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EDITORIAL

The pursuit of new knowledge and innovative practices are essential for advancing patient care & treatment outcomes. Indian Journal of Odontostomatology stands as a key mediator showcasing research trends pertaining to advancements in dentistry. This journal features articles dedicated to emerging trends in dental research, technological advancements, and interdisciplinary approaches to oral health care.

As we look to the future of dental education and practice, it is clear that innovation and interdisciplinary collaboration will play a critical role. By embracing these values, we can provide better patient care, advance the field through research, and promote oral health in our communities.
The challenges we have faced in the past few years has been curbed by plagiarism checking software. It is helpful to ensure the originality of the content with adherence to the academic integrity standards for publication.

On behalf of the editorial board, I wish to express our profound gratitude to the Management , Principal Prof. Dr.Jain Mathew, Vice Principle, Dr.Tina Elizabeth Jacob of St. Gregorios Dental College, for their unwavering encouragemnt and support that helped in the accomplishment of this journal. I also gratefully recognize the contributions of Dr.Nakul P.G, Dr. Anna Oshin Benny and Dr.R.Ramani for their enthusiasm and commitment throughout the publishing process.

Dr. Merin K Joseph
Editor

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***Publication Type**: Original Research*

CBCT: MODERNIZING TRADITIONAL IMAGING PRACTICES – A PILOT STUDY

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Abstract

Objective: To compare the accuracy and reliability of CBCT and Archimedes' Principle in measuring the volume of dry mandibles.

Study Design: The study analyses 5 dry human mandibles using Cone Beam Computed Tomography (CBCT) and Archimedes' Principle for volumetric measurement. CBCT provide 3D imaging of each mandible, with volume calculations done using specialized software. Archimedes' Principle is used to measure the volume by submerging the mandibles in water and calculating the displaced liquid.

Results: The results of the study shows both CBCT and Archimedes' Principle provide similar volumetric measurements of the mandibles. However, CBCT may offer higher precision and resolution for 3D imaging, while Archimedes' Principle may be more straightforward and cost-effective

Conclusion: Both CBCT and Archimedes' Principle are reliable methods for measuring the volume of dry mandibles, showing similar accuracy. CBCT offers the benefit of high-resolution 3D imaging, while Archimedes' Principle presents a more accessible and cost-effective option. Together, these techniques can improve forensic identification, particularly in cases with damaged or incomplete skeletal remains. Hence this pilot study highlights on the volumetric measurement of mandible using CBCT and Archimedes principle

Keywords: CBCT, Archimedes principle, Mandible, Volume measurements

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INTRODUCTION

Cone Beam Computed Tomography (CBCT) is an advanced imaging technique that has significantly transformed medical and forensic sciences by offering high-resolution 3D imaging with relatively low radiation exposure compared to traditional CT scans. Initially developed for dental and maxillofacial imaging, CBCT has expanded its applications to a wide range of fields, including orthopaedics, ENT (ear, nose, and throat), and forensic science. This technology has proven invaluable in providing detailed images of bone structures, allowing for more precise diagnosis, planning, and analysis[1].

In forensic science, where identifying skeletal remains is often crucial, CBCT has emerged as a powerful tool. Its ability to visualize and measure bones in three dimensions makes it particularly useful when traditional methods are inadequate, such as in cases where bones are fragmented, disfigured, or missing. In forensic anthropology, the accurate assessment of skeletal remains for sex determination, age estimation, and trauma analysis is essential, and CBCT aids in these processes by offering a non-invasive, detailed view of bone morphology[2].

In addition to its traditional applications, CBCT is increasingly being combined with other methods, such as Archimedes' principle, for volumetric analysis of skeletal structures like the mandible. This integration allows for more precise and reliable forensic identification, particularly in cases where other

methods might fail due to incomplete or damaged remains[3]. The combination of CBCT with established principles is helping to create new values for old concepts, advancing forensic investigations and redefining approaches to skeletal analysis.

MATERIALS AND METHODS:

1. Study Objective

To compare the accuracy and reliability of Cone Beam Computed Tomography (CBCT) and Archimedes' Principle for the volumetric measurement of dry mandibles.

2. Study Type

This study type is experimental

3. Materials and Sample Selection

- Sample
  - The study uses five dry human mandibles that are free from any pathological changes or prior alterations
- Inclusion Criteria:
  - Mandibles that are fully intact and unaltered.
  - Mandibles of patients within 50-70 years of age
- Exclusion Criteria:
  - Mandibles with any form of pathological alteration (e.g., tumour's, infections).
  - Mandibles that have been previously altered or are incomplete (missing significant parts such as the body or ramus).
  - Specimens that do not show signs of severe wear, fractures, or prior surgical modifications.

4. Methodology

Step 1: CBCT Imaging (Figure 1)

- Equipment: A CBCT scanner Carestream is used to acquire 3D imaging of each dry mandible.
- Procedure: Each dry mandible is placed in the CBCT scanner, positioned to ensure the full mandible is included in the scan.
- Scan Parameters:

  Field of View (FOV): 10*10 cm
  Voxel Size: 75 µm.
  Exposure Time: 30 seconds
  Tube Voltage: 60–90 kV.
  Tube Current: 2–15 mA.
- Image Reconstruction and Segmentation: The CBCT images are reconstructed into a 3D model using Anatomage software.
- Volumetric Measurement: The volume of the mandible is calculated by the software as the total volume of the segmented 3D model in cubic centimetres' (cm^3).

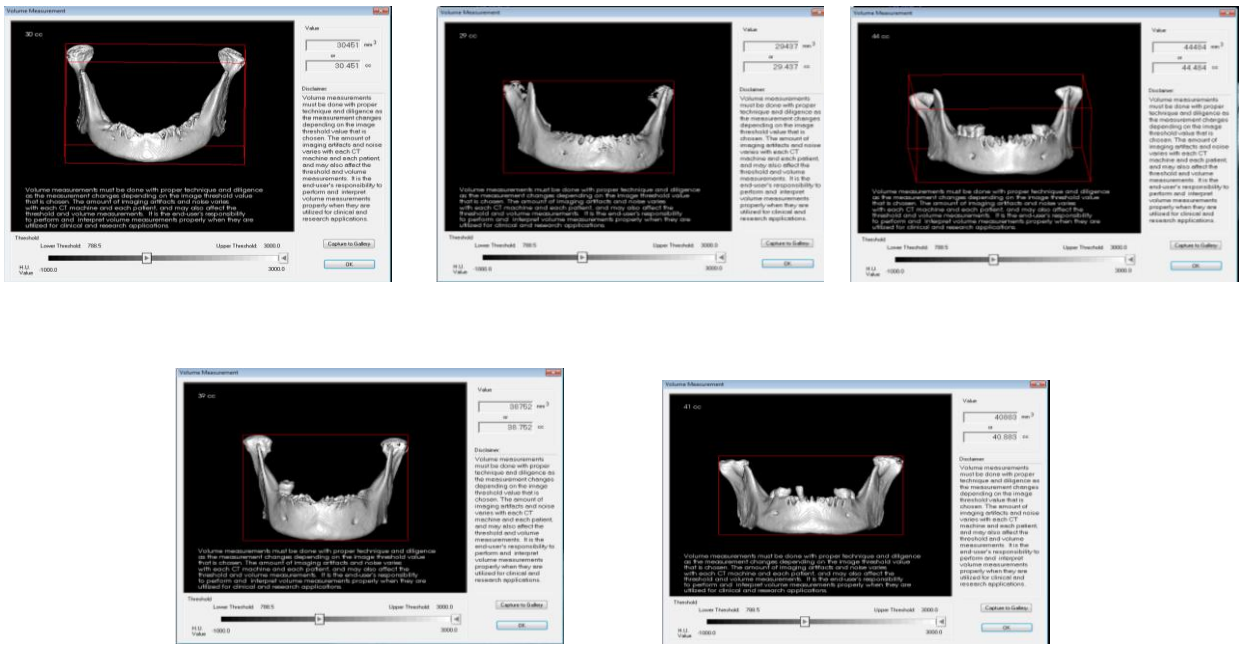

Figure 1: Volumetric measurement of mandible using CBCT

Step 2: Archimedes' Principle of Displacement (Figure 2)

- ❖ Preparation of Mandibles: Each dry mandible is properly assessed and made sure that it is free of any debris, and prepared for fluid displacement.
- ❖ Displacement Procedure:
  - ➢ A graduated cylinder is filled with distilled water.
  - ➢ The mandible is carefully submerged in the liquid. The displacement of the liquid corresponds to the volume of the mandible.
  - ➢ The volume of displaced liquid is measured using another calibrated cylinder. This value represents the volume of the mandible in milliliters(ml)

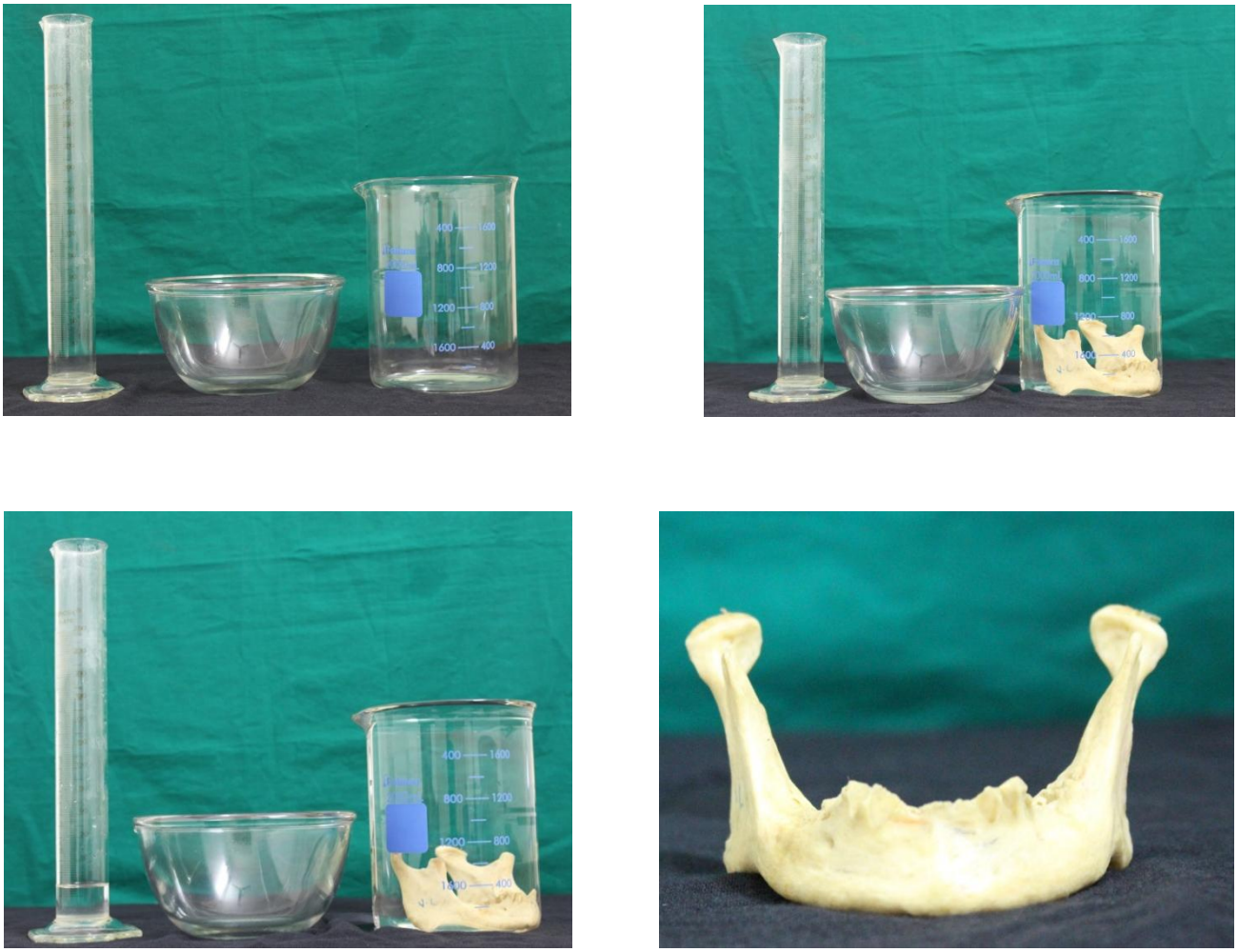

Figure 2: Volumetric measurement of mandible using Archimedes Principle

RESULTS

Dry Mandible	First measurement	Second measurement	Third measurement	Measurement (Through CBCT)
Mandible 1	29 ml	30 ml	30ml	30451mm^3
Mandible 2	28.5 ml	29 ml	28.5 ml	29437mm^3
Mandible 3	44 ml	44 ml	43.5 ml	44484mm^3
Mandible 4	38 ml	38 ml	39 ml	38752mm^3
Mandible 5	41.5 ml	41.5 ml	42 ml	40883mm^3

DISCUSSION

This study aimed to investigate the correlation between Cone Beam Computed Tomography (CBCT) and Archimedes' Principle in the context of evaluating dry human mandibles. The application of CBCT as a modern diagnostic tool provided new insights into traditional principles that have been widely accepted for centuries. Specifically, the use of CBCT in this study allowed for precise measurements of volume and density, which could then be compared to traditional methods such as the displacement of water. By doing so, this research sought to explore how advanced imaging technologies, such as CBCT, can enhance our understanding and application of established physical principles, ultimately offering more efficient, accurate, and non-invasive alternatives for scientific evaluation.

Reinforcing Archimedes' Principle with CBCT

Archimedes' Principle states that an object submerged in a fluid experience an upward buoyant force equal to the weight of the fluid displaced by the object. This principle has been fundamental in determining the volume of irregularly shaped objects, such as the human mandible, by measuring the displaced fluid. Traditionally, this process involved immersing the object in a fluid (water) and measuring the volume of the displaced fluid, a method that has inherent limitations, such as the risk of errors due to inaccurate submersion or air bubbles.

The study found that the use of CBCT scans to measure the volume of dry mandibles yielded results consistent with Archimedes' Principle. In this study, the volumes determined by CBCT imaging were within a ±1% margin of error compared to the displacement method. This accuracy reinforces the idea that CBCT can replicate the results of traditional methods with a high degree of reliability, but with significant advantages in terms of speed, precision, and non-invasive nature. Moreover, the 3D reconstructions provided by CBCT allowed for the visualization of fine details, such as the microstructure of the bone, which cannot be easily observed with traditional fluid displacement techniques.[6]

Advantages of CBCT Over Traditional Methods

1. Non-Invasive Nature: CBCT scanning offers a non-invasive alternative to traditional displacement methods. Immersing the mandible in water for displacement requires careful handling to avoid air pockets and to ensure accurate submersion. Furthermore, in a clinical setting, this approach would be impractical and potentially damaging to the specimen. In contrast, CBCT allows for high-resolution imaging without any physical contact with the specimen.[4]This feature significantly reduces the risk of handling errors and preserves the integrity of the specimen, making CBCT a valuable tool in both research and clinical practices.

2. Higher Precision: CBCT provides more precise and accurate measurements of the mandible's volume and density than traditional methods. This is due to the high spatial resolution of CBCT imaging, which allows for the creation of highly detailed 3D models of the mandible. These models can be manipulated to measure the volume of any irregularly shaped object with a high degree of accuracy[5]. The fine resolution of CBCT can also detect subtle variations in bone structure that would be difficult to discern

using traditional methods like fluid displacement[8].

3. Faster and More Efficient: While the displacement method of measuring volume can be time-consuming and labour-intensive, CBCT allows for a much faster evaluation. Once the scan is completed, the data is immediately available for analysis, enabling rapid volume and density measurements. It also reduces human error and the labour associated with manually measuring the displacement of fluids[5].

Challenges and Limitations

Despite the significant advantages, there are a few limitations in applying CBCT technology in place of traditional methods like Archimedes' Principle. These limitations should be considered in future research and clinical applications.

1. Material Density Considerations: One limitation of CBCT scanning is the potential variability in density measurements. The density calculations obtained through CBCT scans could be slightly affected by imaging artifacts or variations in bone density that are difficult to account for using traditional methods. For example, bones with higher mineral content may appear denser on a CBCT scan than bones with lower mineralization, which could skew the density values compared to those derived from displacement methods. The imaging resolution of CBCT could also fail to resolve micro-heterogeneities in the bone material, which would be more easily accounted for through direct submersion techniques[8].

2. Fluid Interaction in Displacement: Although CBCT provides a non-invasive method to measure volume, the Archimedes' Principle method still holds value in understanding the displacement of fluids, which provides a direct physical measurement. However, this traditional method requires proper handling of the specimen and accurate fluid measurements, which can be subject to errors such as air bubbles or incorrect fluid levels. The method also has limitations when dealing with extremely small or complex geometries where precise displacement measurement is challenging[7].

Integration of CBCT with Archimedes' Principle

The integration of CBCT with Archimedes' Principle in this study provides a fresh perspective on how modern imaging technologies can enhance our understanding of established scientific principles. In particular, the use of CBCT scans to confirm the volumes obtained via fluid displacement solidifies the role of CBCT as a reliable method for evaluating bone structures and densities in clinical and research settings. The application of Archimedes' Principle offers a straightforward, physical method for volume measurement, while CBCT provides the advantage of a 3D model, allowing for more detailed analysis of complex anatomical structures[4].

The detailed 3D information provided by CBCT scans can enhance the application of Archimedes' Principle, enabling a more comprehensive approach to diagnostics in dental practices[5].

CONCLUSION

This study confirms that CBCT can be used to replicate the findings of Archimedes' Principle, providing new insights into the measurement of volume and density in dry mandibles. The integration of CBCT with traditional physical methods, like Archimedes' Principle, offers substantial advantages, including non-invasive measurements, faster results, and high precision. The findings from this research open the door for further studies that explore the use of modern imaging technologies in reinterpreting traditional physical principles in new and innovative ways.

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Publication Type: *CASE REPORT*

SEAMLESS TRANSITION FROM TOOTH EXTRACTION TO IMMEDIATE DENTAL IMPLANT PLACEMENT WITH PROVISIONAL RESTORATION FOR OPTIMAL REHABILITATION

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Abstract
An implant is defined as any object or material, such as an alloplastic substance or other tissue, that is partially or completely inserted into the body for therapeutic, diagnostic, prosthetic, or experimental purposes. Immediate implant placement refers to the insertion of a dental implant into an extraction socket at the time of tooth extraction or explantation. In contrast, delayed implant placement occurs in edentulous areas after the healing process has been completed, with new bone formation following the loss of a tooth or teeth. The recent perspective is "why wait when it can be done immediately." Immediate implant placement offers several advantages, and numerous studies have explored this approach.

Keywords: Immediate implant placement, Esthetic rehabilitation, Immediate implants

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INTRODUCTION
There are three basic approaches to replace a missing tooth or teeth including removable dental prosthesis, fixed dental prosthesis, and dental implants. Each alternative has its own benefits and shortcomings. It is important to consider the patient's financial, medical, and emotional condition for the best treatment.[1]
In a report by Denissen HW, Kalk W, Erdhis HA, Van Waas MA, a delay of 3 months or more after tooth extraction in the anterior maxilla resulted in such an advanced stage of resorption, that only narrow diameter implants could be used. Due to these external and internal dimensional changes in the socket and dimensional changes of the mucosa after 1 year, these sites may not be suitable for implant placement.[2] The protocol for immediate implants eliminates the socket ossification period or combines the socket ossification period with the osseointegration period. This reduces the treatment time by 6 - 8 months and the concomitant bone resorption associated with extraction.[3]
Initially a 3-6 month stress free healing period was recommended by Branemark et al to achieve optimum bone healing and osseointegration prior to loading. This undue waiting period was always a source of inconvenience, both to the patient and clinician, and many a time the reason for opting against implant therapy[4]. A number of studies have shown that the survival rate of implants placed following extraction of teeth with root fractures, perforations and combined endodontic periodontal problems is similar to that of implants placed in healed ridges[5]

CASE REPORT
A 33 years old male patient named Mahin K K OP NO: 286429 reported to the Department of Prosthodontics of St Gregorios Dental College, Chelad, with chief complaint of fractured upper front tooth and wanted them to be replaced by a prosthesis to restore esthetics and speech. Past dental history revealed that patient met with an accident that led to

this condition. A thorough intraoral examination was done. The maxillary arch was completely dentulous supported by a well-formed ridge. Mandibular teeth were periodontally stable without any mobility.

Clinical diagnosis

Extra oral examination

The extraoral findings included face which was square tapered and symmetric with normal forehead and normal-set ears, impaired vision and straight profile.

Intra oral examination

Intraorally, the patient exhibited well-shaped arches with well-formed ridge. Elli's Class 3 fracture and Grade II mobility appreciated on 21. Mandibular teeth were periodontally stable without any mobility. Other intraoral clinical examinations revealed crowding in maxillary and mandibular arches.

Diagnosis

Based on history and clinical evaluation a provisional diagnosis of Ellis class 3 fracture of 21 with grade II mobility.

Treatment plan

Patient was explained about different treatment options

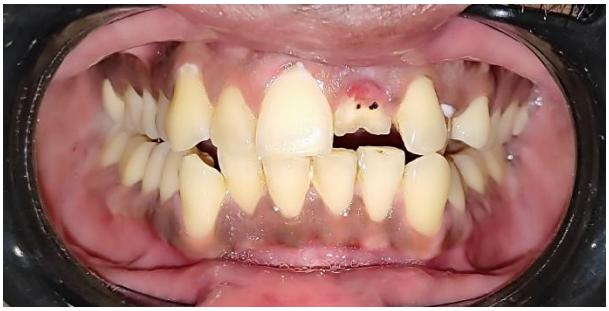
1. Implant supported prosthesis (Immediate or Delayed)
2. Fixed partial denture replacing 21
3. Removable partial denture

Due to aesthetic concerns, Patient was not willing to go for delayed implant placement and opted for immediate implant placement followed by provisionalization using Maryland like bridge.

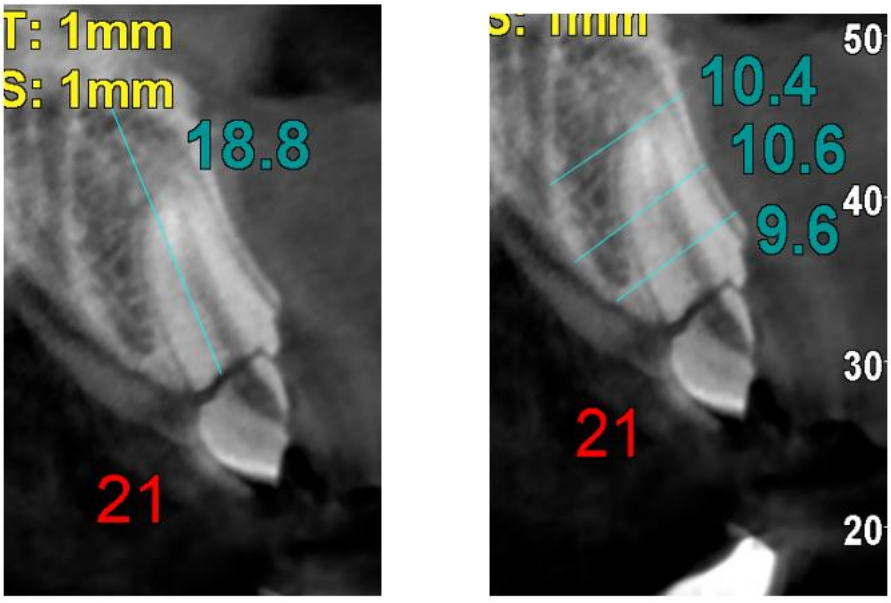
Pre prosthetic treatment approach

Pre-operative photographs were recorded and the Presurgical radiographic evaluation was done with panoramic radiograph along with CBCT

Appropriate length and width of available bone were determined with the help of CBCT and accordingly dental implants were selected for insertion.



Pre-operative view



Multiplanar Image of 21

CBCT report revealed alveolar bone dimensions as follows

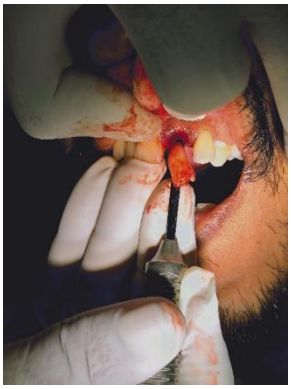
Implant site	Slice no	2mm subcrest	6.0mm subcrest	10.0mm subcrest	Bone height (crest-till Floor of nasal fossa
21	88	9.6	10.6	10.4	18.8

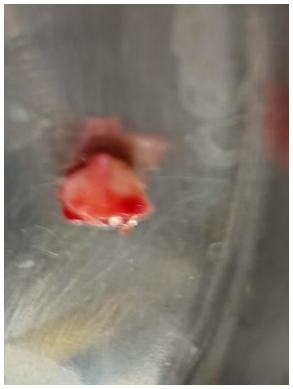
Tooth no: /region	Bone Division /Bone Density
21	A /D2

Radiographic interpretation suggested sufficient bone width and bone height for implant placement in 21 regions.

Prosthetic treatment approach

Following injection of 2% lignocaine local anesthetic solution, 21 was atraumatically removed using periotome.





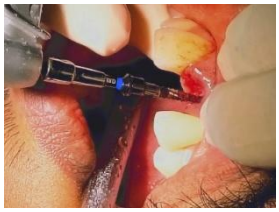
Atraumatic extaction of 21 using periotome

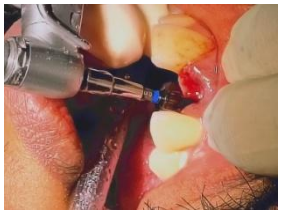
Extraction sockets were thoroughly debrided and inspected with the help of periodontal probe for any defect or possible perforation of cortical plate.

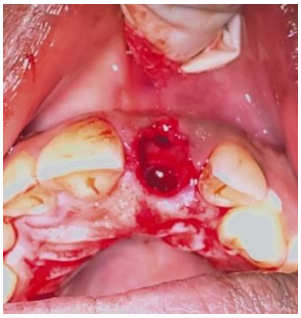
Autogenous graft obtained from extraction site

Autogenous graft obtained from the extraction site to fill the labial bone defect after implant placement prior to suture.

Osteotomy sites were prepared with sequential order of drills. Implants (Dentium Implant System size 4.3mm x 13mm) were inserted in the prepared osteotomy sites with insertion torque of 25 NCm, and adequate primary stability was obtained.



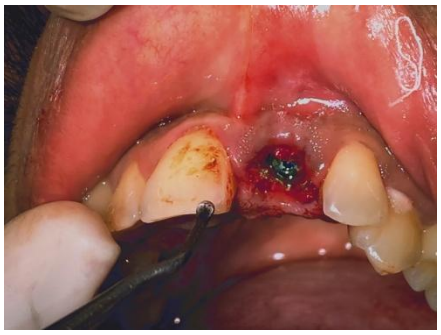




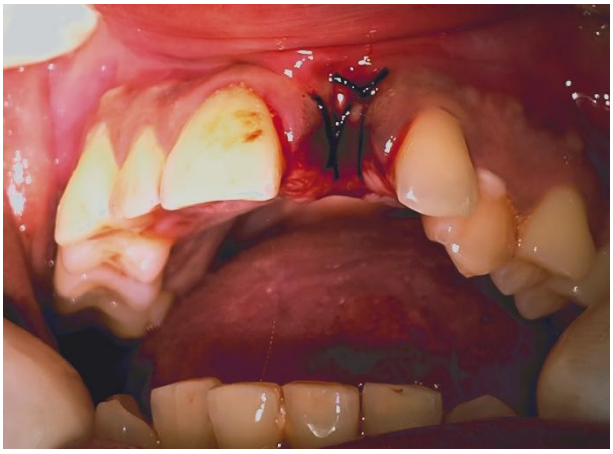
Osteotomy site preparation with sequential order of drills

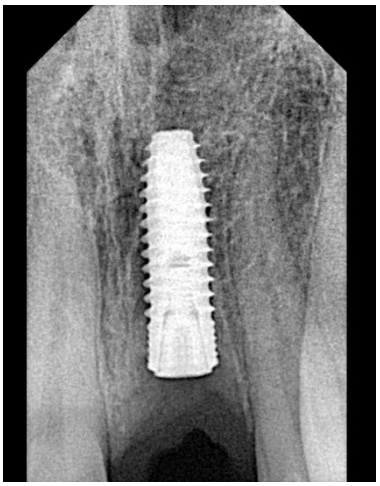
Cover screw placed and Postoperative intraoral periapical radiograph was taken, confirming the accuracy of placement of implants.

Suturing was done and Post-operative instructions given.



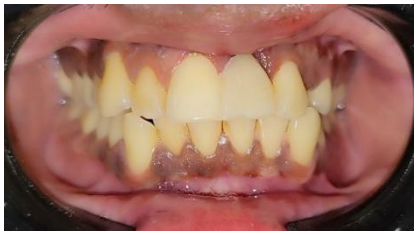
4.3mm x 13mm implant inserted and cover screw placed

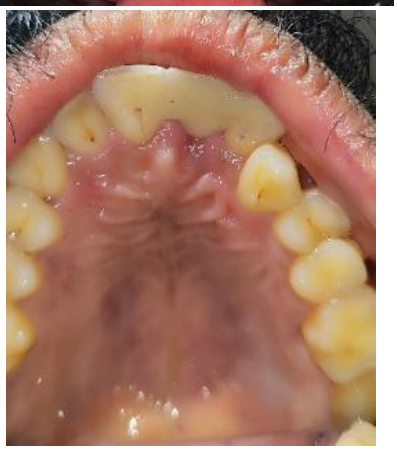




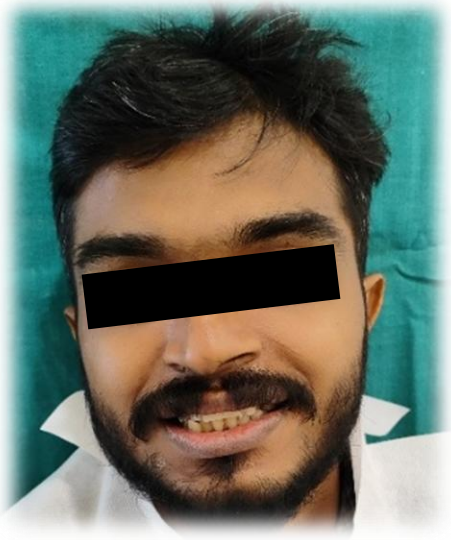
Suturing done and IOPAR taken to confirm accuracy of placement of implants

One week later on the day of suture removal healing was found satisfactory and Provisionalization was done using composite restoration similar to Maryland like bridge. Provisional restoration was relieved from occlusion.





Provisionalization was done using composite restoration similar to Maryland like bridge



Post-operative view

DISCUSSION

In the modern era, immediate implant concept is gaining popularity for replacing missing teeth, especially when anterior teeth are missing. Krump and Barnett reported high success rates with dental implants placed at the time of extraction[6].

Immediate placement of a dental implant in an extraction socket was initially described more than 30 years ago by Schulte and Heimke in 1976 The advantages of immediate implant placement techniques are reductions in the number of surgical interventions, a shorter treatment time, an ideal three-dimensional implant positioning, the presumptive

preservation of alveolar bone at the side of the tooth extraction and soft tissue aesthetics. The common disadvantages of this technique are morphology of the side, the presence of periapical pathology, the absence of keratinized tissue, thin tissue biotype, and lack of complete soft tissue closure over the extraction socket.[7]

Attard and Zarb carried out a review and concluded that the success of early loading implants may not be compromised by placement in fresh extraction sockets as long as history of marginal periodontitis is avoided[8]while Quirynen et al. concluded that the incidence of implant failure is significantly higher when combining immediate implant insertion with immediate loading.[9] Ferrara et al. conducted a study combining immediate placement and early loading of 33 implants and they found satisfactory esthetic and functional results from patient's point of view.[10]

The stability of the implant may be checked with resonance frequency analysis. Several publications have been there regarding the need of barrier membranes or bone grafts in the extraction sockets during placement of the immediate implants.[11]

CONCLUSION

Although numerous studies highlight the benefits of immediate implant placement over delayed implant placement, the success of an immediate implant relies heavily on factors such as proper case selection, accurate diagnosis, thorough treatment planning, and ensuring initial stability. Some studies suggest that there is little difference in marginal bone loss between immediate and delayed implant placements. However, it is clear that immediate implant placement saves time, requires less invasive surgical procedures, and offers significantly better aesthetic outcomes when the final restorations are placed.

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***Publication Type**: Case Report*

A CASE REPORT ON CENTRAL GIANT CELL GRANULOMA OF THE MAXILLA

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Abstract

The central giant cell granuloma is a rare, proliferative and benign lesion in nature. It is commonly seen in children and younger adults. Majority of the cases are seen in females with 70 percent of cases occuring in mandible. The exact etiology is unknown. If untreated, these lesions may enlarge and produce gross deformity. This article presents a case report of a 16-year-old female patient diagnosed with a central giant cell granuloma in the left maxilla.

Objective : Management of central giant cell granuloma in a 16 years old female patient.

Case report : The case concerns a 16-year-old female patient diagnosed with a central giant cell granuloma in the region of the maxillary central incisors. The lesion was causing pain and swelling in the upper front tooth area. Surgical removal of the granuloma was performed under local anesthesia.

Conclusion : The surgical procedure had a good prognosis and healing was found to be satisfactory.

Keywords: artificial intelligence, periodontitis, machine learning, diagnosis, convolutional neural networks

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INTRODUCTION

Central giant cell granuloma (CGCG) of the jaws is a relatively uncommon condition, making up less than 7% of all benign jaw lesions.[13] The World Health Organization (WHO) defines it as an intraosseous lesion composed of cellular fibrous tissue containing multiple hemorrhagic foci, clusters of multinucleated giant cells, and occasionally, trabeculae of woven bone.[1,8,1,0,19]

CGCG was initially described by Jaffe as a "giant cell reparative granuloma of bone," as it was believed to be a reparative reaction of bone, possibly in response to intramedullary haemorrhage or trauma.[10] The term "reparative" is no longer considered appropriate since the lesion is essentially destructive.[3,4,5,10,13]

The exact cause of this remains unknown, but its presence in individuals with genetically associated conditions, such as neurofibromatosis type 1, cherubism, and Noonan-like syndrome, suggests a potential genetic basis.[15] It's been suggested that the CGCG in the jawbones may arise from an exaggerated reparative process, often triggered by prior trauma or intraosseous hemorrhage, which leads to a reactive granulomatous response.[7,8] Less commonly, CGCG may be associated with conditions like hyperparathyroidism, cherubism, Paget's disease, or Noonan-like multiple giant cell lesion syndrome.[11,14] This lesion is more frequently observed in females than males, with a sex ratio of 2:1.[1] Predominantly seen in mandible,[6] With the first molar being the chief area of concern. The clinical presentation can range from a slow-growing, asymptomatic lesion to an aggressive form characterized by pain, local bone destruction, and root resorption. [17] The most frequent symptom is a painless swelling, leading to facial asymmetry.[10]

Histologically, it is characterized by a fibroblast-rich stroma with intercellular collagen, hemosiderin pigment, and extravasated blood vessels.[10] Multinucleated giant cells are diffusely present throughout the lesion.[16] Radiographically, it presents as a unilocular or multilocular radiolucency, with varying degrees of cortical plate expansion and destruction.[13] Tooth displacement is observed more often than root resorption.[4]

Surgical curettage is the most widely used treatment for CGCG at present, [1,4] with recurrence rates ranging between 11% and 49%.[1,15] Alternative treatment approaches, including corticosteroid injections, calcitonin, and interferon-alpha, have also been proposed in the literature.[1]

CASE REPORT

A 16-year-old female patient presented to the Department of Oral and Maxillofacial Surgery at St. Gregorios Dental College with a complaint of a fractured tooth in the upper front region. She had been experiencing swelling and pain for the past six months but denied any history of trauma. Tooth mobility had been observed for about five months.

Her general health history showed no evidence of syndromes or systemic diseases, and both her medical and familial history were unremarkable. Intraoral examination revealed that there were fractures present in the maxillary right and left central incisors (Ellis Class II fracture), along with moderate enamel hypoplasia affecting the same teeth. On palpation, the hard palate in relation to teeth 11 and 21 was firm, with no signs of swelling or pus discharge. Pulp vitality testing indicated that teeth 11, 21, and 23 were vital, while tooth 22 was non-vital (Fig. 1).

Fig 1: Presurgical site

The patient was advised to undergo an intraoral periapical radiograph and a panoramic radiograph. The panoramic radiograph revealed a well-defined radiolucent lesion measuring approximately 2.5 cm × 2.5 cm in the maxillary central incisor region. Distal displacement with external root resorption was observed in relation to the maxillary left canine. Additionally, a blunderbuss canal with an open apex was observed in the maxillary left central incisor.

The presence of an inverted pear-shaped radiolucency between the left central and lateral incisors suggested the possibility of a globulomaxillary cyst. Furthermore, the lesion's location at the apical region of tooth 21 raised suspicion of a periapical cyst. On clinical evaluation and radiographic findings, a differential diagnosis of the lesion being a periapical cyst or a globulomaxillary cyst was considered. (Fig. 2)

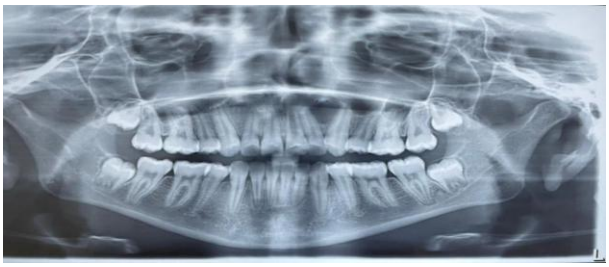

Fig2 : Orthopantomograph

To further assess the diagnosis, the patient was advised to undergo a CBCT for a three-dimensional evaluation of the pathology and its orientation in relation to adjacent hard and soft tissues.

The CBCT scan revealed a solitary, well-defined and round osteolytic lesion in the periapical region of teeth 21 and 22. The lesion measured approximately 14.0 mm (anteroposterior) × 11.8 mm (buccopalatal) × 11.7 mm (superoinferior) and extended mesially up to the midline. The lesion's borders were partially corticated, and buccal as well as marked palatal bone expansion was observed, along with destructive variations in the cortical bone. Internally, the lesion appeared completely radiolucent.

Additionally, divergence of the root of tooth 23 was noted, but the nasal floor remained intact. Tooth 21 exhibited a coronal radiopaque restoration, with a single root featuring a wide canal and an open apex. The nasopalatine nerve canal also appeared intact. (Fig. 3, 4)

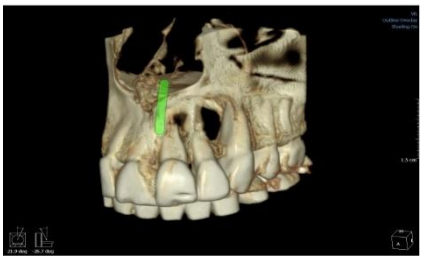

Fig 3 : The CBCT scan revealed a osteolytic lesion in the periapical region of teeth 21 and 22

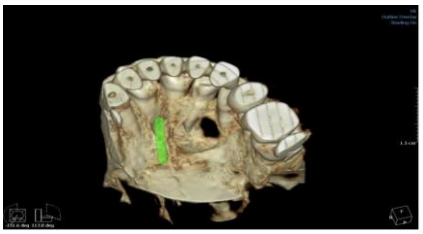

Fig 4: CBCT revealed destruction of cortical plate of hard palate

Based on the CBCT findings, a radiographic diagnosis of a periapical osteolytic lesion in the region of teeth 21 and 22 was established. The treatment plan was formulated after evaluating the panoramic radiograph and CBCT scans.

Endodontic treatment was initiated with access opening in the maxillary left central and lateral incisors, followed by biomechanical preparation. One week later, obturation was performed. Surgical treatment was performed on the same day in the Department of Oral and Maxillofacial Surgery.

Cyst enucleation was carried out under local anesthesia, which included buccal infiltration, infraorbital, nasopalatine and greater palatine nerve block. A triangular flap with a releasing incision distal to the maxillary left canine was created, and a full-thickness mucoperiosteal flap was reflected. The lesion was completely removed, preserving an intact rim of buccal bone. An excisional biopsy was performed, and the specimen was sent for histopathological examination.

Vicryl 3/0 absorbable sutures were placed, and the patient was put on antibiotics, analgesics, anti-inflammatory medications, and vitamin supplements for a period of five to seven days postoperatively. (Fig. 5)

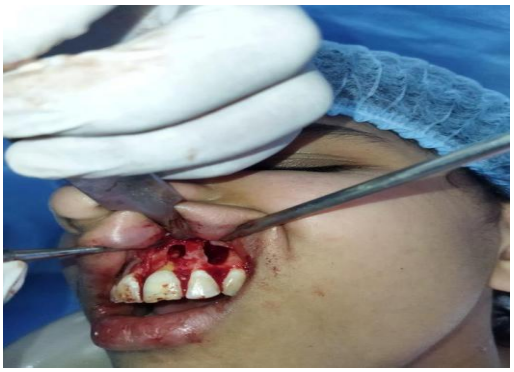

Fig 5:Surgical site

At the one-week follow-up, satisfactory healing with no complications were noticed. Histopathological examination of the H&E-stained soft tissue specimen revealed a connective tissue stroma containing sheets of chronic inflammatory cells, including lymphocytes, plasma cells, foamy macrophages, and multinucleated giant cells. Additionally, cholesterol clefts and endothelial cell proliferation were observed. The presence of vascular channels and entrapped red blood cells further supported the diagnosis of CGCG.
The patient was reviewed again after one month, showing good healing and remaining asymptomatic. (Fig. 6)

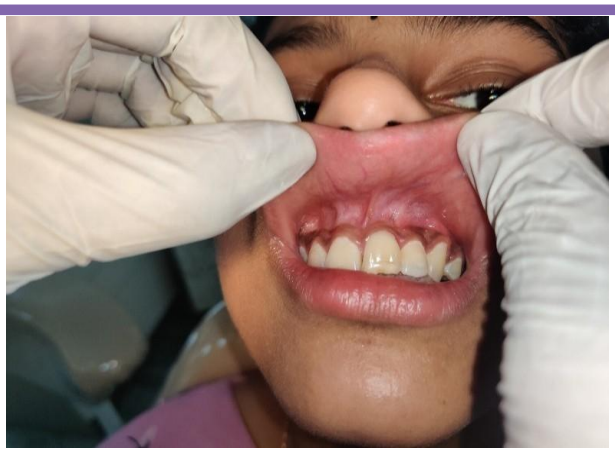

Fig 6:1 month follow up

DISCUSSION

Central giant cell granuloma (CGCG) is a rare, non-neoplastic lesion primarily affecting the mandible and maxilla. Jaffe initially considered it to be a localised reparative process linked to traumatic intraosseous haemorrhage or a periosteal reaction.[3] He defined giant cell tumours as "a distinct neoplasm arising from undifferentiated supporting connective tissue of the marrow, which can be clearly identified based on its cytological characteristics."

CGCG being common in kids and young adults, typically within the first three decades of life.[12] The lesion is twice as prevalent in females as in males.[7] Based on the histological features Chuong et al, classified it into aggressive and non-aggressive.[10] Non-aggressive lesions exhibit slow growth, mostly assymtomatic with no evidence of root resorption or cortical perforation, and a low recurrence tendency. In contrast, aggressive lesions are characterised by pain, rapid growth, root resorption, cortical perforation, and a higher likelihood of recurrence. These asymptomatic slow growing lesions are often detected incidently on routine radiographs, whereas aggressive variants presents with facial swelling and pain.

The radiographic characteristics of CGCG are not consistently defined.[2] Some studies describe it as a unilocular radiolucency, while others report a multilocular pattern.[2] Wood and Gauz noted that the lesion may initially present as a solitary "cyst-like" radiolucency, which can later develop into a "soap bubble" appearance as it enlarges.[9]

Histologically, CGCG is characterized by a densely cellular fibroblastic stroma, containing spindle shaped plump cells with high mitotic rate and increased vascularity.[9] Multinucleated giant cells are typically clustered around hemorrhagic areas.[9]

Giant cell granuloma of the jaw is a benign condition that typically shows a favorable response to

treatment.[3] Management depends on clinical, radiographic, and histological findings.[6] Surgical curettage remains the most commonly employed treatment. While simple curettage is usually effective, more extensive lesions may necessitate surgical resection.[15,17] A recurrence of 11% to 49% following surgical treatment,[13] with a higher recurrence rate observed in aggressive lesions and younger male patients.[1] In the case presented, the patient underwent surgical excision and curettage of the remaining bone.[1]

Adjunctive medical therapies for CGCG include corticosteroids, calcitonin, bisphosphonates, and interferon alpha.[14,20] Calcitonin, a peptide hormone produced by thyroid C cells,[14] inhibits osteoclastic activity, thereby reducing serum calcium levels and promoting osteoblastic function.[1] While human and salmon calcitonin are available, only salmon calcitonin is commercially used.[1] Administration methods include subcutaneous injection and nasal spray.[15] However, calcitonin therapy may lead to side effects such as hypocalcemia and secondary hypoparathyroidism, and long-term use, particularly in children, can be intolerable.[2]

Jacoway et al. first introduced intralesional corticosteroid therapy,[2] which induces apoptosis in osteoclast-like cells and inhibits bone resorption.[1] Corticosteroids can be either be used alone or paired with other treatments like bisphosphonates and calcitonin.[15] However, combining corticosteroids with bisphosphonates carries risks, including medication-related osteonecrosis of the jaw.[19] Additionally, corticosteroids are relatively contraindicated in patients with diabetes mellitus, peptic ulcers, and immune-compromised conditions.[19]

Interferon alpha, known for its antiviral and anti-angiogenic properties, has been utilised in treating hemangiomas and various malignant tumours.[1,15] Abukawa found that interferon alpha can stimulate mesenchymal cells to differentiate into osteoblasts, enhancing bone formation in CGCG. When used as monotherapy for aggressive CGCG, interferon alpha has demonstrated effectiveness in reducing lesion growth.[1]

Imatinib, a protein tyrosine kinase inhibitor commonly used to treat chronic myeloid leukemia and gastrointestinal stromal tumors,[15] Imatinib has demonstrated a dose-dependent inhibition of RANK in osteoclasts, suggesting an anti-osteolytic effect.[11,18] This indicates that Imatinib could be a potential treatment for osteolytic lesions such as CGCG.[15,7] Although surgery remains the gold standard for CGCG management, adjunctive therapies can be incorporated to minimise the risk of recurrence.

CONCLUSION

Lesions like giant granulomas are very less common.[6] Despite extensive discussion and debate in the literature, its exact nature remains uncertain.[1] While simple curettage is an effective treatment, larger or more extensive lesions, like the one presented in our case, may necessitate resection.[13] Combining surgical treatment with medical therapies significantly reduces the risk of recurrence.

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***Publication Type**: REVIEW ARTICLE*

SHORT ROOT ANOMALY AND ORTHODONTIC TREATMENT

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Abstract

Objective

This review aims to provide a comprehensive understanding of Short Root Anomaly (SRA), a rare developmental dental condition, with a focus on its diagnosis, etiology, clinical presentation, and implications for orthodontic treatment planning.

Study design

This is a narrative literature review analyzing current scientific evidence and case-based insights concerning SRA. It draws on genetic, molecular, radiographic, and clinical perspectives to outline best practices in the orthodontic management of affected patients.

Results

SRA predominantly affects maxillary central incisors and premolars, is often bilateral and symmetrical, and may have a genetic basis. Affected teeth exhibit a poor crown-to-root ratio and increased susceptibility to root resorption during orthodontic treatment. The condition is non-progressive, unlike idiopathic root resorption. Diagnostic clarity can be enhanced through radiographs and CBCT. Orthodontic strategies require reduced force levels, minimal tooth movement, and anchorage alternatives such as TADs and functional appliances. Regular monitoring is crucial to prevent adverse outcomes.

Conclusion

SRA presents significant orthodontic challenges due to the risk of root resorption and limited anchorage capacity. Individualized treatment planning, early diagnosis, light-force mechanics, and continuous monitoring are vital to achieving successful outcomes. Further research into molecular pathways may improve therapeutic approaches in the future.

Though rare, its presence poses significant challenges in orthodontic treatment planning and execution due to increased susceptibility to root resorption and reduced anchorage potential. This review aims to explore the etiology, diagnosis, clinical implications, and treatment strategies of SRA in orthodontic patients.

Key words: short root anomaly, short root, ortodontic tratment,root resorption

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INTRODUCTION

Short Root Anomaly (SRA) is an uncommon developmental condition, observed in about 1.3% of the population [1,4]. It primarily affects females and typically involves maxillary central incisors and the first premolars. It is a rare dental condition characterized by abnormally short and blunt tooth roots, often presenting with a root-to-crown ratio of 1:1 or less. Due to its impact on orthodontic biomechanics and risk of exacerbated root resorption, accurate diagnosis and tailored treatment are crucial [4]. Due to increased susceptibility to root resorption and reduced anchorage potential it also causes significant challenges in orthodontic treatment planning and execution. This review aims to explore the etiology, diagnosis, clinical implications, and treatment strategies of SRA in orthodontic patients.

This anomaly is most frequently found in the maxillary central incisors, with premolars being the next most commonly affected teeth [1,2,4]. Teeth affected by SRA exhibit rounded, blunted, or tapered root apices, resulting in a poor root-to-crown ratio.

While healthy teeth typically have an average root/crown ratio of 1.6, this decreases to just 1.1 in those impacted by SRA [1,5]. This condition is often bilateral and symmetrical and may appear in multiple family members, which suggests a strong genetic component [2].

Differentiation between congenital SRA and idiopathic root resorption (IRR) is crucial. Unlike IRR, SRA is non-progressive and usually diagnosed before any orthodontic intervention

Key diagnostic indicators for distinguishing SRA from IRR include:

(1). SRA typically presents with bilateral symmetry and smooth apical blunting, whereas IRR is characterized by irregularities in the root due to resorption.

(2.) SRA is often linked to other developmental anomalies and a familial history of the condition [13].

(3) The distinction between the two is important from a clinical point of view because IRR, unlike SRA, may have varying periods of progressive resorption [2].

ETIOLOGY

Genetic factors

- SRA is considered primarily genetically determined.
- It can be inherited in an autosomal dominant pattern with incomplete penetrance.
- Dental anomalies associated with SR anomaly include tooth agenesis, taurodontism, microdontia, dilacerations, and dentin dysplasia type I.

Environmental and iatrogenic factors

- Although rare, environmental factors such as radiation therapy, chemotherapy, and trauma during dental development may result in acquired short roots.
- Syndromes such as Down syndrome and Stevens-Johnson syndrome have also been linked to SRA.

Molecular mechanisms

Molecular studies have implicated disruptions in signaling pathways critical for root development, including nuclear factor I C-type (Nfic), osterix (Osx), hedgehog (Hh), bone morphogenetic proteins (BMPs), transforming growth factor-β (TGF-β), Smad, Wnt, β-catenin, and dickkopf-related protein 1 (DKK1). These factors interact in complex networks, and their dysregulation can lead to impaired odontogenesis and the manifestation of SRA. Either overactivation or suppression of this signaling influences the normal odontogenesis [7].

Molecular analysis of gingival crevicular fluid in SRA patients has identified a distinct process involving the activation, complex formation, and fragmentation of matrix metalloproteinase 9 (MMP-9). Because of its low collagenolytic resorptive activity, MMP-9 reinforces the theory that developmental root shortening in SRA is not a result of root resorption.

Additionally, animal studies have demonstrated that the loss of nuclear factor I genes leads to root shortening as a result of disrupted odontoblast differentiation. Although unable to clearly delineate the exact inheritance pattern for SRA, studies have established a hereditary and genetic predisposition.

DIAGNOSIS AND CLINICAL PRESENTATION

Accurate diagnosis of SRA is crucial for effective treatment planning. Clinically, SRA presents with short, blunt roots, predominantly affecting maxillary central incisors and premolars. Radiographic assessment plays a crucial role in differentiating SRA from other conditions, including incomplete root formation, external apical root resorption, dentin dysplasia type I, and post-traumatic root hypoplasia. Cone Beam Computed Tomography (CBCT) has been instrumental in evaluating root morphology and identifying EARR, making it a crucial tool for differential diagnosis. Differentiating between congenital short roots and orthodontically induced root resorption is essential. Genetic forms of SRA usually exhibit bilateral and symmetrical presentation and may have familial patterns

The pathognomonic features of SRA are as follows:

- ❖ The teeth have short plump roots with rounded apices
- ❖ crown to-root ratios of 1:1
- ❖ The short root condition (rizomicry) is not caused by root resorption or any external factors; instead, it exhibits a familial tendency. The apices of the roots are closed
- ❖ And the teeth are often asymptomatic
- ❖ The prevalence of SRA among white populations has been reported as 1.3%-2.4% [12,15].
- ❖ Generalized forms of rizomicry have been reported, higher prevalence for localization of the condition in the maxillary incisors and premolars has been observed [2].

ORTHODONTIC IMPLICATIONS

1. Risk of root resorption

Patients with SRA are significantly more prone to orthodontically induced root resorption due to:

- High stress concentration in shortened roots (as shown in finite element analysis by Oyama et al.)
- Reduced root surface area to distribute applied forces
- Potential existing fragility of the root cementum

2. Reduced anchorage potential

Short roots offer less periodontal support, making it difficult to use such teeth for anchorage or to withstand retraction or intrusive forces.

3. Treatment planning constraints

Limited scope for tooth movement involving affected teeth

- Need for lighter forces, longer treatment duration,

and continuous monitoring

- Strategic selection of anchorage units (e.g., temporary anchorage devices, extraoral appliances) becomes critical

Orthodontic treatment considerations in patients with short root anomaly

Orthodontic management of patients with SRA requires meticulous planning to minimize the risk of exacerbating root resorption. While orthodontic movement is not universally contraindicated, caution is advised, especially in severe cases.

1. Comprehensive diagnosis before treatment

Before initiating any orthodontic movement, it is essential to:

- Perform panoramic and periapical radiographs, or CBCT in selective cases, to assess root length and morphology.
- Identify which teeth are affected—central incisors and premolars are most commonly involved.
- Take a thorough family and medical history to rule out syndromic associations or systemic influences.
- Distinguish SRA from post-orthodontic external apical root resorption (EARR)—SRA is congenital, non-progressive, and often bilateral.

2. Minimize orthodontic force levels

Orthodontic forces should be:

-Low in magnitude and intermittent

- Applied over longer periods to allow tissues to adapt gradually.
- Controlled using super elastic wires with light continuous forces (e.g., NiTi wires in early stages).

Avoid:

- Heavy retraction forces (especially on anterior teeth)
- Intrusive mechanics (which cause significant apical stress)
- Rapid tooth movements or torquing of roots

3. Treatment modifications & appliance choices

Preferred Strategies:

- Functional appliances (e.g., activators, twin blocks, headgear):
  - Effective in growing patients for skeletal correction without stressing roots.

  This approach employed in the case documented by Marques et al. effectively prevented additional root damage
  - Headgear can distalize molars and restrain maxillary growth while preserving anterior root integrity.
- Segmental mechanics:
  - Isolate movement of unaffected teeth and reduce unwanted forces on SRA-involved teeth.

-Temporary Anchorage Devices (TADs):

- Provide absolute anchorage without burdening short-rooted teeth.
- Useful for intrusion, retraction, or molar distalization.

- Self-ligating bracket:
  - May reduce friction and allow lighter force applications.

Avoid or use with caution:

- Continuous archwires that involve short-rooted teeth.
- En-masse retraction mechanics.
- Intrusive movements on incisors with SRA (especially with mini-screws or reverse curve wires)

4. Anchorage planning

Anchorage control is crucial since teeth with short roots provide limited resistance. Use:

- TADs
- Extraoral anchorage (headgear)
- Reinforcement from unaffected posterior teeth
- Passive mechanics on short-rooted teeth to minimize involvement in anchorage units

5. Retention protocols

Due to potential post-treatment instability

- Use fixed lingual retainers to maintain incisor positions.
- Consider vacuum-formed retainers or Hawley retainer for overall arch stability.
- Retention may need to be lifelong, especially if the periodontal support is reduced.

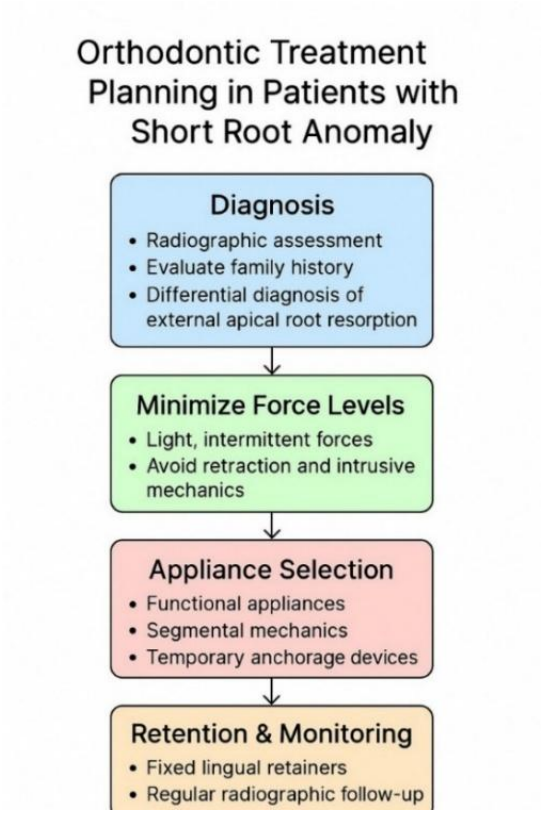
6. Monitoring during and after treatment

- Take periodic radiographs (every 6–12 months) to monitor for:
  - New or progressing root resorption
  - Tooth mobility
  - Bone loss
- Cease or modify treatment immediately if adverse changes occur.
- Consider ending treatment early if stability is achieved and further movement risks root health.

CONCLUSION

Short Root Anomaly, though rare, is a significant condition in orthodontics due to its impact on treatment safety and success. Orthodontic treatment for patients with SRA demands careful planning to

reduce the likelihood of aggravating root resorption.



While orthodontic movement is not universally contraindicated, caution is advised, especially in severe cases.

Early and accurate diagnosis, preferably before initiating active mechanics, is key to preventing adverse outcomes such as severe root resorption or tooth loss. Conservative and individualized treatment planning, combined with the use of functional orthopaedic appliances and regular radiographic monitoring, reduced-force protocols can lead to favourable outcomes even in complex cases. Clinicians must remain vigilant and flexible, prioritizing the long-term health and stability of the patient's dentition. Further research is needed to elucidate the molecular mechanisms underlying SRA and to develop targeted interventions that can enhance treatment predictability and patient safety.

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APPLICATION OF ARTIFICIAL INTELLIGENCE IN DIAGNOSIS, TREATMENT AND PROGNOSIS IN PERIODONTOLOGY

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Abstract

Objective

Periodontal disease is a major public health concern with profound impacts on oral and systemic health. As diagnostic tools evolve, Artificial intelligence (AI) has become a game-changing technology in periodontology as diagnostic technologies advance, offering improved diagnostic precision, effective treatment planning, and individualized care

This review explores AI's applications in periodontal diagnostics, particularly through convolutional neural networks (CNNs) and other deep learning models, highlighting their current performance, clinical benefits, and limitations. It also examines the challenges in AI integration, including ethical concerns, data requirements, and clinical adoption barriers. While AI is not a replacement for clinical expertise, its synergistic use may redefine periodontal care paradigms.

Keywords: artificial intelligence, periodontitis, machine learning, diagnosis, convolutional neural networks

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INTRODUCTION

Periodontitis is a chronic inflammatory condition that affects the supporting structures of the teeth, resulting in progressive attachment loss and alveolar bone degradation. With a global prevalence affecting approximately 10–15% of the adult population, periodontitis ranks as one of the most common causes of tooth loss and has systemic associations with diabetes, cardiovascular diseases, and adverse pregnancy outcomes.[1]

Even with clinical improvements, diagnosing periodontitis is still difficult and necessitates extensive clinical probing, radiographic analysis, and clinical knowledge. Diagnostic inconsistencies are caused by a variety of factors, including subjective interpretations, time constraints, and skill variability. Promising solutions to these problems include artificial intelligence (AI), which makes it possible to diagnose periodontal disease earlier, more reliably, and accurately.[2,3]

AI FUNDAMENTALS AND APPLICATIONS IN PERIODONTOLOGY

AI in dentistry encompasses various techniques, including machine learning (ML), deep learning (DL), and artificial neural networks (ANNs). Within these Convolutional neural networks (CNNs) have been used extensively to evaluate periodontal bone loss in radiographs and are especially effective for image-based diagnostics.[4]

CNNs process radiographic data through layered filters to detect patterns indicative of disease, enabling objective classification of periodontal status. Alveolar bone loss (ABL) can be detected with F1 values as high as 0.894 in studies employing CNNs (e.g., VGG-16, YOLOv5, Deetal-Perio).[5]

CNN models such as Deetal-Perio use extensive annotated datasets to learn how to identify specific markers of periodontitis. They leverage thousands of dental images, learning from a combination of supervised and unsupervised methods to distinguish subtle variations in bone density, trabecular patterns,

and anatomical positioning. Moreover, the integration of CNNs with clinical metadata enables a comprehensive diagnostic approach that goes beyond visual interpretation.

Alotaibi et al. reported that their deep CNN-based detection system for periapical radiographs achieved 73% accuracy in identifying diseased versus healthy cases, and 59% accuracy in classifying severity levels of bone loss.[2] These findings suggest that CNNs may effectively serve as preliminary diagnostic tools, triaging cases that require further manual evaluation.

DIAGNOSTIC INNOVATIONS AND EFFICIENCY GAINS

Traditional diagnostic methods include clinical probing and interpretation of panoramic or periapical radiographs. However, probing is invasive, and radiograph interpretation is prone to error. AI enhances these approaches by:

- Automating detection of CAL and ABL
- Reducing inter-operator variability
- Speeding up image analysis
- Supporting real-time clinical decision-making

Jundaeng et al. reviewed 12 studies and concluded that CNN-based models yielded accuracy between 0.76 to 0.98 for periodontal bone loss detection.[1] These models included hybrid approaches combining deep learning with machine learning classifiers, contributing to enhanced robustness and adaptability. CNNs and ensemble models that combine multiple neural network architectures further improve sensitivity and specificity by filtering out noise and inconsistencies from raw image data.Furthermore, AI tools like Deetal-Perio and transformer networks are capable of recognizing subtle bone defects even in difficult anatomical locations such as molars with vertical bone loss.[5] Transformer networks, known for their ability to handle large-scale sequential data, are showing promise in temporal analysis of disease progression across patient visits.

PERSONALIZED PERIODONTAL DIAGNOSTICS

AI supports the transition from a "one-size-fits-all" diagnostic model to personalized diagnostics. Personalized periodontology, rooted in the precision medicine framework, seeks to stratify patients by molecular profiles, risk factors, and behavioural traits.

Pitchika et al. highlighted that AI can integrate clinical, imaging, and molecular datasets to guide diagnosis and tailor treatments.[6] Tools like risk stratification models informed by AI can predict disease progression and guide early intervention. By examining immunological biomarkers, lifestyle factors like smoking or glycemic management, and patterns of plaque distribution, artificial intelligence has been utilised to evaluate each patient's response to nonsurgical treatments.
This shift is pivotal because risk-based stratification alone may overlook individual variability. For example, AI can distinguish between patients with similar clinical presentations but different underlying biological pathways, enhancing care outcomes. Predictive therapy routes can be made possible by advanced AI models that can even recognize phenotypic groupings of patients with comparable illness trajectories.

TREATMENT PLANNING AND PROGNOSIS

AI applications extend beyond diagnosis to assist in:

- Treatment simulations (e.g., in implant planning)
- Prognosis prediction
- Treatment response monitoring
- Patient engagement and behaviour tracking

Spartivento et al. discussed that AI tools are now capable of aiding in decision-making for nonsurgical therapy, evaluating the risk of disease progression, and even suggesting intervention types based on patient-specific data.[5] These systems factor in long-term risk models derived from population-level data and individual prognostic factors to recommend customized care plans.

Moreover, hybrid networks combining CNNs and transformer architectures are being developed for longitudinal assessment and integration of multimodal data (clinical, radiographic, and behavioural), potentially offering a holistic treatment planning framework. Reinforcement learning is also emerging as a novel method for adaptive treatment strategies, where AI learns and adjusts recommendations based on patient outcomes and feedback loops.

Li Y et al., 2024 introduced a test AI-MST (artificial intelligence -multimodal sensing toothbrush) to guide patients into effective oral hygiene by sending real time data to clinicians. This device showed significant improvement in patient oral hygiene compared to control unit and has potential to improve its efficacy and reduce cost.[7]

In another study, the effects of AI-assisted dental monitoring, with and without health counseling, on the outcomes of therapy and the quality of life associated with oral health in patients with periodontitis were evaluated.

The findings demonstrated that AI-assisted dental

monitoring can be utilized to successfully enhance long-term periodontal measures and encourage patients with periodontitis to practice good oral hygiene at home.[8]

CHALLENGES IN CLINICAL INTEGRATION

Despite promising outcomes, significant barriers persist in AI's clinical translation:

- Data Quality & Diversity: Most AI models are trained on limited datasets that may lack diversity, limiting generalizability across populations.[3]
- Interpretability: "Black-box" algorithms raise concerns about explainability and clinician trust.
- ·Regulatory Hurdles: Approval from health authorities and integration into public health systems remain complex.[4]
- ·Ethical Considerations: Data privacy, AI decision-making authority, and liability concerns must be addressed.

To overcome these issues, Moeini and Torabi emphasized the need for regulatory frameworks, data protection protocols, and clinical education on AI tools.[8] Additionally, establishing benchmarking protocols and explainable AI (XAI) methods can foster greater transparency and trust in clinical practice. Infrastructure for data sharing and algorithm evaluation may also be greatly aided by public-private collaborations.

ETHICAL AND EDUCATIONAL IMPLICATIONS

AI adoption raises ethical questions, particularly concerning accountability and patient autonomy. Clinicians must retain decision-making responsibility, using AI as a support tool rather than a replacement. Transparent algorithms and continuous validation are crucial to maintaining patient trust.

Educational efforts are essential to prepare dental professionals for AI integration. As Khan et al. emphasized, clinical training should include digital literacy and competency in interpreting AI-generated insights.[4] Curricula in dental schools and continuing professional development programs must incorporate AI literacy, data handling ethics, and interdisciplinary collaboration to prepare future practitioners.

FUTURE DIRECTIONS

The future of AI in periodontology lies in:

- Integrating 3D imaging for better visualization of vertical defects
- Multi-modal data fusion, including genetic, microbiome, and salivary biomarkers
- Federated learning to overcome data sharing barriers while protecting patient privacy
- AI-driven tele-dentistry, expanding access to care in remote and underserved areas
- Predictive maintenance of oral health using wearable biosensors

If integration is managed properly and cooperatively amongst developers, regulators, and physicians, AI has enormous promise to give early diagnosis, tailored therapy, and better results. Diagnosis and treatment of periodontal disease in a sustainable and fair way. Investment in infrastructure, algorithm transparency, and patient-centered design will determine AI's long-term success in periodontology.

CONCLUSION

Artificial intelligence represents a transformative tool in periodontology, particularly for diagnostic precision, workflow efficiency, and personalized care. Even though recent models like as CNNs and hybrid networks have shown encouraging outcomes, overcoming technological, ethical, and regulatory obstacles is necessary to achieve broad clinical acceptance. AI is not a replacement for human judgment but a partner in enhancing periodontal care. Through responsible integration, clinician training, and continuous research, AI can reshape the landscape of periodontal diagnostics and treatment in a sustainable and equitable manner.

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COLD ATMOSPHERIC PLASMA IN ENDODONTICS: A COMPREHENSIVE REVIEW

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Abstract

Cold Atmospheric Plasma (CAP) has emerged as a promising adjunct in endodontics due to its multifaceted therapeutic properties. This narrative review evaluates the current evidence on the applications and efficacy of CAP, with a particular focus on its antimicrobial activity, safety, device variability, and regenerative potential. CAP has demonstrated potent antimicrobial effects against resistant endodontic pathogens such as Enterococcus faecalis and Candida albicans, especially when used alongside conventional irrigants. It preserves the structural integrity of dentin and can enhance adhesive bonding, offering advantages in restorative procedures. Recent innovations, including portable CAP devices and plasma-activated liquids, have expanded its clinical applicability. Furthermore, CAP shows potential in regenerative endodontics by stimulating stem cell activation and promoting angiogenesis. Overall, CAP represents a safe and effective tool for enhancing endodontic disinfection and tissue healing. However, additional clinical trials and standardized treatment protocols are necessary to validate its efficacy and ensure its integration into routine endodontic practice.

Keywords: Cold atmospheric plasma, endodontics, root canal disinfection, biofilm, antimicrobial therapy, dental adhesion, tissue regeneration

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1.INTRODUCTION

Endodontic therapy aims to eradicate microbial infection from the root canal system and prevent reinfection. Despite advances in mechanical instrumentation and chemical irrigation, complete disinfection remains challenging due to the complex anatomy of root canals and the resilience of microbial biofilms.[1] Persistent infections, often involving *Enterococcus faecalis* and *Candida albicans*, are associated with treatment failures and periapical pathologies [2,3].

Cold atmospheric plasma (CAP) has garnered attention for its antimicrobial efficacy and minimal invasiveness. Operating at near-room temperatures, CAP generates reactive species capable of disrupting microbial structures without damaging surrounding tissues[4]. This review explores CAP's potential in endodontic applications, evaluating its mechanisms, efficacy and integration into clinical practice.

2.MECHANISMS OF COLD ATMOSPHERIC PLASMA

CAP is an ionized gas comprising electrons, ions, reactive oxygen species (ROS), reactive nitrogen species (RNS), ultraviolet photons, and electromagnetic fields. These components interact synergistically to exert antimicrobial effects through:

- **Membrane Disruption:** ROS and RNS compromise microbial cell membranes, increasing permeability and leading to cell lysis [4].
- **DNA Damage:** Ultraviolet photons and reactive species induce DNA strand breaks, hindering

replication and transcription [5].

- **Protein Denaturation:** Electromagnetic fields and reactive species alter protein structures, impairing enzymatic functions [6].

The non-thermal nature of CAP allows for application on heat-sensitive tissues, making it suitable for intraoral procedures [7].

3. ANTIMICROBIAL EFFICACY AGAINST ENDODONTIC PATHOGENS

Recent findings further support the efficacy of antimicrobial activity of CAP, also referred to as non-thermal atmospheric pressure plasma (NTPP). Muniz *et al.* highlighted that both direct and indirect (plasma-activated liquids) applications of NTPP can effectively target key endodontic pathogens, including *E. faecalis* and *Candida albicans*, with maximum disinfection observed at exposure times exceeding 8 minutes. Importantly, the synergistic use of NTPP with conventional irrigants (e.g., chlorhexidine, NaOCl) resulted in superior disinfection outcomes compared to either treatment alone, while also potentially reducing the required plasma exposure time—an advantage in clinical settings [8].

3.1 *Enterococcus faecalis*

E. faecalis is a facultative anaerobe frequently isolated from persistent endodontic infections. Its ability to penetrate dentinal tubules and form resilient biofilms contributes to its resistance. Multiple studies have demonstrated CAP's effectiveness on *E. faecalis*.

- Li et al. reported complete eradication of *E. faecalis* biofilms after 12 minutes of CAP exposure, exceeding the effectiveness of calcium hydroxide and chlorhexidine treatments [1].
- A comprehensive review and meta-analysis encompassing 31 studies concluded that direct CAP application significantly reduces *E. faecalis* colony-forming units [7].

3.2 *Candida albicans*

C. albicans, a fungal pathogen, is implicated in secondary endodontic infections and exhibits resistance to conventional disinfectants. Kerlikowski et al. demonstrated that CAP monotherapy achieved the highest reduction in *C. albicans* load compared to sodium hypochlorite, chlorhexidine [2].

3.3 Broader Antimicrobial Applications

CAP has shown activity against a wide spectrum of oral pathogens including *Streptococcus mutans*, *Lactobacillus spp.*, *Pseudomonas aeruginosa*, and *Actinomyces naeslundii* [7,8]. CAP is effective in disrupting mature biofilms on dentin, resin surfaces, and even titanium implants, making it a powerful decontaminant in restorative and implant dentistry [9].

Moreover, CAP's antimicrobial effect is time-dependent, with longer exposures yielding greater microbial reductions. However, safe and effective exposure parameters must be optimized for different clinical applications.

4. EFFECTS ON DENTAL TISSUES AND ADHESION

4.1 Dentin Integrity

Preservation of dentin's mechanical properties is crucial during endodontic procedures. Studies indicate that CAP treatment does not have a negative impact on dentin hardness or surface morphology. Li et al. observed no significant changes in dentin microhardness or roughness post-CAP application, supporting its safety for dental tissues [1].

4.2 Adhesive Bonding

CAP has demonstrated the ability to improve adhesive bonding to dentin.. In a study by Wang et al., The application of CAP treatment enhanced the mechanical characteristics of the adhesive-dentin interface[3]. Similarly, application of helium CAP on caries-affected dentin increased immediate bond strength and slowed aging-related degradation [4].

4.3 CAP Devices

A range of CAP devices has been created and evaluated for use in dental applications, including:

- **Plasma Jet Devices:** These deliver focused CAP streams generated using inert gases (e.g., helium or argon). Common designs include dielectric barrier discharge (DBD) jets and needle-type applicators.
- **Plasma Brushes:** Designed to treat larger surfaces, such as dentin or resin interfaces, and often use argon plasma under low flow rates.
- **Handheld Plasma Guns:** Compact and portable, these devices are useful in intraoral environments and have shown effectiveness in disinfecting root canal.
- **Microwave-driven Plasmas:** Provide higher stability and lower temperature operation for biomedical use [6].

5. CLINICAL APPLICATIONS AND CONSIDERATIONS

5.1 Root Canal Disinfection

CAP's ability to penetrate complex canal anatomies and disrupt biofilms positions it as a valuable adjunct in root canal disinfection. Its efficacy against resistant pathogens like *E. faecalis* and *Candida albicans* suggests potential in improving treatment outcomes [1,2,8].

5.2 Bleaching of Non-Vital Teeth

CAP has been explored as a bleaching agent for non-vital teeth. A case report demonstrated successful bleaching using CAP without traditional agents, indicating its potential for aesthetic applications in endodontically treated teeth [10].

5.3 Implant Surface Decontamination

Beyond endodontics, CAP has shown promise in decontaminating dental implant surfaces. A comprehensive evaluation reached a conclusion that CAP effectively reduces bacterial loads on implant surfaces, combating biofilms and potentially preventing peri-implantitis [11].

5.4 Tissue Regeneration

Recent research has investigated CAP's potential in enhancing tissue regeneration by promoting angiogenesis and stem cell differentiation. CAP exposure has been found to upregulate markers associated with cell proliferation, matrix deposition and osteogenic differentiation [12]. These effects may be valuable in regenerative endodontic procedures (REPs), where CAP could be used to disinfect and biologically stimulate periapical tissues.

5.5 Indirect Plasma Applications

Besides direct exposure, CAP can be used indirectly through plasma-activated water (PAW). Research has demonstrated that PAW retains reactive species of oxygen and nitrogen (RONS) for extended periods, maintaining its antimicrobial capacity even after storage. Simoncelli et al. and Muniz et al. observed significant bacterial reduction using PAW, particularly in environments mimicking root canal conditions [8]. This approach offers a more flexible and potentially safer clinical application pathway.

6. Limitations and Future Directions

While in vitro and ex vivo studies underscore CAP's potential, clinical translation faces challenges:

- **Standardization:** Variability in CAP devices, gas compositions, exposure times, and application protocols necessitates standardization for consistent outcomes [7].
- **Clinical Trials:** Limited clinical data impede definitive conclusions on CAP's efficacy and safety in vivo. Rigorous clinical trials are essential to validate laboratory findings [8,12].
- **Regulatory Approvals:** CAP devices require regulatory approvals for clinical use, necessitating comprehensive safety and efficacy data [7].

Future studies ought to concentrate on enhancing the parameters of CAP. understanding its interactions with various dental materials, and conducting longitudinal studies to assess long-term outcomes. In addition, exploration into CAP-induced bioactivation of dental stem cells and their utilization in regenerative endodontics could open new avenues for biologically based therapies.

CONCLUSION

Cold atmospheric plasma represents a promising adjunct in endodontic therapy, offering effective antimicrobial action against resistant pathogens without compromising dental tissue integrity. Its potential applications extend to adhesive enhancement, tissue regeneration, bleaching and implant surface decontamination. However, further clinical research and standardization are imperative to fully integrate CAP into routine endodontic practice.

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RECOGNIZING AND MANAGING BODY DYSMORPHIC DISORDER IN ORTHODONTIC PRACTICE

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Abstract

Background:
Body Dysmorphic Disorder (BDD) is a complex psychiatric condition characterized by persistent and intrusive preoccupations with perceived physical defects, which are often minor or imperceptible to others. Given the aesthetic nature of orthodontic care, BDD is of particular relevance in dental settings, where patients may seek repeated or unnecessary treatments driven by distorted self-perception.

Objective:
This review aims to synthesize current evidence on the clinical presentation, diagnosis, and management of BDD within orthodontic practice. It highlights the unique challenges faced by orthodontists in identifying and appropriately addressing patients with undiagnosed BDD.

Methods:
A thorough review of the literature was conducted using key databases to identify studies related to BDD in dental and orthodontic populations. Diagnostic frameworks, behavioral patterns, screening strategies, and interdisciplinary management approaches were examined and summarized.

Findings:
BDD remains underdiagnosed in clinical settings, despite its relatively high prevalence among orthodontic patients. The condition often presents as excessive dissatisfaction with minor dental imperfections and is associated with poor treatment satisfaction, psychological distress, and increased risk of legal conflicts. Screening tools and structured history-taking can aid early recognition, while referral to mental health professionals is essential for definitive diagnosis and treatment, typically involving Cognitive Behavioural Therapy and SSRIs.

Conclusion:
Heightened awareness and systematic screening for BDD are critical in orthodontic practice. Integrating psychological assessment into routine care can improve patient outcomes, reduce clinician burden, and support ethical treatment planning.

Key words: Body Dysmorphic Disorder, Orthodontics, Psychological Screening, Review

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INTRODUCTION

Concerns about physical appearance are a natural part of being human. However, when such concerns become obsessive, centered around perceived—often non-existent—flaws, and significantly impair self-esteem and daily functioning, they may indicate a mental health condition known as Body Dysmorphic Disorder (BDD)[1]. Body Dysmorphic disorder comes under the obsessive-compulsive spectrum. More than a century ago, Italian psychiatrist Enrico Morselli was among the first to clinically characterize what is now referred to as Body Dysmorphic Disorder (BDD). He introduced the term *dysmorphophobia*, drawing from the word dysmorphia, which in Greek denotes a state of physical unattractiveness or deformity.

CLINICAL CHARACTERISTICS

Body Dysmorphic Disorder (BDD) is a psychiatric

condition marked by an intense and persistent dissatisfaction with one or more aspects of one's physical appearance. These perceived flaws are often not observable or are considered trivial by others, yet individuals with BDD experience profound distress and functional impairment in various aspects of life, including social interactions, work performance, and daily routines [2].

The *International Classification of Diseases* (ICD-11), issued by the World Health Organization, similarly describes BDD as a long-standing and intrusive concern about slight or imagined imperfections in appearance. Individuals with this condition often believe that others are paying excessive attention to, or judging them for, these perceived flaws. This often results in heightened self-awareness, avoidance of social situations, and substantial psychological distress [3].

A key diagnostic feature of BDD is the performance of repetitive behaviors or mental acts in response to appearance-related concerns. These behaviors may include repeatedly checking one's reflection, excessive grooming, picking at the skin, seeking constant reassurance, or mentally comparing one's looks to others. These rituals are typically difficult to control and contribute further to the individual's emotional burden and functional impairment [4].BDD shares many features with obsessive-compulsive disorder (OCD), particularly in terms of intrusive thoughts and compulsive behaviors, which is why it is classified within the obsessive-compulsive spectrum in the DSM-5. The condition tends to develop during adolescence and frequently becomes chronic without appropriate intervention. [5].

Individuals with Body Dysmorphic Disorder (BDD) often exhibit a disproportionate focus on the head and facial region, making these areas the most common sources of concern. This is particularly relevant in orthodontic settings, where patients may present with dissatisfaction related to features such as the nose, lips, jawline, teeth, and overall facial symmetry. Specific issues frequently cited include perceived irregularities like acne, scarring, asymmetry, or swelling—often minor or clinically insignificant in nature.

Aesthetic treatments, including teeth whitening, orthodontic braces, and jaw surgery, are commonly pursued by individuals with BDD in an effort to correct these perceived flaws[6]. Orthodontic complaints tend to center on minor tooth rotations, spacing, midline discrepancies, or concerns about tooth size. Even after receiving treatment, many individuals with Body Dysmorphic Disorder continue to feel unhappy with the results and often seek out multiple dental professionals in pursuit of further corrective procedures.

This pattern of repeated treatment-seeking behavior, despite objectively satisfactory results, poses a significant challenge for orthodontists. It can lead to emotional exhaustion for both the patient and the clinician, particularly when expectations remain unmet. Thus, incorporating a detailed evaluation of the patient's psychological state and motivational readiness should be considered an integral aspect of the initial orthodontic assessment. Evaluating the patient's expectations, emotional drivers, and previous treatment experiences can help practitioners identify signs of underlying psychological disorders, such as BDD. Incorporating mental health screening into routine case history-taking not only supports better clinical outcomes but also fosters more ethical, patient-centered care.

DIAGNOSTIC CRITERIA

Body Dysmorphic disorder still remains an underdiagnosed and inadequately treated mental disorder despite being common among the population. A recent study identified a 7.5% incidence rate of the condition among orthodontic patients, significantly higher than the 2.5% observed in the general population[7]. Prompt identification and accurate diagnosis are vital for the effective management and treatment of the disorder.

According to American Psychiatric Association (4th Edition)[8] Body Dysmorphic Disorder is identified by the following core clinical features:

- **Persistent Preoccupation with Appearance**: The individual exhibits a marked preoccupation with one or more perceived flaws or defects in physical appearance, which are either not observable or appear minimal to others. In some cases, there may be an exaggerated response to minor physical anomalies.
- **Functional Impairment:** The individual's persistent preoccupation with perceived flaws or concerns results in pronounced psychological distress and significantly hinders their ability to function effectively in various domains of life. This may manifest as difficulties in maintaining social relationships, reduced performance in academic or occupational settings, and interference with routine daily responsibilities and activities.
- **Exclusion of Other Disorders**: The appearance-related concern is not better explained by the diagnostic criteria of another mental health condition, such as an eating disorder, where concerns are more appropriately focused on body weight or shape.

Table 1
Polo (6) has developed a series of questionnaire which enables the clinician to assess a particular case and evaluate if a particular patient has symptoms of BDD.

SCREENING QUESTIONNAIRE FOR ORTHODONTISTS (By Polo):
The questions are:
how does the patient rate the severity of their orthodontic concern or defect?
How would the patient rate the amount of distress or worries produced by their orthodontic concern, defect, or "unattractive" appearance?
Does this (minor or perceived) defect cause significant distress either socially or related to family/work activities?
Why is orthodontic treatment sought?
Have previous evaluations concerning their orthodontic "defect" been performed?
Why are additional orthodontic evaluations
sought?
Have the expectations for this particular orthodontic procedure reasonable?
Are requests for other cosmetic procedures ever been obtained?
Have these other cosmetic procedures been performed? Are these frequent? –--How many? When?
Is there a history of dissatisfaction with previous cosmetic procedures? Are these multiple?
Does the patient report any history of psychiatric or psychological disturbances or any previous referrals for psychological/psychiatric evaluations?

BODY DYSMORPHIC DISORDER IN ORTHODONTIC SCENARIO

In dental and orthodontic practice, the condition presents a unique challenge. Patients with BDD often express extreme dissatisfaction with facial or dental features such as tooth alignment, spacing, jaw shape, or bite. Despite undergoing multiple evaluations or procedures, these individuals are rarely satisfied with treatment outcomes, leading to repeated consultations and significant frustration for both the patient and the clinician.

Given the aesthetic focus of orthodontic care, practitioners are likely to encounter patients with undiagnosed BDD. Understanding the psychological background of such individuals is critical. Incorporating questions related to self-image, prior cosmetic procedures, and emotional impact into routine patient assessments can aid early detection. When BDD is suspected, referral to a mental health professional is strongly recommended to ensure comprehensive care and avoid the risks associated with untreated psychological disorders.

Shukla et al. [8] recently reported that individuals most commonly sought orthodontic treatment for aesthetic reasons, with functional concerns being cited far less often. This makes it all the more essential for orthodontists to identify patients suffering from mental disorders like BDD from the general public. As Orthodontists, we should be aware of patients who are extraordinarily concerned with insignificant or negligible flaws like rotations, minor spacings, midline diastemas which are negligible and other minor imperfections. Patients seeking evaluations with several orthodontists or patients presenting multiple requests for orthodontic treatment even with repeated reassurances should raise suspicions of BDD.Thus the need for ruling out BDD as part of routine history taking rises. Adding a section on mental health to the routine case history format makes the evaluation easy as well as makes it systematic and a mandatory practice for every patient. Additional time for pertinent case history taking as well as addressing patients concern while discussing practicality and limitations of Orthodontic treatment in a particular case might be necessary and is often useful for the Orthodontist dealing with a patient with BDD.

It is important to note that patients who exhibits

characteristics of obsessive-compulsive disorder (OCD) might have BDD as manifestations of both conditions are similar [9]

The patient's chief complaint must be evaluated thoroughly and it should be determined if their complaints/defects are genuine or just a perceived defect. Enquiring about the same must be done tactfully so as to not offend the patient while reassuring the patient's concerns. Although performing a thorough diagnosis for BDD for every patient is mildly time consuming, it is imperative to remember that the consequences of penalties for preliminary screening misdiagnosis of BDD could be high and we may have to bear the brunt of this for many years. With the number of medicolegal cases on the rise, having a misdiagnosed mental health condition can potentially damage the reputation as well as create a huge psychological load on the treating clinician. A study conducted by Sarver et al. found that approximately 40% of surgeons had been subjected to either physical or legal threats from patients diagnosed with Body Dysmorphic Disorder (BDD). Thus, making a mental health history taking mandatory in all patients can potentially reduce the risk for inadvertently treating a BDD patient without proper counselling and the risks that follow the same.

TREATMENT FOR BODY DYSMORPHIC DISORDER

The average age of onset of this condition is 17 years of age [10] and the symptoms develop gradually. Thus, the importance of evaluation for the condition in adolescent patients is paramount and if condition is suspected, the patient is to be referred to a psychiatrist for definitive diagnosis and management of the condition treatment[11]. The treatment modalities consist of [12] a combination of Selective Serotonin Reuptake Inhibitors (SSRIs) and Cognitive behavioural therapy (CBT). CBTs consists of a regimen of psychotherapy sessions centered on addressing and altering dysfunctional behaviour patterns by responding via a combination of exposure, behavior therapy and response prevention which involves gradual exposure with fear-inducing situations while resisting the urge to compensate via safety seeking behaviours with the goal of developing better coping mechanisms thus improving the quality of life. SSRs used for treatment of this condition include fluoxetine [12], fluvoxamine, clomipramine and escitalopram and it is advised that patient should remain on medication for relatively long periods to avoid relapse.

It is important to remember that a person affected with BDD might concomitantly have other mental disorders like OCD, the orthodontist should not try to reach such a diagnosis alone and every attempt should be made to refer the patient to a well-qualified and competent psychiatrist .It is also essential to remember that diagnosis of psychiatric conditions is complex and thus accurate identification of a medical condition is vital to initiate appropriate treatment in a timely manner.

While orthodontists are not typically equipped with the training required to diagnose or manage psychological conditions such as Body Dysmorphic Disorder, it is essential that they remain vigilant for indicative signs and engage in appropriate collaboration with mental health professionals to facilitate comprehensive patient care.

CONCLUSION

Body Dysmorphic Disorder (BDD) is a mental health condition where individuals become excessively concerned with perceived flaws in their appearance—flaws that are often minor or invisible to others. This condition is particularly relevant in orthodontics, as many patients seek treatment to improve their facial aesthetics.

Although it is unrealistic for orthodontists to carry out comprehensive psychological assessments on every patient, being aware of the possibility of BDD is important. Including a few well-chosen questions during the initial consultation can help flag individuals who may have underlying psychological concerns that could affect their treatment journey.

Table 2
Simple screening questionnaire for clinicians to incorporate into their routine case history:

1. What are your main goals or expectations from this treatment?
2. How do you feel about your appearance overall?
3. Is there something specific about your appearance that you'd like to change?
4. Do you avoid certain situations or activities because of how you look?
5. Have you ever consulted anyone else about this concern?

FUTURE PROSPECTS AND SUGGESTIONS

In the context of orthodontics, future research into Body Dysmorphic Disorder (BDD) should focus on the complex relationship between perceived facial appearance and psychological well-being. Since orthodontic treatment often targets facial and dental aesthetics, patients with undiagnosed BDD may seek orthodontic care not for functional improvements, but to "fix" imagined flaws. This can lead to unrealistic expectations, dissatisfaction with outcomes, and a cycle of repeated or unnecessary treatments. Research is needed to develop screening tools that help orthodontists identify signs of BDD early and refer patients for appropriate mental health support. Studies could also explore the psychological impact of orthodontic treatment on individuals with body image concerns, examining whether treatment alleviates or exacerbates symptoms. Integrating psychological assessment into orthodontic consultations and investigating how social media influences patient expectations are also critical areas for future exploration. This approach promotes a more ethical, holistic model of care that prioritizes both physical and mental health.

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CISSUS QUANDRANGULARIS: NATURE'S WAY TO HEAL AND INTEGRATE IN ORAL IMPLANTOLOGY

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Abstract

Since ancient times, plants have been a natural source of treatments and therapies for human health. Among them, medicinal herbs have gained significant attention due to their widespread use and minimal side effects. Despite the availability of numerous synthetic compounds, many of the most effective drugs are still directly or indirectly derived from the plant kingdom. Plant extracts have demonstrated diverse pharmacological properties, and their cost-effective production allows for greater investment in the research and development of novel therapeutics, accelerating patient access to new treatments.Cissus quadrangularis Linn., a perennial climber widely used in traditional Indian medicine, has garnered attention for its multifaceted therapeutic benefits. This plant has been reported to possess significant bone fracture healing properties and antibacterial, antifungal, antioxidant, anthelmintic, antihemorrhoidal, and analgesic activities. Rich in carotenoids, triterpenoids, and ascorbic acid, Cissus quadrangularis has shown promising medical potential, including gastroprotective effects when combined with NSAID therapy and benefits in lipid metabolism and oxidative stress regulation.This review highlights its bone healing and pharmacological properties, emphasizing its role in osseointegration and overall health.

Keywords: cissus quandrangularis, bone healing , osseointegration

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INTRODUCTION AND BACKGROUND

Cissus quadrangularis is an indigenous medicinal plant seen in India. The plant is known as "Har-sankar" in Hindi and "Asthisanghara" in Sanskrit. In old practice the use of this plant was to promote fracture healing process. The plant contains a high amount of Vitamin C, carotene A, anabolic steroidal substance and calcium. Cissus quadraangularis is rich in Vitamin C, carotene A, anabolic steroidal substance, calcium. This may increase the osteoblastic activity to help in repair the fracture bones. It can be used in post implant insertion to accelerate the osteointegration. Dental implants are inert, alloplastic materials embedded in the maxilla and/or mandible for the management of tooth loss and to aid replacement of lost orofacial structures. The implants have become an important therapeutic modality in the last decade, mainly after the works developed by Brånemark (1960s), in which the direct contact between the bone functional tissues and the biomaterial titanium was termed osseointegration. Implant Stability and Success mainly depends on osteointegration. The great majority of clinicians and patients are interested in shortening the treatment time between tooth extraction and implant placement[6].

CLASSIFICATION:

Kingdom	:	Plantae
Division	:	Magnoliophyta
Class	:	Magnoliopsida
Order	:	Vitales
Family	:	Vitaceae
Genus	:	Cissus
Species	:	*quadrangularis*

Fig 1: *Cissus quadrangularis* Linn.

Fig 2: Stems and Leaves of *Cissus quadrangularis* Plant

BIOACTIVE COMPONENTS OF CISSUS QUADRANGULARIS

The major constituents are ascorbic acid, carotene A, ketosteroid, triterpenoids, unsymmetric tetracyclic triterpenoids along with β-sitosterol, β-amyrin, and β-amyrone. In addition, it also contains flavonoids, phytosterols, resveratrol, piceatannol, pallidol, parthenocissine, quadragularins and water-soluble glycosides. The unique chemical constituents of CQ are - novel flavonoids and indanes, as well as phytosterols and keto-steroids that have shown promise as powerful and efficient antioxidants .These substances improve healing by releasing Transforming Growth Factor(TGF).In addition to the bioactive phyto components it also contains high amount of vitamin C, vitamin A, anabolic steroidal substances, and calcium. The steroidal substances showed marked influence on early. regeneration of all connective tissue of mesenchymal origin, and thereby, improve bone formation and healing.It is also a source of minerals including potassium calcium, zinc, sodium, iron, lead, cadmium, copper and magnesium. The stem extracts contain rich amounts of calcium and phosphorus.[1]

PLANT EXTRACTS

The plant parts get homogenized or macerated with a solvent like alcohol or water. The extraction mode depends on the texture and water content of the plant material. A water-immiscible solvent such as petroleum ether is used for the separation of alkaloids and quinines. The extraction is performed by repeated maceration with agitation percolation or by continuous extraction by Soxhlet extraction. The ethanolic extract showed osteogenic and antibacterial activity. The air-dried powdered whole plant of was extracted with solvents such as n-hexane, chloroform, ethyl acetate, ethanol, and methanol using the Soxhlet apparatus.

Aqueous extracts obtained by maceration were dried and dissolved in water. The dissolution was facilitated by a sufficient quantity of dimethyl sulfoxide. The principal active constituents of the plant are saponins, phytosterols, and polar phenolic compounds, so extracted best in the solvent of the highest polarity along with other polar constituents.[9]

Without being toxic, researchers found that a Cissus ethanolic extract promoted the differentiation, growth, and mineralization of human osteoblast-like SaOS-2 cells[12]

Flavonoids have been shown to mimic the effects of CAMP by inhibiting CAMP phosphodiesterase. Due to the abundance of flavonoids in C. quadrangularis, there may have been an increase in cAMP levels, which may have encouraged the expression of IGF 1 mRNA and protein levels. The phytoestrogens in C. quadrangularis may have behaved similarly to estradiol in boosting IGF expression, explaining the increase in IG and I expression after treatment with the plant.[10]

Using dual energy-emission X-ray analysis and histology, this Cissus formulation (75mg/kg and 100mg/kg) indicated substantial improvements in bone density, thickness, and toughness.

In clinical trials, based on radiological and clinical observations, it was found that C. quadrangularis will cause considerable reduction in the healing time of fractures. Radiologically one of study suggested an early callus formation as well as clinical pain, tenderness, and swelling were significantly absent in Cissus group. It was observed that C. quadrangularis neutralizes the antianabolic effect of steroids such as cortisone in healing of fractures.

Inhibition of tissue regeneration and repair and retarding formation of the specific skeletal are antianabolic effects of cortisone. This will stimulate the cells of mesenchymal origin, namely the fibroblasts, the chondroblasts, and the osteoblasts by C. quadrangularis. These cells have greater impact on osteoblastic proliferation than other cellular responses. It causes less amount of tissue reaction in the fractured region, which leads to optimum decalcification in the early stage with minimum of callus formation.Therefore, deposition of calcium is just enough to join two broken segments of bone, and that is why its remodeling takes much less time.Cissus is also shown to cause early gain in the tensile strength of fractured bones of its normal strength at the end of

6 weeks. C. quadrangularis builds up the skeletal of the fractured bone, namely its mucopolysaccharides, collagen, phosphorus, calcium, and others.
Mucopolysaccharides supplies raw materials for repair. Rapid the utilization of these raw materials earlier will be completion of healing process.

ROLE IN PERIODONTAL HEALTH

Periodontal diseases are a set of inflammatory illnesses that affect the teeth's supporting components.Luteolin, one of the components included in Cissus quadrangularis (CQ), along with flavonoids decreases the inflammatory process by inhibiting lipoxygenase. Additionally, it successfully upregulates HO-1 while downregulating iNOS and Tumor Necrosis
Factor.Hence, CQ extracts are promising candidates in the management of periodontal diseases.[2]

Maxillofacial fractures

As already discussed, Cissus also includes vitamins A and C, both of which are useful for the production of collagen. As a result, it accelerates the speedy formation of the chemical composition of the bone, thereby hastening the bone repair process.According to Brahmkshatriya H. et al.[3], C. quadrangularis accelerated the healing of fractured jaw bones and helped to reduce pain and edema. [2]

Dental implants

Dental implants have transformed restorative dentistry by providing an effective way to replace missing teeth. These devices made of titanium or titanium alloy are put into the jawbone to act as simulated tooth roots and support artificial crowns. Despite their high success rates, issues including peri-implantitis and delayed osseointegration can shorten the lifespan of implants.It has been studied whether Cissus extracts can improve osseointegration.[2] According to studies, certain phytochemicals found in Cissus, such as quercetin, may raise bone mineral density, decrease osteoclastogenic marker expression, and stimulate osteoblast activity. Its ethanolic extracts have been demonstrated to activate osteoprotegerin (OPG) and decrease the production of receptor activators of nuclear factor ligand (RANKL).[5] These factors can hasten dental implant integration with host bone.

CONCLUSION

Currently, no regenerative material has a predictable regenerative potential. Alternative and herbal therapies are emerging as modern medical choices due to their minimal or no side effects, efficiency, low cost, bioavailability, and patient compliance. However, the complete mechanism of action and efficacy of the phytoactive nutrients in Cissus quadrangularis (CQ) are still being unraveled.
It is well known for its osteogenic potential and has been used in bone regeneration for
dentoalveolar defects and maxillomandibular fractures. Extracts of Cissus have been found to be exceedingly safe, with no reported side effects at commonly used doses. However, its
application in prosthodontics and implantology is still in its early stages.

In vitro and in vivo studies have shown promising results, demonstrating its effectiveness as a bioactive compound for bone regeneration. The specific constituents responsible for its action are yet to be fully explored. More in vitro, in vivo, and animal studies are required to bridge
the existing knowledge gaps.

In the near future, It holds potential as an effective adjunct to disease management, and an organic, biodegradable, and eco-friendly scaffold for bone healing and osseointegration

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BioRoot INLAY: A COMPREHENSIVE REVIEW

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Abstract

The management of immature teeth with open apices remains a significant challenge in endodontics due to anatomical complexities, structural fragility, and difficulty in achieving a hermetic seal. Traditional apexification techniques, while effective, are limited by prolonged treatment duration and potential adverse effects on root strength. The BioRoot Inlay technique offers an innovative approach by utilizing custom-fabricated, biocompatible obturation materials that conform precisely to the internal anatomy of the root canal. This review article provides an in-depth analysis of the BioRoot Inlay method, including historical context, material science, biological mechanisms, step-by-step clinical procedures, advantages, limitations, indications, contraindications, clinical evidence, and future research directions.

Keywords: BioRoot inlay, open apex, bioceramics, custom obturation, apical seal, dentine boding

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1. INTRODUCTION

The successful endodontic treatment for teeth with open apices—commonly observed in immature teeth affected by trauma, infection, or congenital abnormalities—requires overcoming anatomical and biomechanical challenges. Open apices lack an apical constriction, complicating containment of obturating materials and increasing the risk of extrusion[1]. Moreover, thin radicular walls render these teeth susceptible to fracture under loads [2]. The BioRoot Inlay technique addresses both obturation and reinforcement by using a custom-fabricated, bioactive inlay that conforms precisely to the canal anatomy and promotes periapical healing[3,4].

2. HISTORICAL PERSPECTIVE AND NEED FOR INNOVATION

2.1 Calcium Hydroxide Apexification

First described by Frank in the 1960s. As per his studies, calcium hydroxide induced apical barrier formation in 6–24 months but weakened dentin by collagen degradation with long-term use[5].

2.2 Mineral Trioxide Aggregate (MTA) Plug Technique

Introduced by Torabinejad and Chivian in 1999, MTA formed an apical barrier in one or two visits and demonstrated excellent biocompatibility but showed prolonged setting time and handling challenges[6,7].

2.3 Regenerative Endodontic Procedures (REPs)

REPs aimed to restore pulp vitality and continue root maturation but showed inconsistent outcomes and required strict case selection and technique sensitivity[8,9].

2.4 Development of BioRoot Inlay

BioRoot Inlay emerged as a single-visit, biologically sound alternative, providing immediate obturation and reinforcement while leveraging the bioactivity of

calcium silicate cements[4,10].

3. MATERIALS USED IN BIOROOT INLAY FABRICATION

3.1 Biodentine

Composition: Tricalcium silicate, calcium carbonate, zirconium oxide.
Setting Time: 10–12 minutes.
Properties: High compressive strength, minimal shrinkage, bioactivity through hydroxyapatite formation and dentin-like mechanical behaviour[11,12].

3.2 Mineral Trioxide Aggregate

Composition: Tricalcium silicate, dicalcium silicate, bismuth oxide.
Advantages: Superior sealing ability, biocompatibility and bacteriostatic action.
Limitations: Extended setting time (3–4 hours) and showed potential discoloration[6,7].

3.3 Bioceramic Sealers

Bioceramic sealers chemically bond to dentin, flow into micro-irregularities, maintain high pH for antimicrobial effect and support periapical healing[13].

4. CLINICAL TECHNIQUE: STEP-BY-STEP PROTOCOL

1. Preoperative Assessment

Radiographic and clinical evaluation of tooth anatomy, vitality, and apical morphology[14].

2. Access and Canal Preparation

Conservative access, chemomechanical debridement with rotary files, irrigation using 2.5–5.25% NaOCl and 17% EDTA to remove smear layer[15].

3. Canal Impression

Use of addition silicone or PVS impression material with a lubricated master file to capture canal topography[4].

4. Inlay Fabrication

Fill silicone impression with mixed Biodentine or MTA; after setting, trim and contour the inlay to fit the canal[16].

5. Trial Insertion

Radiographic confirmation of inlay fit and working length[4].

6. Sealer Application

Apply bioceramic sealer within the canal and seat the inlay to full working length using gentle pressure[17].

7. Final Restoration

Seal the coronal third with gutta-percha or composite resin, followed by a permanent restoration to prevent microleakage[18].

5. BIOLOGICAL PRINCIPLES AND HEALING RESPONSE

BioRoot Inlays leverage calcium silicate bioactivity to:
Create an alkaline environment by sustained Ca release, producing antimicrobial conditions[11].
Stimulate hard tissue formation by promoting cementoblastic and osteoblastic activity for apex closure[19].
Drive biomineralization, forming hydroxyapatite-like layers that enhance dentin bonding[12].
Improve sealing ability, as slight material expansion occurs during hydration, thus enhancing marginal adaptation[13].

6. ADVANTAGES

- Single-visit obturation and reinforcement
- Customized anatomical fit
- Enhanced fracture resistance
- Effective apical sealing with reduced extrusion risk
- Compatibility with regenerative protocols[4,16,19].

7. LIMITATIONS

- Technique sensitivity and learning curve
- Chairside fabrication time
- Potential dimensional changes during setting
- Higher material cost and limited standardized kits
- Need for long-term clinical data
- Challenges in curved or calcified canals[9,10].

8. INDICATIONS

- Immature teeth with open apices
- Blunderbuss canals
- Thin radicular walls requiring reinforcement
- Failed or contraindicated REPs
- Cases demanding single-visit endodontics[4,12].

9. CONTRAINDICATIONS

- Severely curved or calcified canals
- Acute systemic infections
- Uncooperative patients
- Lack of operator expertise
- Inaccessible apical anatomy[9].

10. CLINICAL EVIDENCE

1. Rosaline et al. (2018) reported success in 5 cases of immature anterior teeth treated with Biodentine inlays, demonstrating apical closure and periapical healing over 12–18 months[4].

2. Kottoor et al. (2019) observed 100% healing in 20 maxillary incisors with open apices treated via Biodentine inlays over 24 months[5].

3. Patel & Duggal (2021) described a paediatric case achieving symptom resolution and bone regeneration within 3 months using a custom Biodentine inlay[12].

4. Nirupama et al. (2022) found Biodentine inlays superior to MTA plugs in marginal sealing and fracture resistance in vitro[9].

5. Sharma et al. (2023) demonstrated higher push-out bond strength of BioRoot Inlay compared to MTA apexification[10].

6. Shin et al. (2025) showed that indirect ultrasonic activation of premixed calcium silicate cement improved the obturation quality in vitro[11].

11. FUTURE DIRECTIONS AND RESEARCH NEEDS

- Integration of CAD/CAM and 3D-printed inlay systems
- Randomized controlled trials comparing BioRoot Inlay with traditional methods
- Finite element analysis for stress distribution in restored teeth
- Long-term cohort studies evaluating clinical success and survival rates
- Development of standardized kits and protocols[20.]

12. CONCLUSION

The BioRoot Inlay technique represents an innovative approach for managing immature teeth with open apices by combining immediate obturation, bioactivity, and structural reinforcement. While early clinical and laboratory data are encouraging, robust long-term and randomized studies are needed to validate its routine application in endodontic practice.

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The journal of St. Gregorios Dental College invites contributions in any aspect of dental science in the form of original research, case reports and reviews. Manuscripts must be prepared in accordance with "Uniform requirements for Manuscripts submitted to Biomedical Journal" developed by International Committee of Medical Journal Editors (October 2008)

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