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Review Article

Complex Tooth Extraction: An Overview

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Abstract:

Tooth extraction is a common dental procedure, but complex cases present significant challenges due to anatomical and pathological variations. Factors such as root dilaceration, fusion, gemination, hypercementosis, dense cortical bone, and ankylosis can complicate extraction, increasing the risk of root fractures, excessive bleeding, infection, and paresthesia. Proper preoperative assessment, including cone-beam computed tomography (CBCT), is crucial for identifying these complexities and planning appropriate surgical techniques. Advances in minimally invasive approaches, such as piezosurgery and periotomes, have improved outcomes by reducing trauma and enhancing healing. This literature review synthesizes documented cases of complex extractions, highlighting the challenges encountered and the effective management strategies employed. By integrating current evidence and surgical advancements, this review aims to enhance clinical decision-making, improve patient outcomes, and minimize complications in complex tooth extractions.

Keywords: Surgical extraction ,Tooth Extraction, Dental anomalies, Complications

Introduction

Tooth extraction is one of the most frequently performed procedures in dentistry, with studies estimating that approximately 10–15% of all dental visits involve some form of tooth removal[1]. Indications for extraction include severe caries, periodontitis, dental trauma, and orthodontic or prosthodontic considerations[2]. While routine extractions are generally straightforward, certain anatomical and pathological conditions can complicate the procedure, leading to increased risk of complications such as root fractures, excessive bleeding, infection, and paresthesia[3].

One of the primary challenges in complex extractions is the presence of abnormal root morphology, including root dilaceration, fusion, or gemination, which can significantly hinder conventional extraction techniques[4].

Additionally, hypercementosis, characterized by excessive cementum deposition on the root surface, and conditions like dense cortical bone or ankylosis further complicate the procedure by increasing resistance during extraction[5]. Failure to properly assess these factors preoperatively can lead to procedural failures and postoperative complications, emphasizing the need for meticulous surgical planning and technique selection.

Several studies highlight the importance of a thorough understanding of dental and

maxillofacial anatomy, combined with advanced surgical skills, in successfully managing complex extractions[6]. Cone-beam computed tomography (CBCT) has become an invaluable tool in preoperative planning, allowing for precise visualization of root configurations, bone density, and proximity to vital structures such as the inferior alveolar nerve[7]. Moreover, minimally invasive techniques, including piezosurgery and the use of periotomes, have been shown to reduce trauma to surrounding tissues and improve healing outcomes[8].

This literature review aims to systematically compile and analyze documented cases of complex tooth extractions, focusing on the various challenges encountered and the effective management techniques employed. By synthesizing current evidence and surgical advancements, this review seeks to enhance clinical decision-making, improve patient outcomes, and reduce the incidence of complications associated with complex extractions.

Complex Tooth Extractions

Abnormal Shape and Number of Tooth Roots

Root dilaceration is a complex anatomical anomaly that poses significant challenges during tooth extraction. It is defined by a sharp angular deviation between the long axis of the crown and the affected root (figure 1)[9], which complicates tooth extraction and increases the risk of root fracture. Due to the disruption of the usual linear relationship between the dilacerated crown and the root, impaction often complicates. The position of the curvature or bend in the root can make tooth movement difficult and increase the risk of complications, including root resorption, bone fenestration, and cortical plate perforation[10].

The surgical extraction of a dilacerated tooth typically involves the elevation of a mucoperiosteal flap through a sulcular labial releasing incision to expose the alveolar bone and the affected tooth. The alveolar bone surrounding the tooth crown is selectively removed to create adequate space for controlled tooth elevation and extraction. If the crown and root form an acute angle, sectioning of the tooth may be necessary to facilitate extraction. Following tooth removal, the socket is irrigated with a normal saline solution, and the flap is sutured to promote healing[11]. In cases of severe dilaceration, the high risk of root fracture necessitates a multidisciplinary approach to ensure optimal management and minimize complications[12].

In certain cases, orthodontic traction can be utilized to guide a dilacerated tooth into occlusion. This approach is more feasible when the dilacerated crown is positioned palatally relative to its root, the angle between the root and crown axis is either perpendicular or obtuse, and the crown is located closer to the alveolar ridge. However, several limitations must be considered when opting for orthodontic traction, including prolonged treatment duration, the risk of root perforation, and potential tooth necrosis. Careful case selection and comprehensive treatment planning are essential to achieving successful outcomes while minimizing complications[11].

Other developmental anomalies, such as fusion (the merging of two tooth buds into a single root with two root canals) or gemination (the partial development of two crowns from a single root), can also complicate the extraction process[13].

In cases of fusion, the presence of multiple root canals and irregular root structures makes extraction challenging (figure 2)[9]. For example, fused teeth may have a shared pulp chamber or a combination of fused and separate canals, necessitating detailed radiographic evaluation, such as cone-beam computed tomography (CBCT), to effectively plan the procedure. Without such imaging, there is a high risk of incomplete extraction or damage to surrounding structures[14].

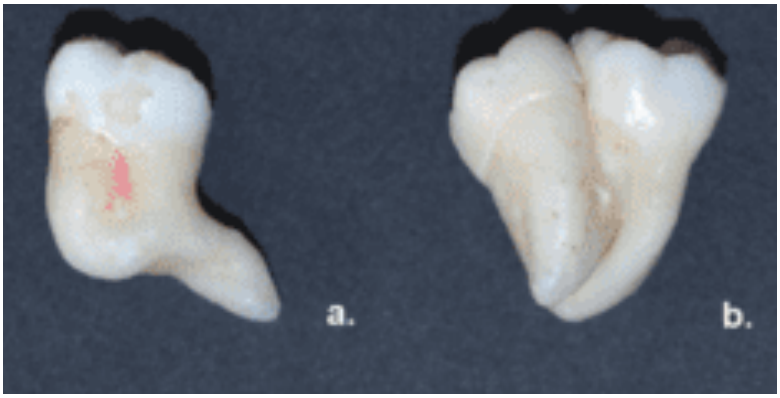


Figure 1: Developmental altelerations of tooth morphology. (a. Root dilaceration; b. tooth fusion)[9]

Gemination presents a unique set of challenges due to its abnormal crown and root morphology (figure 2)[15]. The enlarged crown can make forceps placement difficult during extraction, while the single yet irregularly shaped root increases the likelihood of fracture. Additionally, geminated teeth often exhibit weakened structural integrity due to incomplete division of the tooth germ, further complicating the extraction process[16].

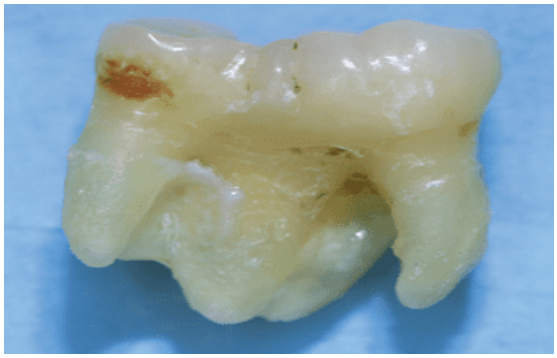


Figure 2: Tooth gemination[15].

Both fusion and gemination can lead to complications such as root fractures, excessive bleeding, or damage to adjacent teeth during extraction. Proper diagnostic imaging and careful surgical planning are essential in managing these anomalies to minimize risks and ensure successful outcomes[17].

The initial assessment involves clinical and radiographic examination, with cone-beam computed tomography (CBCT) recommended for a detailed evaluation of the root canal system and dental structures. CBCT is particularly valuable for assessing the potentially complex root canal system, which can vary significantly between fused and bifurcated teeth. This imaging modality enables specialists to accurately navigate the tooth structure, especially in cases of endodontic pathology or elective endodontic treatment that may be required due to pulp exposure during the surgical sectioning of a bifid crown. By providing precise anatomical details, CBCT aids in treatment planning and helps minimize complications during both endodontic and surgical procedures[18].

The extraction technique depends on the specific characteristics of fusion or gemination. A two-step separation technique can be employed, which involves the surgical exposure of the root and initial separation followed by closure to allow connective tissue growth. Once connective tissue healing is achieved, the labial flap is re-elevated, and the crown is separated

using a high-speed handpiece. The sectioned tooth can then be extracted using extraction forceps[19].

Alternatively, a single-step separation and extraction technique may be performed, which results in exposed cementum and dentin surfaces, followed by epithelial ingrowth into the socket. The choice of technique should be based on the complexity of the case, with careful consideration given to minimizing trauma and optimizing healing outcomes[19].

Hypercementosis

In certain conditions, the excessive production of cellular cementum surpasses normal thresholds, altering the natural root morphology. When this growth exceeds physiological limits, impairing the root's normal function, it results in a condition known as hypercementosis[20].

Hypercementosis often leads to an enlarged, bulbous root, particularly in the apical third of the tooth. This abnormal root morphology can increase the tooth's retention within the socket, making extraction more challenging. The excessive cementum deposition may also contribute to a stronger attachment to the surrounding bone, necessitating advanced extraction techniques to minimize complications[21] (figure 3)[21]

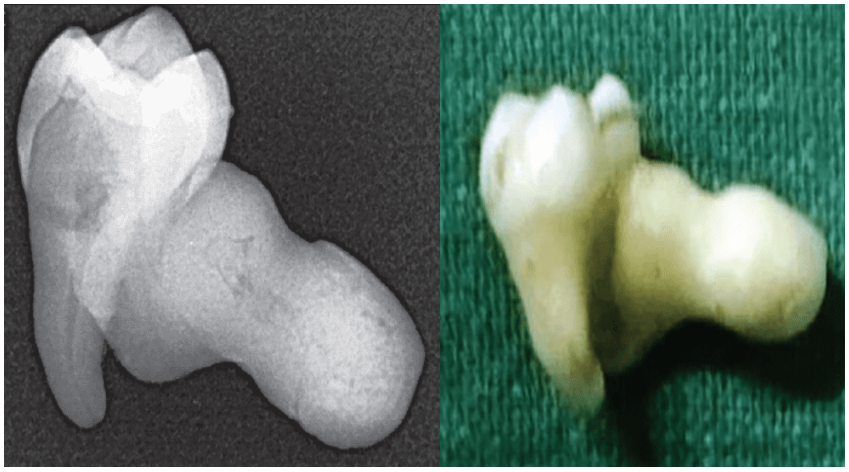


Figure 3: Hypercementosis tooth[21]

One of the primary complications associated with hypercementosis is increased resistance during extraction due to the enlarged root structure. Excessive cementum deposition can form irregular protrusions or nodules that interlock with the surrounding alveolar bone, making tooth mobilization more difficult[21,22].

Hypercementosis also increases the risk of root fracture during extraction. The thickened cementum creates stress points along the root surface when force is applied, particularly in cases where the cementum has fused with an adjacent tooth—a condition known as acquired concrescence. In such scenarios, surgical sectioning of the tooth or adjacent bone may be necessary to prevent damage to surrounding structures[21,23].

Another potential complication is pulpal necrosis, which can occur due to the obstruction of blood supply through the apical foramen caused by excessive cementum deposition[24].

Preoperative radiographic evaluation, such as cone-beam computed tomography (CBCT), is essential for identifying these morphological changes and planning potential surgical interventions[21,22].

A surgical approach is often required when extracting teeth affected by hypercementosis. Elevation of a mucoperiosteal flap may be necessary to provide adequate access to the tooth and

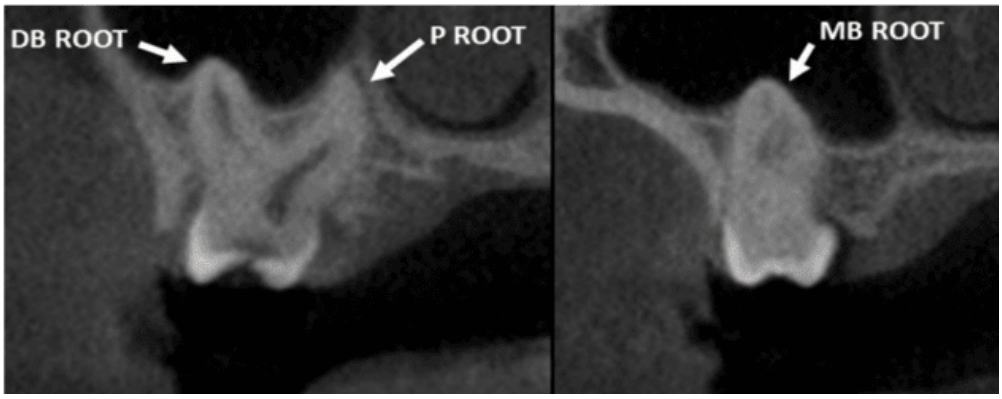
surrounding bone. In cases of extensive hypercementosis, tooth sectioning may be required to facilitate extraction. Sectioning helps reduce resistance and allows for easier manipulation of tooth fragments, ultimately leading to a more controlled extraction process[22,23].

Additionally, the use of specialized instruments such as periotomes and root elevators can aid in severing the periodontal ligament and facilitating tooth displacement. A study has highlighted that careful application of these instruments minimizes trauma to surrounding tissues and reduces the risk of complications, such as root fractures or damage to adjacent teeth[22,23].

Post-extraction management is also crucial; socket preservation techniques can be employed to maintain alveolar bone integrity and promote optimal healing. Proper surgical planning and atraumatic extraction techniques are essential to improving clinical outcomes and minimizing complications associated with hypercementosis[22,23].

Ankylosis and Bone Sclerosis

Ankylosis and bone sclerosis are significant complications in tooth extraction due to their impact on the structural and functional relationship between the tooth and the surrounding alveolar bone. Ankylosis is defined as the pathological fusion of the tooth root to the alveolar bone, resulting in the loss of the periodontal ligament space (figure 4)[25]. This fusion prevents the normal physiological movement of the tooth, causing it to be rigidly attached to the bone. Bone sclerosis, characterized by increased bone density and reduced elasticity, further exacerbates the difficulty of extraction by creating a more rigid and brittle bone environment. These conditions require advanced surgical techniques to ensure safe and effective tooth removal while minimizing damage to the surrounding structures[26].



(A) (B)

Figure 4. CBCT coronal plane showing absence of periodontal ligament space in the roots. (A) Distobucal and palatal root, (B) Mesiobuccal root[25]

Ankylosed teeth present unique challenges during extraction due to the absence of the periodontal ligament, which typically acts as a cushion and facilitates tooth movement. Without this ligament, standard luxation techniques are often ineffective, as there is no flexible interface to allow tooth mobility[27].

A study highlighted that ankylosis is commonly associated with trauma, such as avulsed or intruded teeth, where damage to the periodontal ligament enables bone cells to invade and fuse with the root surface. This condition often necessitates a surgical approach, including tooth sectioning or removal of surrounding bone, which increases both the complexity and duration of the procedure. Proper preoperative assessment and surgical planning are essential to manage ankylosed teeth

effectively and minimize complications[27].
sclerosis further complicates the extraction of ankylosed teeth by creating a denser and less vascularized bone matrix around the affected tooth. This increased bone density requires greater force during extraction, thereby elevating the risk of complications such as root fractures or damage to adjacent anatomical structures. Additionally, sclerotic bone is less responsive to remodeling after surgical intervention, potentially leading to delayed healing or alveolar defects [28,29].

Complications resulting from ankylosis and bone sclerosis include iatrogenic jaw fractures, particularly in cases where excessive force is applied during extraction. For instance, mandibular fractures have been reported in cases where ankylosed teeth were extracted without adequate preoperative planning[28].

Additionally, aggressive extraction techniques can cause damage to surrounding soft tissues or adjacent teeth, further complicating postoperative recovery. These risks highlight the importance of careful surgical planning, proper imaging assessments, and controlled extraction techniques to minimize trauma and improve clinical outcomes[28].

A 2023 study emphasized that preoperative imaging, such as cone-beam computed tomography (CBCT), is crucial for identifying ankylosis and sclerotic bone changes to develop an appropriate surgical plan. Proper radiographic assessment enables clinicians to anticipate challenges and implement strategies to minimize intraoperative risks and optimize patient outcomes[28,29].

Once the diagnosis is confirmed, surgical intervention is often required. A common technique involves raising a mucoperiosteal flap to gain access to the ankylosed tooth. This approach allows clinicians to better visualize the tooth and surrounding bone, facilitating a more controlled extraction process[26].

In severe cases of ankylosis, tooth sectioning may be necessary to facilitate removal. Sectioning reduces resistance during extraction and allows for easier manipulation of tooth fragments, thereby minimizing trauma to adjacent tissues. This method improves surgical efficiency and helps prevent complications associated with excessive force application[26].

Another effective method for managing ankylosed teeth is the decoronation technique. This procedure involves the removal of the tooth crown at the cementoenamel junction while leaving the root intact within the alveolar bone. The primary objective of decoronation is to preserve the height and width of the alveolar bone while maintaining potential future restorative options. Studies have shown that this technique can yield favorable outcomes in terms of bone preservation and aesthetic considerations, particularly in growing patients who may experience changes in their dental arch over time. By maintaining alveolar integrity, decoronation provides a viable long-term solution for cases where immediate extraction may lead to significant bone loss[30].

Post-extraction management is crucial to ensuring optimal healing and preventing complications. Following extraction or decoronation, clinicians should consider socket preservation techniques, such as bone grafting, to maintain alveolar bone integrity. These approaches help prevent bone resorption and facilitate future restorative procedures[30].

Additionally, regular follow-up appointments are essential to monitor healing progress and address any potential complications that may arise during the recovery process. By implementing these strategies, dental professionals can effectively manage ankylosed teeth while

minimizing risks and improving successful patient outcomes[30].

Fragile Teeth Post-Endodontic Treatment

Endodontic treatment, while effective in managing pulpal and periapical diseases, often results in a significant reduction in tooth strength, making treated teeth more susceptible to fractures. This fragility arises from multiple factors, including extensive loss of tooth structure during access cavity preparation, radicular shaping, and the effects of intracanal medicaments (figure 5)[31]. The loss of dentin, particularly in the pericervical region, weakens the tooth and increases its vulnerability to fracture during extraction[32,33].

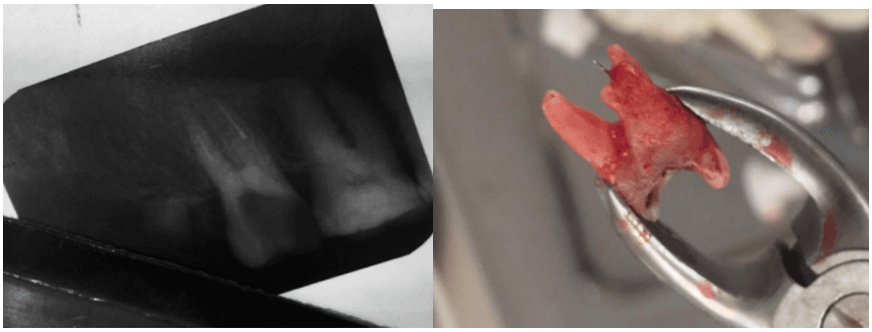


Figure 5: Extracted Tooth Post-Endodontic Treatment[31]

A 2024 study highlighted that teeth with prior endodontic treatment are more likely to experience fractures under extraction forces due to their reduced structural integrity and altered biomechanical properties. Additionally, the absence of vital pulp contributes to this fragility, as the lack of dentin hydration reduces its elasticity and resistance to mechanical stress[33].

One of the primary challenges in extracting fragile teeth is the increased risk of root fractures. These fractures can complicate the procedure by leaving retained root fragments embedded in the alveolar bone, often necessitating additional surgical intervention. A narrative review on post-extraction complications highlights that teeth with vertical root fractures or extensive restorative work are significantly more difficult to extract due to their weakened structure and irregular fracture patterns[33].

Furthermore, the presence of previous restorative materials, such as posts or crowns, can interfere with the application of extraction forces and increase the complexity of the procedure. These factors necessitate careful preoperative planning and the use of specialized techniques to minimize complications during extraction[33].

Another complication associated with the extraction of fragile teeth is the potential damage to surrounding tissues. Excessive force applied to remove brittle roots can lead to alveolar bone fractures or soft tissue trauma. A study on post-extraction complications emphasizes that improper handling of fragile teeth significantly increases the risk of iatrogenic injuries, necessitating cautious application of extraction forces and, in some cases, a surgical approach to minimize damage[33].

Similarly, a piezotome utilizes ultrasonic micro-vibrations to make precise bone cuts without causing damage to adjacent soft tissues. This approach has been shown to reduce postoperative complications, such as pain and bone resorption, making it an ideal choice for the extraction of fragile teeth. In cases where significant coronal structure is missing, tooth sectioning into smaller fragments may be necessary. This technique involves strategic division of the tooth using a high-speed handpiece to

facilitate the removal of individual segments. Research has demonstrated that sectioning reduces resistance during extraction and lowers the risk of root fracture, particularly in teeth with complex root morphology or extensive restorative work[34].

Additionally, preoperative imaging, such as cone-beam computed tomography (CBCT), is essential for assessing root anatomy and effectively planning the extraction procedure. CBCT provides detailed three-dimensional visualization, allowing clinicians to anticipate challenges and optimize surgical strategies, thereby improving patient outcomes[34].

Post-extraction management is equally crucial in ensuring optimal healing. Socket preservation techniques, such as bone grafting or the use of alveolar bone preservation materials, can help maintain alveolar bone volume and prepare the site for future prosthetic restoration. Atraumatic extraction methods not only improve immediate outcomes but also reduce long-term complications associated with alveolar bone resorption. By preserving the structural integrity of the extraction site, these techniques contribute to better functional and esthetic rehabilitation, enhancing the overall success of restorative treatments[34].

Conclusions

Tooth extraction may present significant challenges due to various factors. Abnormal root morphology and variations in root number, including dilaceration, fusion, and gemination, complicate the extraction process and increase the risk of complications such as root fracture. Hypercementosis, characterized by excessive cementum deposition leading to root enlargement, further increases resistance and fracture risk. Ankylosis and bone sclerosis result in the fusion of the tooth with the alveolar bone and increased bone density, making tooth mobilization more difficult and often requiring more invasive techniques. Additionally, endodontically treated teeth are more prone to fractures due to their compromised structural integrity. Therefore, comprehensive preoperative evaluation using imaging modalities such as cone-beam computed tomography (CBCT), meticulous treatment planning, and mastery of appropriate surgical techniques are essential to minimize complications and achieve successful tooth extractions.

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