Dental Elevator Fracture During Exodontia: A Scoping Review with Risk Stratification and Clinical Management Framework

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ABSTRACT

Background: Fracture of dental elevators during exodontia is a rare but clinically significant intraoperative complication that may result in retained foreign bodies, infection, delayed healing, and medico-legal implications. The available evidence remains fragmented and predominantly limited to case reports and small case series [1,5,7].

Aim: To map and synthesize existing evidence on dental elevator fracture during tooth extraction and to develop a structured clinical framework for risk stratification, prevention, and management.

Methods: A scoping review was conducted in accordance with PRISMA-ScR guidelines. Electronic databases including PubMed, Scopus, and Google Scholar were systematically searched using predefined keywords. Studies comprising case reports, case series, and relevant review articles were included. Data were extracted on etiology, contributing factors, clinical presentation, management strategies, and outcomes. The findings were analyzed using qualitative thematic synthesis and used to develop a novel Operator–Instrument–Procedure (OIP) risk model.

Results: A total of 142 records were identified, with 11 studies included after screening. Dental elevator fracture was most commonly associated with mandibular third molar extractions [5,14]. Contributing factors were categorized into operator-related, instrument-related, and procedure-related domains [4,7,10,14]. Most fractures were detected intraoperatively and managed by immediate retrieval [4,5], although delayed presentations were also reported [1,2].

Conclusion: Dental elevator fracture is a multifactorial and largely preventable complication. The proposed OIP-based framework provides a structured approach to risk assessment, prevention, and management.

Keywords: Dental elevator; Exodontia; Instrument fracture; Complications; Oral surgery; Third molar extraction

INTRODUCTION

Tooth extraction remains one of the most commonly performed procedures in oral and maxillofacial surgery [3]. Although generally safe, a range of intraoperative and postoperative complications may occur, including soft tissue injury, root fracture, and, in rare instances, instrument breakage [9,14].

Fracture of dental elevators during extraction represents an uncommon but clinically significant intraoperative complication that has been sporadically reported in the literature [1,5,7]. Dental elevators function based on biomechanical principles of leverage and wedging; however, improper use or excessive force can subject these instruments to significant stress, increasing the likelihood of fracture [4,10].

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Retained fractured fragments may remain asymptomatic for prolonged periods and are often detected incidentally during radiographic examination [1]. In some cases, these fragments may result in infection, delayed healing, or foreign body reactions [2].

Despite its clinical importance, the literature on dental elevator fracture remains limited and fragmented. Therefore, this scoping review aims to synthesize available evidence and provide a structured clinical framework for understanding, preventing, and managing this complication.

To our knowledge, this is among the first reviews to propose a structured risk stratification model (Operator–Instrument–Procedure model) for dental elevator fracture.

MATERIALS AND METHODS

Study Design

A scoping review methodology was adopted to comprehensively map existing evidence related to dental elevator fracture during tooth extraction, given the limited and heterogeneous nature of available studies.

Reporting Guidelines

The review followed the **PRISMA-ScR (Preferred Reporting Items for Scoping Reviews)** guidelines.

Search Strategy

A systematic search was conducted using the electronic databases PubMed, Scopus, and Google Scholar. The search strategy incorporated a combination of predefined keywords, including “dental elevator fracture,” “instrument breakage,” “exodontia complications,” and “third molar extraction complications,” to ensure comprehensive retrieval of relevant literature.

Manual screening of reference lists was additionally conducted.

Eligibility Criteria

Inclusion criteria comprised studies that reported fracture of dental elevators during extraction, including case reports, case series, and review articles, provided they were published in the English language.

Exclusion criteria included studies related to endodontic instrument fractures, non-dental procedures, and publications that were not available in English.

Study Selection

Titles and abstracts were screened, followed by full-text assessment. Disagreements were resolved by consensus.

Data Extraction

The following data were systematically extracted from the included studies: study type and characteristics, etiology of fracture, the tooth involved, identified risk factors, management strategies, and reported clinical outcomes.

Data Synthesis

Due to heterogeneity in study design and reporting, a **qualitative thematic analysis** was performed. Findings were grouped into key domains and used to construct a conceptual **Operator–Instrument–Procedure (OIP) model** for risk stratification and clinical application.

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RESULTS

A total of 142 records were identified through database searching. After removal of duplicates, 110 records were screened. Following title and abstract screening, 28 full-text articles were assessed for eligibility, of which 11 studies were included in the final analysis.

Instrument fracture during tooth extraction was found to be a rare occurrence across the included studies [3-5]. Most reported cases involved mandibular third molars, particularly in situations with limited access and visibility [5-14].

Etiology

The most frequently reported causes included excessive uncontrolled force applied during luxation, improper use of elevators and incorrect fulcrum placement, instrument fatigue resulting from repeated sterilization cycles, and, less commonly, underlying manufacturing defects.

Clinical Management

In the majority of cases, fractured fragments were identified intraoperatively and successfully retrieved immediately (4-5). However, delayed detection cases were also reported, in which fragments remained asymptomatic until identified radiographically (1-2).

Radiographic imaging, particularly panoramic radiographs or CBCT where indicated, was essential for localization prior to removal (2).

Study	Study Type	Selection Bias	Reporting Bias	Overall Risk
Balaji (2013)	Case report	High	Low	Moderate
Miranda-Rius (2015)	Case report	High	Low	Moderate
Gentili (2026)	Review	Moderate	Low	Moderate
Mahdi (2025)	Case report	High	Low	Moderate
Ali (2016)	Case report	High	Moderate	High
Kesharwani (2019)	Case report	High	Low	Moderate
Joshi (2017)	Case report	High	Moderate	High

Table: Risk of Bias Assessment

DISCUSSION

This review provides a comprehensive and structured interpretation of dental elevator fracture as a multifactorial complication involving operator technique, instrument integrity, and procedural complexity.

Operator-related factors were the most prominent contributors. Improper fulcrum positioning and excessive force application were consistently implicated across studies, highlighting the critical importance of surgical technique [4-7].

Instrument-related factors, particularly material fatigue due to repeated sterilization cycles, were also significant. This emphasizes the need for routine inspection and maintenance of surgical instruments [4-10].

Procedure-related factors, including mandibular third molar impaction and limited access, further increased fracture risk. These findings suggest that fracture results from a synergistic interaction between operator technique, instrument condition, and procedural complexity [5-14].

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Two distinct clinical pathways were identified: immediate intraoperative detection and delayed incidental diagnosis [1-2]. Immediate retrieval remains the preferred approach, whereas delayed cases require radiographic evaluation and careful management planning.

The absence of standardized guidelines highlights the need for structured clinical frameworks. This review proposes an integrated model to guide prevention and management.

Prevention

These measures collectively reinforce a proactive approach to preventing complications by emphasizing proper technique and instrument care. Prevention involves careful fulcrum placement combined with controlled application of force, routine inspection of instruments both before and after procedures, avoidance of using worn or damaged instruments, and ensuring adequate visibility and access during the extraction process.

PROPOSED OIP RISK MODEL

Operator Factors

Excessive force

Improper fulcrum placement

Inexperience

Instrument Factors

Material fatigue

Damaged or worn instruments

Manufacturing defects

Procedure Factors

Mandibular third molar extraction

Limited access

Dense bone or impaction

Risk stratification

Risk Level	Criteria	Clinical Action
Low	Simple extraction, intact instrument	Routine precautions
Moderate	Mild impaction, prolonged use instrument	Inspect instruments, controlled force
High	Deep impaction, limited access, high force	Senior surgeon, surgical approach
Very high	Reuse + difficult anatomy + poor access	Avoid elevator, consider sectioning

Management Algorithm (Simple + Publishable)

Step 1: Detect fracture

Immediate vs delayed

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Step 2: Assess location

Visible vs embedded

Step 3: Radiographic evaluation

OPG / CBCT if needed

Step 4: Decision

Immediate retrieval → if safe

Surgical retrieval → if embedded

Observation → if asymptomatic + high risk removal

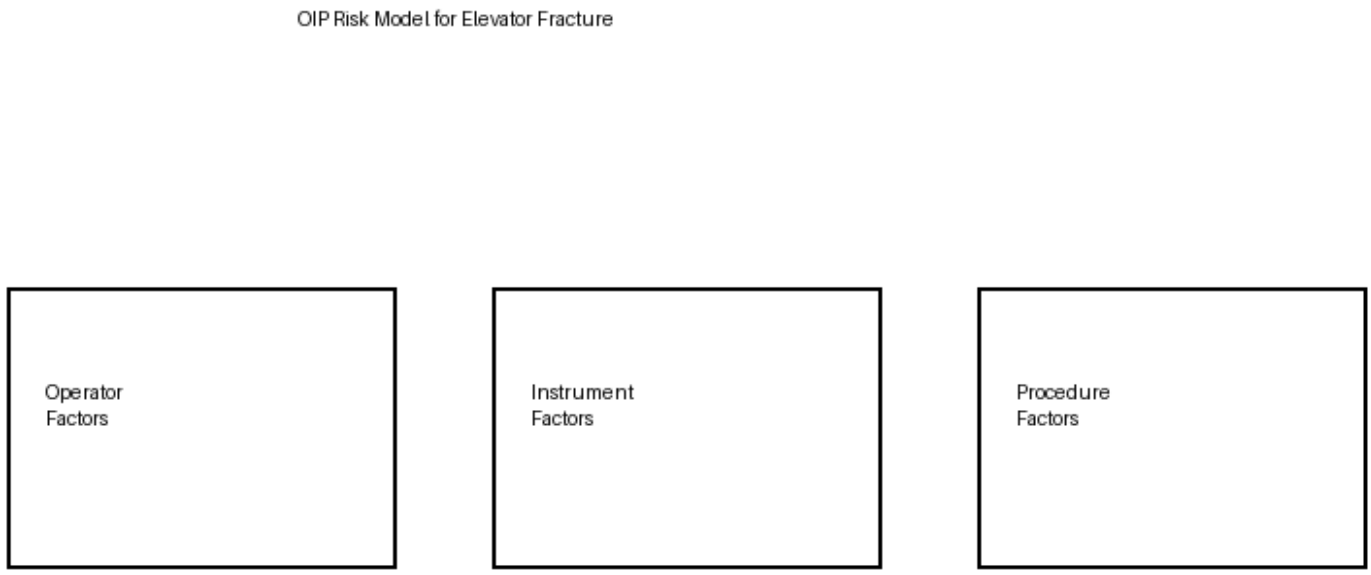

Figure: Proposed Operator–Instrument–Procedure (OIP) Risk Model illustrating the multifactorial etiology of dental elevator fracture during exodontia.

Management

Prompt recognition and appropriate management of dental elevator fracture are critical to minimize complications and ensure optimal patient outcomes. The management approach depends on multiple factors, including the timing of detection, location of the fractured fragment, accessibility, and the potential risk to surrounding anatomical structures.

In cases where fracture occurs and is identified intraoperatively, **immediate retrieval remains the preferred approach**, provided that the fragment is accessible and can be removed without causing additional trauma to surrounding tissues [4-5]. Careful exploration using adequate illumination, suction, and gentle manipulation is essential. Excessive or blind attempts at retrieval should be avoided, as they may displace the fragment deeper into adjacent tissues or anatomical spaces.

When the fractured segment is not readily visible or is suspected to be embedded within bone or soft tissue, **radiographic evaluation becomes mandatory**. Panoramic radiographs (orthopantomograms) are generally the first-line imaging modality, offering an overview of fragment location. However, in complex cases, particularly

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where proximity to vital structures such as the inferior alveolar nerve or maxillary sinus is suspected, **cone beam computed tomography (CBCT)** provides superior three-dimensional localization and aids in surgical planning [2].

Management decisions must then be guided by a **risk–benefit assessment**. If the fragment is superficial and accessible, surgical retrieval should be undertaken. However, in situations where the fragment is deeply embedded or located near critical anatomical structures, **conservative management may be justified**, particularly in asymptomatic patients [1-2]. In such cases, periodic clinical and radiographic follow-up is recommended to monitor for complications such as migration, infection, or foreign body reaction.

Delayed detection represents another important clinical scenario. Fragments that remain undetected intraoperatively may later present incidentally on radiographs or due to symptoms such as infection, swelling, or persistent pain. Symptomatic cases generally require surgical removal, whereas asymptomatic retained fragments may be managed conservatively with observation and long-term follow-up [2].

Referral to an oral and maxillofacial surgeon is strongly recommended in situations where the localization of the fractured fragment is uncertain, when surgical access is limited, or when the fragment lies in close proximity to vital anatomical structures. It is also indicated in cases where initial attempts at retrieval have been unsuccessful.

In addition to clinical management, **proper documentation** of the event is essential. Detailed recording of the intraoperative complication, management steps taken, and patient communication is critical from both clinical and medico-legal perspectives.

Ultimately, management of dental elevator fracture requires a **structured and individualized approach**, balancing the risks of retrieval against the potential consequences of retaining the fragment.

Limitations

The findings of this review should be interpreted in light of several important limitations inherent to the available literature.

First, the evidence base is limited and predominantly consists of **case reports and small case series**, representing a low level of scientific evidence [1-7]. These study designs are inherently subject to bias and do not allow for robust statistical analysis or establishment of causal relationships.

Second, there is significant **heterogeneity among the included studies**. Variations in clinical scenarios, operator experience, reporting standards, and outcome measures limit the ability to perform direct comparisons across studies or synthesize findings quantitatively.

Third, **publication bias** is a major concern. Rare or unusual complications are more likely to be reported in the literature, potentially leading to overrepresentation of severe cases while underestimating the true incidence of dental elevator fracture. Fourth, many studies lack detailed reporting of critical variables, including operator experience and skill level, the type and design of the instrument used, the specific surgical technique employed, and the degree of force applied.

This lack of detailed information limits the ability to perform deeper mechanistic analysis and identify precise causative factors.

Fifth, the restriction to **English-language publications** may have resulted in the exclusion of relevant studies published in other languages, introducing language bias.

Sixth, the majority of included reports do not provide **long-term follow-up data**, limiting understanding of the long-term outcomes associated with retained instrument fragments, including potential delayed complications.

Despite these limitations, this review provides a structured synthesis of available evidence and contributes by proposing a conceptual and clinically relevant framework for understanding and managing this complication.

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Clinical Implications

The findings of this review have important implications for improving clinical practice, particularly in the prevention of dental elevator fracture and optimization of surgical decision-making.

A key implication is the need to emphasize **preventive strategies based on sound biomechanical principles**. Controlled and incremental application of force, along with appropriate fulcrum selection, is essential to minimize excessive stress on the instrument during luxation [4-7]. Clinicians should avoid uncontrolled or excessive levering, especially in anatomically constrained environments such as mandibular third molar regions.

Effective **surgical decision-making** plays a crucial role in reducing risk. Preoperative assessment should identify cases with increased procedural complexity, including impacted teeth, dense cortical bone, and limited access or visibility [5-14]. In such scenarios, reliance solely on elevation should be avoided, and alternative approaches such as tooth sectioning or surgical extraction should be considered. Early escalation to more controlled surgical techniques can significantly reduce the likelihood of instrument failure.

Another important implication is the role of **structured training and education**. Operator-related factors remain the most significant contributors to elevator fracture. Therefore, adequate training in exodontia techniques, including the biomechanical use of elevators, is essential. Incorporation of simulation-based training, supervised surgical exposure, and continuous professional development programs can enhance operator competence and reduce technical errors.

The findings also highlight the importance of implementing **standardized instrument protocols** in clinical settings. Instruments should be routinely inspected for signs of wear, corrosion, deformation, or tip damage before and after procedures. Repeated sterilization cycles can compromise material integrity over time, increasing susceptibility to fracture [4,10]. Establishing guidelines for instrument lifespan, maintenance, and timely replacement is critical in preventing fatigue-related failure.

Intraoperatively, maintaining **adequate visibility, access, and ergonomics** through appropriate flap design, retraction, and lighting further supports safe instrumentation and reduces technical challenges.

Finally, the integration of the proposed **Operator–Instrument–Procedure (OIP) model** into clinical practice provides a structured framework for identifying risk factors preoperatively and intraoperatively. By systematically evaluating these domains, clinicians can adopt a proactive approach to complication prevention and improve overall surgical safety.

Future Research Directions

Given the limited and predominantly low-level evidence available, there is a clear need for further research to better understand the etiology, prevention, and management of dental elevator fracture.

Future studies should prioritize **prospective clinical research** aimed at determining the true incidence of instrument fracture and identifying statistically significant risk factors. Such studies should incorporate standardized data collection methods to improve reliability and comparability.

Biomechanical investigations represent a critical area for future exploration. Studies evaluating the distribution of stress on dental elevators during extraction procedures, including finite element analysis, could provide valuable insights into the mechanical factors contributing to fracture [4]. Understanding load tolerance and fracture thresholds of different instrument designs would help inform safer clinical practice.

Research into **instrument materials and manufacturing processes** is also warranted. Evaluating the effects of repeated sterilization cycles on material properties and structural integrity may help establish evidence-based guidelines for instrument lifespan and replacement [10].

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Another important area is the development of **standardized reporting protocols** for instrument-related complications. Uniform reporting of clinical variables—including operator experience, type of procedure, instrument used, and outcomes—would significantly enhance the quality of future evidence.

Large-scale, **multicenter studies** are needed to overcome limitations of small sample sizes and improve generalizability. Collaboration between institutions would facilitate the collection of more robust datasets.

Furthermore, there is a need to develop and validate **evidence-based clinical guidelines** for the prevention and management of dental elevator fracture. The proposed OIP model provides a preliminary conceptual framework, but further validation through clinical research is necessary.

Finally, integration of **educational interventions and training modules** focusing on proper elevator use and biomechanical principles may contribute significantly to reducing the incidence of this complication.

CONCLUSION

Dental elevator fracture during tooth extraction is an uncommon but clinically significant complication that reflects the interplay between operator technique, instrument integrity, and procedural complexity rather than an isolated instrument failure. Although the current body of evidence is limited and primarily derived from case reports, consistent patterns emerge that highlight the preventable nature of this complication.

This scoping review synthesizes existing literature and advances understanding by framing elevator fracture within a structured **Operator–Instrument–Procedure (OIP) model**, emphasizing that risk is multifactorial and predictable in high-risk clinical scenarios such as mandibular third molar extractions with limited access. The integration of this conceptual model with a practical risk stratification approach and management algorithm provides clinicians with a systematic method to anticipate, prevent, and manage such events.

Importantly, the findings underscore that adherence to fundamental surgical principles—including controlled force application, appropriate fulcrum selection, and routine instrument inspection—remains central to prevention. Early recognition and appropriate management, guided by clinical judgment and radiographic assessment, are essential to minimize complications and optimize patient outcomes.

While this review contributes to a structured and clinically applicable framework, it also highlights the need for higher-quality evidence. Future prospective and biomechanical studies are required to validate the proposed model and to support the development of standardized clinical guidelines. Ultimately, incorporating these insights into routine practice has the potential to enhance surgical safety, improve decision-making, and reduce the incidence of this avoidable complication.

Conflict of Interest

The authors declare that they have no financial, personal, or institutional conflicts of interest that could have influenced the work reported in this manuscript.

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