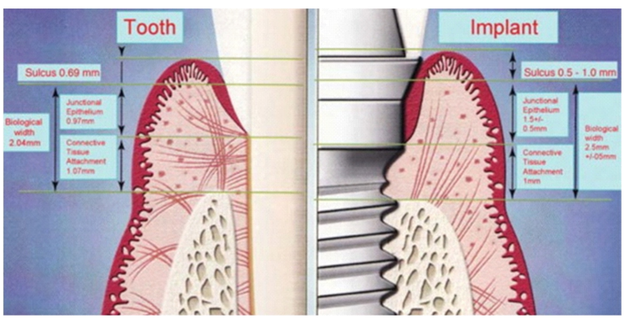


Figure 10 : Schematic demonstrating differences between supracrestal tissue attachment around teeth and implants.[1]

Conclusion

The concept of biologic width, now recognized as supracrestal tissue attachment (STA), remains a cornerstone in periodontal and restorative dentistry, ensuring the health and longevity of both natural teeth and implants. STA serves as a critical protective barrier, safeguarding underlying alveolar bone from microbial invasion and mechanical trauma. Its dynamic nature demands precise management to prevent clinical complications such as inflammation, gingival recession, and bone loss. As research continues to refine our understanding of STA, particularly around implants, clinicians must prioritize careful margin placement and thorough diagnostic assessments, moreover adhering to these principles will help preserve periodontal integrity and optimize long-term treatment outcomes.

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AJOAD
A Journal of Advanced Dentistry
Open Access Full Text Article

Sports And Orthodontics - Protecting Smiles On The Field

Received on : 17 02 2025 | Accepted on : 19 02 2025 | Published on : 29 07 2025

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Introduction

Athletes, regardless of their discipline, are at a heightened risk of dental injuries due to the physical demands of their activities. Safeguarding their oral health is essential, not only for maintaining an attractive smile but also for promoting overall well-being, thus, enhancing their peak performance.[1]

Sports-related oral injuries account for approximately 14% of all dental injuries, with an estimated five million teeth being damaged annually as a result of sports activities.[2] Contact sports, such as football, basketball, baseball, soccer, wrestling, hockey, ice hockey, and cricket characterized by direct physical interaction with other players or objects, pose a particularly high risk of trauma and injuries. Although non-contact yet high-risk sports, such as kung-fu, skiing, mountain biking, cycling, and rock climbing, also contribute to this statistic.

Common dentoalveolar injuries seen in athletes include tooth avulsion, fractures, subluxation, and intrusion, all of which show significant prevalence in recent studies. Jaw and mouth injuries are not uncommon in these activities, further emphasizing the need for preventive measures. To reduce the impact of such injuries, the use of protective gear, such as mouthguards, is strongly recommended for contact sports athletes.[2]

Oral injuries are significantly more common among athletes who do not wear mouthguards. The reluctance to use mouthguards is often attributed to issues such as difficulty in breathing and speaking, bad breath, xerostomia, nausea, increased costs, or a lack of awareness about the importance of the protective device.[3] Greater adoption of mouthguards tends to be associated with sports like martial arts, where facial impacts and collisions are more frequent, highlighting the critical need for this safety measure.[4]

Prevalence of Oral Injuries In Sports

Pasternack JS et al. found that 27% of baseball players experienced orofacial injuries during contact sports. In 2008, Wenli M reported that the prevalence of orofacial injuries among basketball players was 80.6% in professionals and 37.7% in semi-professionals. According to Caglar E et al., 16.6% of football athletes were affected. Galic T et al. observed that handball led to orofacial injuries in 21.8% of athletes. In the same year, Praveena J et al. reported a prevalence rate of 33.8% for hockey players.[5]

A study involving 10-18-year-old Kabaddi players in Delhi-NCR reported a 44.02% prevalence of orofacial injuries. The most commonly affected area was the orbit (26.67%).[6]

Research conducted by Savreen et al. revealed that among schoolchildren aged 6 to 16 years in Amritsar found that 20.20% had experienced dental trauma while playing sports. Notably, 68% of these children had never used mouthguards, highlighting a gap in preventive measures.[7]

Mojarad F reported that the most commonly affected age group for orofacial injuries is 12 years old, with a prevalence of 38.2%. The distribution of injuries across various sports, in descending order, is as follows: handball (16.4%), boxing (16.4%), wrestling (14.5%), baseball (12.7%), soccer (10.9%), judo (9.1%), volleyball (9.1%), taekwondo (5.5%), gymnastics (3.6%), and karate (1.8%).[8]

Impact of Oral Injuries

Malocclusions can predispose individuals to a higher risk of dental injuries, especially during sports or physical activities. The types

How to Cite This Article : Dagar et al. - Updent - A Journal of Advanced Dentistry. (2025). Sports And Orthodontics - Protecting Smiles On The Field. Updent- A Journal of Advanced Dentistry, 14(1), 51–54. https://doi.org/10.5281/zenodo.16558039
.

of malocclusions that are particularly prone to injuries include:[2]

- Increased Overjet (Class II, Division 1 Malocclusion): More exposed and vulnerable to direct trauma, leading to fractures, avulsion, or displacement of upper front teeth.
- Open bite : Lack of protection from the lower teeth increases the likelihood of trauma to the anterior teeth, especially in falls or impacts.
- Deep bite : The lower teeth and surrounding soft tissues are more injury prone.
- Crowding : More susceptible to indirect trauma, such as fractures or root damage, due to uneven force distribution during impact.
- Crossbite : Increased risk of injury to the supporting structures.
- Edge-to- edge bite : Higher risk of chipping, fractures, and enamel wear during trauma.
- Spacing & midline diastema : Exposed teeth are more prone to trauma due to less protection from adjacent teeth.
- Class III malocclusion: Lower teeth are more exposed to impact.

Role of Orthodontics In Sports

Orthodontic patients who participate in contact sports are at a heightened risk of sustaining various oral injuries, ranging from minor to severe. Orthodontics other than treating existing malocclusion plays a vital role in sports dentistry, offering solutions to prevent injuries and protect athletes' smiles by treating malocclusions prone to injuries.[1]

Orthodontics plays a crucial role in the health and performance of athletes, particularly when it comes to preventing injuries, enhancing performance, and safeguarding young athletes during their early involvement in sports.

1. Treating Malocclusions Prone to Injuries : Athletes with untreated malocclusions, or misalignments of the teeth and jaws, are more susceptible to facial injuries, particularly during contact sports. Orthodontic treatment can correct these malocclusions, helping to minimize the risk of injury by ensuring that the bite is aligned, reducing the likelihood of trauma to the teeth and jaw during high-impact activities.
2. Addressing Functional and Parafunctional Conditions: Orthodontists also play a key role in treating functional and parafunctional conditions, such as teeth grinding (bruxism) or jaw clenching, which are often exacerbated by the stress of athletic performance. By correcting these conditions, orthodontic intervention not only helps in preventing further dental complications but can also enhance an athlete's overall performance. A properly aligned bite can lead to improved efficiency in breathing, speaking, and eating-all of which contribute to better focus and physical performance on the field.
3. Protecting Young Athletes in Early Stages of Sport Participation : Many young athletes begin their sports journey at an early age. For those already undergoing orthodontic treatment, there's an added concern of protecting the dental and jaw structures during these formative years. The orthodontist's role extends beyond treatment to providing protective devices such as mouthguards, ensuring that the orthodontic work is safeguarded from potential injuries. These protective measures are especially important as young athletes are at higher risk of sustaining trauma to the face due to the intensity of sports activities.

Dental Injuries Common In Sports

Some of the most common injuries faced by orthodontic patients in sports include:

- Lacerations to the cheeks, lips, and tongue: A stray elbow or blow to the face can cause cuts to the lips, gums, or cheeks. When braces are involved, these injuries can become more severe due to the sharp edges of the orthodontic appliances. Mild cuts can often be managed by rinsing with salt water, but more severe cases may require emergency medical attention.
- Chipped or broken teeth : Minor chipping affects only the enamel, impacting aesthetics but typically causing no pain. However, cracks that extend deeper into the dentin, pulp, or root can lead to significant sensitivity and intense pain, requiring prompt dental intervention.
- These risks highlight the importance of protective measures, such as wearing custom-fitted mouthguards, for orthodontic patients engaged in sports activities.

Different Orthodontic Appliances For Athletes

Athletes use various orthodontic appliances depending on their treatment needs, lifestyle, and level of physical activity. These appliances are designed to align teeth while minimizing risks associated with sports participation.

Fixed appliances, such as metal and ceramic braces, are durable but require careful management to avoid damage during sports, while self-ligating braces reduce maintenance needs. Lingual braces, placed on the inner surfaces of teeth, provide a discreet option and reduce the risk of external trauma.

Retention appliances, including removable or fixed retainers, are used post-treatment to maintain alignment and can be paired with mouthguards for added protection.

Clear aligners, like Invisalign, are popular among athletes as they are removable and less likely to interfere with sports activities. For athletes, clear aligners paired with custom mouthguards often emerge as the preferred option due to their removability, aesthetic appeal, and compatibility with protective measures.

One of the most common option is mouthguards. A mouthguard is a protective device typically worn on the maxillaso as to minimize any risk of injuries to the teeth, jaws, and surrounding soft tissues. It is essential for preventing dental and orofacial injuries and thereby, is strongly recommended for sports that pose a risk of trauma to the teeth and related structures.[9]

Mouthguards function by absorbing the energy generated at the impact site and dispersing the remaining energy across surrounding tissues. They shield the tongue, lips, and cheeks from lacerations caused by the sharp edges of teeth and help prevent angle and condylar fractures by providing support to the mandible.[10]

Types of Mouthguards

Custom-fitted laminated mouthguards provide superior protection to orofacial structures in comparison to other varieties, including boil-and-bite mouthguards. Occlusal stability, a betteradaptability,[11] and greater protection, is seen to be offered with only 25%-50% thinning during its fabrication. The increased thickness of the material allows for enhanced energy absorption, making them more effective in preventing injuries.[10]

Boil-and-bite' mouthguards are least recommended for any level of sports due to their tendency to dislodge during activity, potentially obstructing the airway.[12] In comparison to custom-fitted mouthguards, boil-and-bite options have an inferior fit, often causing discomfort, looseness, and even nausea.[13] They do not offer customization with denser material to suit for particular sports and are more prone to deformation due to the reduced heat used in their molding process.9Additionally, they experience significant thinning during fabrication, with a reduction of 70%-99%, giving athletes a false sense of security due to the substantial loss of protective thickness.[14]

Polyolefin materials hold great potential due to their increased shock absorption and reduced water absorption compared to ethylene vinyl acetate. Additionally, they provide a prolonged working time, allowing more time for precise intraoral fitting.[15]

Design of Mouthguards

The design and construction of mouthguards should include the following specifications:

1. Coverage should extend to the distal side of the maxillary first permanent molar, with recommended thicknesses of 3 mm on the labial/buccal surface, 3 mm on the occlusal surfaces, and 2 mm on the palatal/lingual surface.[16,17]
2. Bilateral and balanced occlusion for optimal fit and function.[18]
3. Athletes participating in any sport with a risk of dental or facial trauma, like rugby, football, kickboxing, boxing, taekwondo, basketball, and sports like ice hockey, field hockey, and lacrosse, should use laminated custom-fitted mouthguards.[9]
4. Weartime instructions : These mouthguards should be worn not only during competitions and games but also during training sessions.

Impact of Wearing Mouthguards

A custom-fitted laminated mouthguard with a minimum thickness of 3 mm is highly effective in reducing impact forces to the teeth, outperforming over-the-counter mouthguards.[9] Clenching while wearing a mouthguard further enhances its ability to absorb impact.[19] There has been no significant difference in the reduction of impact forces to the head, irrespective of whether a mouthguard is worn or not.

Use of a mouthguard does affect stomatognathic function that is related to static or dynamic balance in postural control. A positive correlation has been established between biting force level, increased limb muscle activity and neurophysio-logic excitability that contributes to postural stance stabiliz-ation and joint fixation.[9]

Conclusion

Participation in sports activities poses a significant risk of dental and facial injuries, making protection a critical component of an athlete's safety. Orthodontic patients, in particular, require special attention to safeguard their smiles during physical activity. The use of properly designed and custom-fitted mouthguards has proven to be the most effective way to prevent trauma to the teeth, jaws, and soft tissues, ensuring preservation of both function and aesthetics. By promoting awareness and advocating for the consistent use of protective gear, including during training sessions, orthodontists and sports professionals can play a vital role in protecting smiles on the field and fostering a culture of safety in sports.

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A Journal of Advanced Dentistry
Open Access Full Text Article

Orthodontics for All Ages

Received on : 17 02 2025 | Accepted on : 19 02 2025 | Published on : 29 07 2025

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Introduction

Orthodontics involves the correction of dental and jaw abnormalities to enhance function and aesthetics. Various orthodontic appliances help straighten teeth and fix bite irregularities.[1] This field is not limited to any specific age group and benefits both children and adults.

Orthodontic treatment is commonly initiated after the eruption of permanent teeth to address issues such as overcrowding, overbites, underbites, and proclined teeth.[2] Early intervention, typically around age 7, can help guide jaw development and create space for adult teeth, reducing the need for complex treatments later.[3]

Scientific evidence supports early treatment for posterior crossbites, mild to moderate Class III malocclusions, Class II malocclusions, open bites, and arch length discrepancies. Early interventions prevent extensive and expensive future procedures. Unlike adolescents, adult patients often require a multidisciplinary approach due to tooth migration from extractions or periodontal disease.[3]

Orthodontics for Children : Building the Foundation

The American Association of Orthodontists recommends a child's first orthodontic checkup by age 7. [4] Early treatment aims to correct orthodontic issues before they become severe, preventing irreversible damage and minimizing the need for extensive Phase II treatment. Treatment effectiveness depends on patient growth, cooperation, and appropriate timing.[5]

Benefits of Early Treatment:[6]

- Correction of Maxillary Transverse Deficiency: Early intervention aids in jaw development and alignment.
- Management of Severe Skeletal Malocclusions:
- Class II Malocclusion: Patients with >7 mm overjet benefit from early treatment to avoid future complications.
- Class III Malocclusion: Patients with <1 mm overjet and maxillary deficiency respond well to protraction therapy before age 10.

Advantages of Early Treatment:[7]

- Improved socialization
- Better patient cooperation
- Reduced need for extractions and surgery

Disadvantages of Early Treatment

- Potential for misdiagnosis
- Extended treatment time
- Increased costs and caries risk

Orthodontics for Adolescents: Perfecting the Smile

Orthodontic treatment during adolescence corrects malocclusions and enhances facial aesthetics.8 Braces and aligners help improve occlusion, tooth alignment, and self-esteem.[9]

Psychological and Functional Benefits:

- Correcting malocclusion enhances body image and self-confidence.[10]
- Malocclusions, such as Class II and Class III conditions, can lead to uneven tooth wear, enamel damage, and tooth decay.
- Class II malocclusion, affecting 20-25% of the population, is commonly linked to mandibular retrusion. Treatment involves repositioning the mandible forward and improving chin positioning.[11]

Treatment Options:

- Functional and Orthopedic Appliances: Twin blocks, face masks, and headgear stimulate mandibular/maxillary growth.[11]
- Fixed Braces & Clear Aligners: Conventional braces remain effective, while

How to Cite This Article : Yadav et al. - Updent - A Journal of Advanced Dentistry. (2025). Orthodontics for All Ages. Updent- A Journal of Advanced Dentistry, 14(1), 55–56. https: // doi.org/ 10.5281/ zenodo.16558072

clear aligners provide aesthetic and hygienic benefits.[9]

- Aesthetic Orthodontics: Lingual braces, ceramic brackets, and plastic brackets cater to the rising demand for discreet treatment.[9]

Orthodontics for Adults: It's Never Too Late

The number of adults seeking orthodontic treatment has significantly increased due to advancements in aesthetic and functional appliances. Adults undergo orthodontic treatment for various reasons, including:[12,13]

- Protrusion of upper anterior teeth
- Severe lateral crossbite
- Deep bite leading to tooth sensitivity
- Crowding causing periodontitis
- Traumatic occlusion
- Spacing due to missing teeth

Treatment Considerations

- Preprosthetic Orthodontics : Aims to create favorable conditions for prosthetic placement.[14]
- Skeletal Discrepancies : SARPE (Surgically Assisted Rapid Palatal Expansion) and MARPE (Miniscrew-Assisted Rapid Palatal Expansion) effectively address maxillary deficiencies.[15]

Improved appliance aesthetics, treatment mechanics and social acceptability are some contributing factors involved in the increase of adult population seeking orthodontic treatment.[13]

Technological Advances:[16]

- 3D Imaging & Printing: Personalized appliances and improved diagnostics.
- Digital Scanners: Eliminate traditional impressions.
- AI & Machine Learning: Customized treatment planning.

Conclusion

Orthodontics has evolved to address the needs of patients across all age groups, from early interventions in children to aesthetic and functional solutions for adults. With technological advancements and personalized treatment approaches, orthodontic care has become more efficient, effective, and accessible than ever before.

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A Journal of Advanced Dentistry
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Genetic and Epigenetic Alterations in Oral Cancer Progression

Received on : 26-05-2025 | Accepted on : 15-7-2025 | Published on : 29 07 2025

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Abstract

Background: Oral squamous cell carcinoma (OSCC) represents a significant global health challenge characterized by high morbidity and mortality. Its pathogenesis involves complex genetic mutations and epigenetic modifications influenced by environmental and viral factors, such as tobacco use, alcohol consumption, betel nut chewing, and HPV infection.

Objective: This review aims to provide an in-depth analysis of genetic mutations and epigenetic changes that drive OSCC, highlighting clinical implications, including early detection biomarkers and targeted therapies.

Methods: A comprehensive narrative review was conducted by synthesizing data from peer-reviewed journals, epidemiological studies, and clinical trials. Graphical representations and flowcharts were included to clearly illustrate cancer progression and risk factor prevalence.

Results: Key genetic mutations involving genes such as TP53, CDKN2A, and PD-L1 significantly influence OSCC development. Epigenetic alterations, including DNA methylation and histone modifications, lead to tumor suppressor gene silencing and oncogene activation. Early detection methods, such as assessing p16 methylation, and targeted therapeutic strategies, including LSD1 and immune checkpoint inhibitors, are promising areas for clinical advancement.

Conclusion: Understanding genetic and epigenetic mechanisms underlying OSCC is critical for developing effective preventive measures, accurate diagnostic tools, and personalized therapies. Public education and lifestyle modifications are essential to mitigate the disease burden.

Keywords: Oral Squamous Cell Carcinoma, Genetic Mutations, Epigenetic Alterations, TP53, CDKN2A, DNA Methylation, Tobacco-Related Cancer, Oral Cancer Biomarkers, Targeted Therapy

Introduction

Oral squamous cell carcinoma (OSCC) is a prevalent malignancy of the head and neck, posing a considerable global health issue. According to GLOBOCAN 2018, there were over 355,000 new OSCC cases and approximately 177,000 deaths worldwide[1]. Known risk factors such as tobacco, alcohol, betel nut chewing, and HPV infection significantly increase cancer risk by promoting genetic mutations and epigenetic alterations that facilitate malignant transformation.

This article elucidates the genetic and epigenetic changes involved in OSCC progression, aiming to educate healthcare professionals and patients through clear explanations supported by visual aids.

Genetic Alterations in Oral Cancer

Common Gene Mutations:

TP53: Mutations observed in 40–70% of OSCC cases primarily affect DNA-binding domains (exons 5–8), impairing cell cycle regulation and apoptosis[2].

CDKN2A (p16): Frequently silenced by deletion or methylation, leading to uncontrolled cell

How to Cite This Article : Khanna et al. - Updent - A Journal of Advanced Dentistry. (2025). Genetic and Epigenetic Alterations in Oral Cancer Progression. Updent- A Journal of Advanced Dentistry, 14(1), 57–59. https://doi.org/10.5281/zenodo.16558239

proliferation[3].

CD274 (PD-L1): Overexpression aids tumor immune evasion[4].

Disrupted Signaling Pathways:

p53 Pathway: Compromised TP53 function hinders apoptosis and DNA repair.

p16-Rb Pathway: Disruption promotes unchecked proliferation, particularly following HPV infection[5].

EGFR and Cyclin D1: Activation enhances tumor cell survival and proliferation.

Epigenetic Alterations in Oral Cancer

Epigenetic modifications are reversible and include DNA methylation, histone modifications, and non-coding RNA regulation.

DNA Methylation:

Promoter hypermethylation of p16 silences its expression, facilitating early carcinogenesis [6].

Global hypomethylation leads to genomic instability and oncogene activation.

Histone Modifications:

Enzymatic activity of LSD1 and EZH2 represses tumor suppressor genes, suggesting LSD1 inhibitors as potential therapeutic agents [7].

Non-Coding RNAs:

· Dysregulated miRNAs and lncRNAs significantly impact oncogene and tumor suppressor gene expression [8].

Environmental Factors and Their Molecular Interactions

Tobacco, Alcohol, and Betel Nut:

Tobacco implicated in ~40% of OSCC cases, with synergistic carcinogenic effects alongside alcohol or betel nut [9].

HPV Infection:

HPV-16 induces degradation of critical tumor suppressors, p53 and Rb proteins. Overexpressed p16 serves as a marker of HPV-related OSCC[10].

Age and Chronic Exposure:

Continuous exposure leads to cumulative molecular alterations, significantly increasing OSCC risk[11].

Progression from Normal Tissue to OSCC

Stepwise Transformation:

Normal Oral Mucosa→Premalignant Lesions (Leukoplakia): Initial epigenetic modifications (p16 methylation).

Carcinoma in Situ: Widespread genetic and epigenetic disruptions.

Invasive OSCC: Aggressive mutations enhancing invasiveness and metastasis[12].

Cellular Models:

Reduced E-cadherin expression and increased EGFR signaling characterize cancerous transformation.

3D culture studies highlight cancer stem cell markers (OCT4, SOX2, NANOG), signifying aggressive cellular subpopulations[13].

Clinical Implications

Early Detection Biomarkers:

p16 methylation detectable in saliva or serum; immunohistochemistry aids HPV-associated cancer identification.

Targeted Therapies:

LSD1 inhibitors: Potential reversal of histone-mediated gene silencing.

Immune checkpoint inhibitors (anti-PD-L1): Enhance immune-mediated tumor clearance.

EGFR inhibitors: Effective against specific OSCC subtypes.

Prevention Strategies:

Public health recommendations emphasize reducing tobacco, alcohol, and betel nut use.

HPV vaccination effectively reduces virus-related cancer incidence[14].

Graphical Insights

5-Year Survival Rates: Localized (84%), Regional (66%), Distant metastasis (39%) [15].(Figure: 1)

Risk Factor Contributions: Tobacco (40%), Alcohol (20%), Betel nut (10%), HPV (6%), Others (24%).(Figure: 2)

Conclusion:

Early diagnosis significantly improves OSCC outcomes. Understanding the genetic and epigenetic drivers facilitates advanced diagnostic and therapeutic approaches.

Patient Recommendations:

Avoid tobacco, alcohol, and betel nut.

Consider HPV vaccination.

Regular dental examinations for early detection.

Discuss emerging genetic and epigenetic tests and treatments with healthcare providers.

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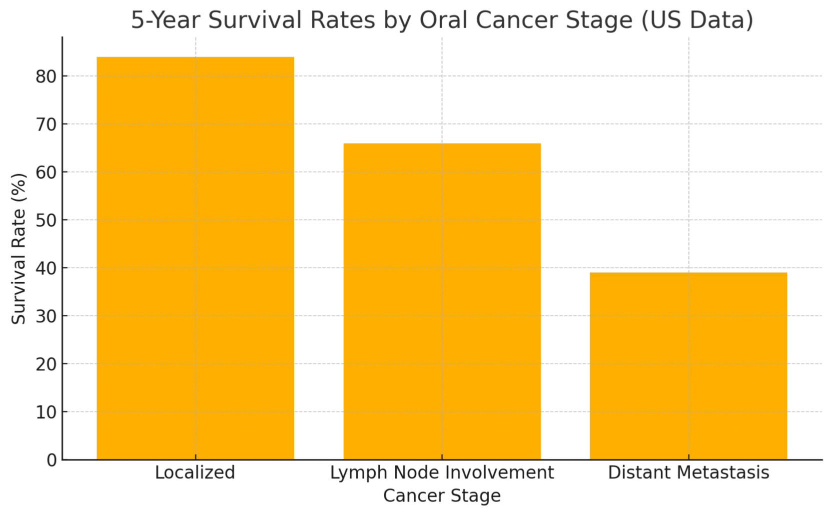

Figure: 1

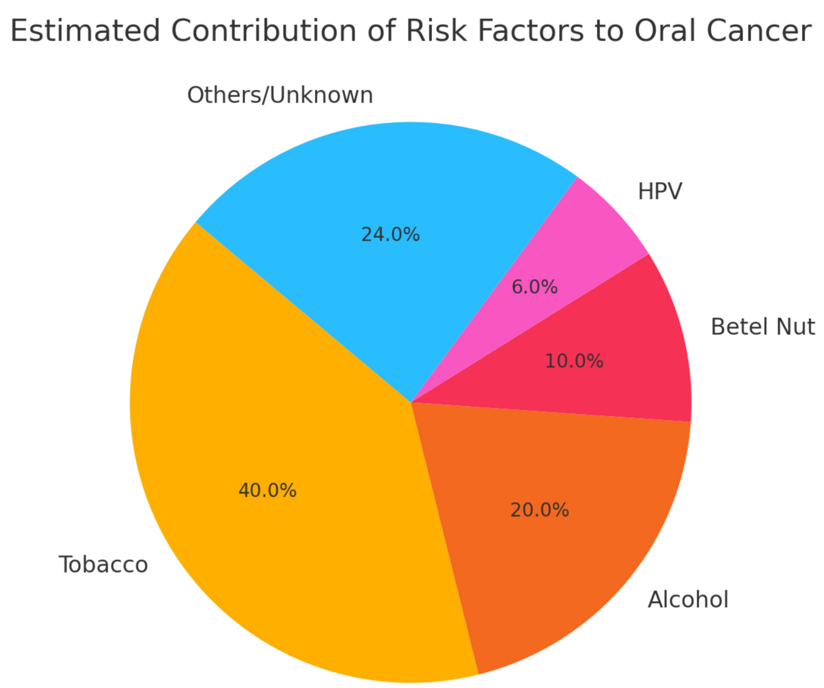

Figure: 2

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Smart Materials In Orthodontics : A Futuristic Approach

Received on : 14-10-2024 | Accepted on : 02-12-2024 | Published on : 29 07 2025

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Introduction

The importance of a well-coordinated interaction of orthodontists with biomedical engineers for the production of many customised orthodontic appliances has been underappreciated[1]. Usually, the bio-medical engineers, hired by many orthodontic appliance manufacturing companies, develop the appliances, overlooking the day-to-day clinical difficulties faced by the orthodontists in their busy practices[2]. Innovations are the need of the hour which could address a critical clinical concern; for example, a material that has easy handling characteristics and shortens chair side time or one that significantly improves the quality of treatment by addressing important varia-bles such as treatment, duration and cost. The aim of this review is to describe the curr-ent trends and innovations of biomedical materials and their implications in orthodo-ntic science[3,4].

Shape-memory polymers (SMPs): Polymers play a vital role in orthodontics and dentistry due to their diverse applicat-ions. Aesthetic concerns, particularly the metallic appearance of traditional orthodo-ntic appliances like brackets and archwires, have driven the development of alternatives such as ceramic, plastic, or polycarbonate brackets and Teflon-coated archwires[5]. Shape Memory Polymers (SMPs) are advan-ced materials that can return to their original shape after deformation when triggered by external stimuli like heat, light, or water. Their unique properties include transpare-ncy, lightweight nature, cost-effectiveness, and a shape-recovery force lasting up to three months[6]. With a glass transition tempe-rature close to body temperature, SMPs are especially useful for aligning and leveling teeth in patients seeking aesthetic solutions. These polymers are effective in correcting malaligned or severely rotated teeth and have become increasingly popular among clinicians[7,8].

Brackets with force moment sensors : When a two couple system or an indeterminate force system is employed using orthodontic appliances, the amount of forces and moments cannot be appropriately determined. Lapatki et al. developed a smart bracket equipped with a stress sensor system embedded in its base, designed to measure the three-dimensional forces and moments acting on the bracket and subsequently on the tooth. None of the material has been tested yet , research is still pending in this sector[8-10].

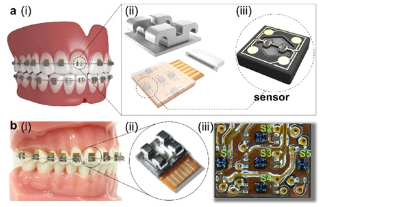

Fig 1 : Brackets with force moment sensors

Self-healing materials : In recent decades, hydrogels with remarkable bio-mimicking characteristics have been developed. Studies have highlighted cross-linked hydrogels capable of self-healing, showcasing their advanced functional properties. These materials can be incorporated in wires and brackets in form of nano sized bubbles . When a bracket breaks, these bubbles rele-ase the monomer, which polymerizes upon exposure to air, filling the fractured space. This process helps reduce bracket and wire damage and shortens overall treatment time[10-12].

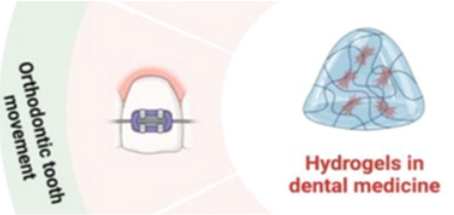

Fig 2 : Hydrogel In Medicines

How to Cite This Article : Verma et al. - Updent - A Journal of Advanced Dentistry. (2025). Smart Materials In Orthodontics : A Futuristic Approach. Updent- A Journal of Advanced Dentistry, 14(1), 60–61. https://doi.org/10.5281/zenodo.16558462

Biomimetic adhesives : Attaching brac-kets to the tooth surface involves preconditi-oning the enamel, which results in changes to its thickness and color. Hence to prevent da-mage to tooth surface a biomimetic material naming Geckelwas introduced. This adhe-sive combines elements inspired by the natu-ral adhesion mechanisms of geckos and mussels, functioning effectively in both dry and wet environments. In orthodontics, biom-imetic adhesives are applied by coating bracket bases with L-3,4-dihydroxyphenylalanine (DOPA), a key adhesive protein found in mussels. DOPA ensures strong bonding to the enamel surface. Works well in both dry and wet conditions[13].

Fig 3: Showing gecko adhesive system

Self-cleaning materials : Plaque buildup around brackets and tooth surfaces can severely harm the periodontium, lead-ing to issues like gingivitis, bone loss, and white spot lesions. The use of materials capable of effectively removing organic and inorganic deposits from calcified surfaces and brackets has been under research to mitigate these effects. The photo-catalytic properties of titanium oxide with UV light are a key focus in orthodontic materials. Nickel-titanium archwires are modified into crystalline rutile by electrolytic titanium oxide film treatment followed by heat application[14].

Biodegradable or bioresorbable miniimplants : These polymer materials address the risk of inflammation, infection, and loosening associated with conventional temporary ancho-rage devices. However, ensuring the safe removal of their byproducts from the body remains essential. By changing the ratio of PLA/PGA such product can be made .They have a setback of delayed resorption time. Continues studies and research will perhaps facilitate development od such a product[12].

Fluoride releasing materials : Bonding materials like compomers and resin-modified glass ionomer cements (RMGICs) have demonstrated a reduction in caries developm-ent but require further trials due to concerns about their bond strength. The transformation of hydroxyapatite into fluorapa-tite crystals enhances fluoride's anti-cariogenic properties, as high fluoride levels in plaque are bactericidal and help prevent enamel demineralization. Casein Phosphopeptide-Amorphous Calcium Phosphate (CPP-ACP) supports calcium and phosphate retention in plaque, preventing their loss and promoting remineralization[15].

To maintain elevated fluoride levels in orthodontic patie-nts, methods such as slow-release devices, chewing gums, and elastomers have been utilized, showing increased fluoride presence in the oral cavity. However, incorporating fluoride into these materials significantly alters their mechanical prop-erties. Extensive trials are needed to establish standardized guidelines for fluoride use in orthodontics to minimize adverse effects like white spot lesions and ensure safe, effective treatment[16].

BPA free polymers : Orthodontic materials must be biocompatible with oral tissues, non-toxic, and mechanically stable throughout treatment. A growing concern is the release of Bisphenol-A (BPA) from materials like polycarbonate brackets and orthodontic composites (e.g., bis-DMA), thermo formed Biocryl retainers and Transbond XT. BPA exposure is linked to health risks such as premature puberty, ovarian cancer, disruption of male reproductive organ development, and increased anxiety, depression, and social difficulties in children. Methods to reduce BPA leaching include soaking retainers in hot water for a few hours prior to delivery, removing any excess adhesive before curing, ensuring that all adhesive is fully cured around the bracket's peripheral mar-gins, having the patient rinse with warm water after bonding, and/or using an orthodontic adhesive that does not contain a BPA derivative which includes EXA , EXB,Phenyl carbamoyloxy -propane dimethacrylate (PCDMA) and Aromatic-free ureth-ane dimethacrylate monomers[17].

Conclusion : This review explored biomedical materials, their current trends, orthodontic applications, and future pers-pectives. Collaboration between orthodontists and biomedi-cal engineers is crucial for customizing orthodontic appliances, ensuring better patient outcomes with minimal complications from the tools used.

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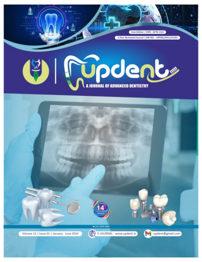

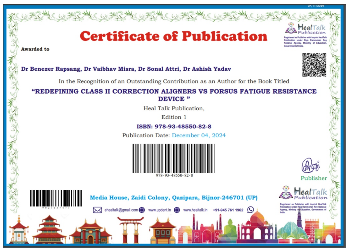
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In the Recognition of an Outstanding Contribution as an Author for the Book Titled

"REDEFINING CLASS II CORRECTION ALIGNERS VS FORSUS FATIGUE RESISTANCE DEVICE"

Heal Talk Publication,

Edition 1

ISBN: 978-93-48550-82-8

Publication Date: December 04, 2024

Media House, Zaidi Colony, Qazipura, Bijnor-246701 (UP)

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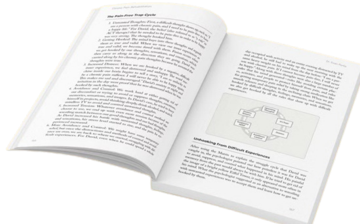

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