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Systematic Classification of Dental Anatomical Variations and Their Impact on the Complexity of Simple Extractions

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ABSTRACT

Objective: To categorize anatomical variations into mild, moderate, and difficult extraction scenarios, thereby providing valuable insights to new general practitioners for appropriate treatment planning before the start of the procedure to lessen post-op complications like swelling, pain, limited mouth opening, and dry socket.
Study Design: Cross-Sectional Study.
Place and Duration of Study: Oral Maxillifacial Department, HITECH, Taxilla Pakistan, from Feb to Apr 2024.
Methodology: The study was conducted by sharing the Google form-based questionnaire among 400 dental surgeons, specialists, and consultants to give their opinions regarding the difficulty of the extraction procedure.
Results: Our study showed that 90% of clinicians reported dilaceration with maximum extraction difficulty, and 87% considered taurodontium with mild difficulty for extraction.
Conclusion: Our study provides a comprehensive understanding of anatomical variations in tooth structure, offering a detailed overview for dental practitioners, especially in practical settings, and culminating in the development of a practical guide to enhance treatment planning and outcomes. Moving forward, continuous research and collaboration within the dental community can further refine and expand upon these findings to continually improve clinical practices and patient outcomes.

Keywords: Anatomical Variations, Extraction Difficulty, Root Morphology.

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INTRODUCTION

Extraction is a routine dental procedure performed to treat certain dental conditions such as tooth pain, impaction, and tooth-related infections.[1] It is a common term used for the process of removal of teeth from their bony socket as a treatment for various tooth pathologies.[2] Extractions can be simple or surgical. Simple extractions are those that do not involve the raising of a mucosal flap, tooth sectioning, and bone cutting. Simple extractions involve delivering the tooth with extraction forceps after luxation by elevators.[3] The dentist will follow the principles of simple extraction for an amount of expansion of the socket with no bone loss. Usually, it is a simple procedure with very less complications, but sometimes, anatomical variations and root-related anomalies can pose great challenges for dentists and can complicate the procedure. Anatomical variations are defined as abnormal morphological features of teeth that may be hereditary or acquired and may occur as an isolated defect or be associated with a syndrome.[4] Evidence shows that anatomical variation in tooth structure can complicate simple extraction, increasing patient anxiety and fear as well as post-operative complications.[5] Such variations require procedures that involve flap raising, bone and tooth cutting, and sometimes suturing, called surgical or open extraction.[6] Various tooth morphological features are mentioned in the literature that can complicate extraction, including altered tooth position, angulation, root number and anatomy, and various anomalies and pathologies.[7]

All these factors can complicate the extraction procedures as well as lead to post-operative complications.[8] Dental practitioners need to understand these variations, and they must anticipate and prevent various complications that can arise while managing such patients.[9] Therefore, suitable treatment planning before the procedure is required to lessen post-op complications like swelling, pain, limited mouth opening, and dry sockets. It is always advisable for general dental practitioners to take an intraoral radiograph to evaluate tooth and root morphology, configurations, and proximity of vital structures before extraction.[10]

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Accurate estimation of extraction difficulty is essential for safe and effective dental practice, yet existing difficulty assessment indices focus almost exclusively on third molar surgery, leaving general practitioners without evidence-based tools for evaluating the complexity of extracting other teeth. This gap is critical because anatomical variations across different teeth can significantly influence the difficulty of procedures, and young dentists in particular may struggle to anticipate challenges that senior practitioners recognize through experience. To address this unmet need, the present study systematically categorizes anatomical variations in all teeth and develops a practical, experience-based guide to assist clinicians in predicting surgical difficulty before treatment. By offering a structured framework grounded in anatomical features and expert insights, this study contributes a novel tool to the literature that can enhance clinical decision-making, improve patient management, and reduce preventable complications during routine extractions.

METHODOLOGY

It was a descriptive, quantitative, survey-based, cross-sectional study conducted in Oral Maxillifacial Department, HITECH, Taxilla Pakistan, for a period of three months from Feb to Apr 2024. The study was conducted with the approval of the Institutional Ethical Review Board, with the approval number Dental/HITEC/IRB/66 2-14-24. The sample size was calculated using OpenEpi, which calculated the population using the Cochran formula, taking a confidence level of 95%, and a margin of error 5% assuming the population proportion of 0.5. The estimated sample size came out to be 384 participants. To ensure adequate representation and account for potential non-responses, a total of 400 Oral and Maxillofacial Surgery experts were selected. The sampling technique employed was convenience sampling, targeting professionals who were fulfilling the inclusion and exclusion criteria.

Inclusion Criteria: Oral and maxillofacial surgeons of both genders with post-graduate qualifications (MDS, FCPS, or MCPS and equivalent) and a minimum of 5 years of clinical experience, who were willing to participate.

Exclusion Criteria: Professionals who do not have postgraduate qualifications and have less than 5 years of clinical experience were excluded from the study. Incomplete or partially filled survey responses were also excluded from the study.

Initially, a thorough literature review was conducted to identify the anatomical variations that can complicate the simple extraction. The variations reported in the literature are given in Table-I along with the references. 12 anomalies were identified through a literature review, which could complicate the minor procedures related to dentistry. This list was discussed through a focus group with six Oral and maxillofacial surgeons who had more than five years of clinical experience to further narrow it down to those that could complicate tooth extraction based on their expert judgement. After discussion, 3 anomalies were excluded, and the final list of anomalies that were sent for categorization into mild, moderate, and severe is given in Table-II. After expert validation, a survey form was developed and mailed to 400 Oral and Maxillofacial Surgery experts.

The survey form included the list of anatomic variations which have to be classified by the experts into mild, moderate, and severe based on difficulty of extractions. The participation of the experts was optional, and consent forms for participation were taken from all the participants of the study.

For data analysis, frequencies and percentages were calculated to describe the distribution of various anatomical variations (e.g., curved root, divergent root, ankylosed tooth) under the heading of mild, moderate, and severe difficulty levels in tooth extraction. This analysis aimed to categorize these variables to understand their impact on extraction challenges.

RESULTS

A total of 380 responses were received, out of which 230(59.90%) were males and 154(40.10%) were females, having a mean age of 45.00±7.04 years.

Table-II shows that out of 9 anatomical variations, ankylosed, dilacerated, and thin long roots were considered to be the most difficult to extract by the clinician. 348(90.6%) of clinicians considered dilacerated root to be the most difficult to extract, causing severe extraction procedural complications. Besides dilacerated roots, ankylosed and thin long roots were also considered severely crucial factors complicating simple extraction. Approximately 88.8% of clinicians put thin long roots, and 87.2% of clinicians put ankylosed teeth under the category of severely difficult to extract. Curved, divergent, and multirooted teeth were kept in the category of moderately difficult factors in complicating extraction by 70.3%, 92.2%, and 83.3% of clinicians, respectively.

Taurodontism was classified as mildly difficult to extract by 87.2% of clinicians.

Table-I: Anatomical Variations Identified Through Literature

Anatomical variation	Reference Articles
Curved root	Exodontia: Tips and Pearls Hussain Ali Albannai.[11]
Divergent root	Considerations of maxillary tuberosity fractures during extraction of upper molars: a literature review.[12]
Ankylosed tooth	Prevalence of dental anomalies among patients visiting the Riyadh Elm University clinics.[4]
Dilaceration	The Occurrence of Root Dilacerations in Patients Reporting to Islamabad Dental Hospital: A Retrospective Study.[13]
Thin long roots	Prevalence of dental anomalies among patients visiting the Riyadh Elm University clinics.[4]
Multirooted teeth	Considerations of maxillary tuberosity fractures during extraction of upper molars: a literature review.[14]
Mouth opening	Exodontia: Tips and Pearls Hussain Ali Albannai.[11]
Macroglossia	
Nerve proximity	
Malposed teeth	
Taurodontism (enlarged pulp chamber)	

Table-II: Categorizing The Difficulty Status Of Extraction Based On The Anatomical Variations Through Expert Validation

	Mild	Moderate	Severe	
	Frequency(%)	Frequency(%)	Frequency(%)	Total
Curved root	54(14.1)	270 (70.3)	60(15.6)	384(100)
Divergent root	17(4.4)	354(92.2)	13(3.4)	384(100)
Ankylosed tooth	9(2.3)	40(10.5)	335(87.2)	384(100)
Hypercementosed	3(0.8)	72(18.7)	309(80.5)	384(100)
Dilacerated roots	12(3.1)	24(6.3)	348(90.6)	384(100)
Thin long roots	20(5.2)	23(6)	341(88.8)	384(100)
Multirooted teeth	44(11.5)	320(83.3)	20 (5.2)	384(100)
Malposed teeth	152(39.6)	99(25.8)	133(34.6)	384(100)
Taurodontism (enlarged pulp chamber)	335(87.2)	49(12.8)	00(00)	384(100)

DISCUSSION

The findings of this study revealed that curved, ankylosed, and thin long roots were the most common anatomical variations contributing to moderate to severe extraction difficulty. These results underscore the importance of recognizing such variations early, enabling young dentists to anticipate risks and prevent complications.

Literature shows that significant percentages of dental anatomical variation are prevalent among the population.[4] Evidence of literature in Table-I showed that anatomical variation can significantly impact extraction procedures.[3,13] Categorizing these variations into mild, moderate, and severe will serve as an important tool for addressing and managing the difficulties when such conditions are encountered. Most of the studies to evaluate the difficulty of tooth extractions were conducted for third molars.[12]

Al-bannani *et al.,* supported the fact that variations in the anatomical features of a tooth and its roots can complicate dental extraction procedures. Factors that limit the visibility and access to teeth, like macroglossia and limited mouth opening, were reported as factors that can complicate the extraction procedure, but we did not include these variations in our survey, as they were not tooth-related anatomical variations. Evidence shows that variations that include thin, long, curved roots, hypercementosis, ankylosed roots, dilacerated and divergent roots, and taurodontium should be removed by surgical extraction, which is not the expertise of general dental graduates. So referral of such cases to oral and maxillofacial surgeons is advisable.[11]

Dilaceration, which is the bending of the root from its normal longitudinal axis, was considered one of the crucial factors that can complicate the simple extraction and was put under the category of severe difficulty. was also considered a factor that complicates dental procedures in ths study by Al-Mutairi *et al.*[15]

Literature has reported variations like ankylosed teeth and long, thin roots as factors that can complicate the extraction procedures, and it has been shown in a study by Abdur-rahman *et al.,* that the extraction of teeth with root-related anomalies is more difficult to extract in comparison to malposed teeth.[4] A study by Al Omari *et al.,* has also reported difficulty in the extraction procedure in percentages showing ankylosed teeth having difficulty up (25%), and root curvature (35%). 90% of our clinicians reported these as severely crucial factors for extraction.[16] Smilarly Saqib *et al.,* highlighted root curvature to be a significant factor in making extraction difficult and it should be extracted surgically, our experts put divergent roots under the category of moderate-level difficulty.[13]

Our study claimed that Taurodondium which is the abnormality in the internal morphology of the tooth cannot complicate the extraction procedure but Jani *et al.,* reported that general dental practitioners are less aware of this anomaly which can complicate various dental procedures.[17]

Dental professionals must be aware of these anatomical variations and must have a deeper understanding of the protocols required to manage such patients to address the challenges associated with such conditions. They must evaluate such patients preoperatively through x-rays and Cone beam

computed tomography for proper treatment planning and selecting appropriate surgical techniques.[18] With the advancement in dental research and practice various radiographic imaging equipment and virtual planning software are available that can help in planning and managing the difficult patient. In cases where practitioners encounter a challenging patient, they must consider referring to the oral surgeon to minimize complications.

CONCLUSION

The anatomical variations, such as curved, ankylosed, and thin long roots, were identified as common challenges encountered during extractions. These variations often fell into the moderate to severe difficulty categories. Young dentists must identify the anatomical variation before managing patients and should evaluate the risk factors related to such variation to avoid any inconvenience and complications. This guide will provide them with an overview of the variations that can complicate extraction, and by consulting this, they can avoid unforeseen complications that can physically and emotionally harm the patient. This categorization can be included in textbooks as a classification of risk factors that can complicate simple extraction. By this, dental practitioners can improve their patient management and clinical skills, leading to better treatment outcomes. Moving forward, continuous research and collaboration within the dental community can further refine and expand upon these findings to continually improve clinical practices and patient outcomes.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

SM & FH: Data acquisition, data analysis, critical review, approval of the final version to be published.

AH & AG: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

NB & AY: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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