ISSN 1949-8470 (online)

World Journal of *Radiology*

World J Radiol 2024 October 28; 16(10): 497-628

Published by Baishideng Publishing Group Inc

World Journal of Radiology

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World Journal of Radiology

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Editorial Board Member of *World Journal of Radiology*, Dusan Dj Popovic, MD, PhD, FESBGH, Assistant Professor of Internal Medicine and Gastroenterohepatology, Research Assistant Professor, University of Belgrade, Faculty of Medicine, Department of Gastroenterology and Hepatology, Clinic for Internal Medicine, University Clinical Hospital Center "Dr Dragisa Misovic-Dedinje", Belgrade 11000, Serbia. dusan.popovic@med.bg.ac.rs

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RESPONSIBLE EDITORS FOR THIS ISSUE

NAME OF JOURNAL
World Journal of Radiology

ISSN
ISSN 1949-8470 (online)

LAUNCH DATE
January 31, 2009

FREQUENCY
Monthly

EDITORS-IN-CHIEF
Thomas J Vogl

EDITORIAL BOARD MEMBERS
https://www.wjgnet.com/1949-8470/editorialboard.htm

PUBLICATION DATE
October 28, 2024

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World J Radiol 2024 October 28; 16(10): 608-615

DOI: 10.4329/wjr.v16.i10.608

ISSN 1949-8470 (online)

CASE REPORT

Asymmetric outcomes in bilateral maxillary impacted tooth extractions: A case report

Han Liu, Fang Wang, Yan-Li Tang, Xing Yan

Specialty type: Radiology, nuclear medicine and medical imaging

Provenance and peer review: Unsolicited article; Externally peer reviewed.

Peer-review model: Single blind

Peer-review report's classification

Scientific Quality: Grade B, Grade C

Novelty: Grade B, Grade B

Creativity or Innovation: Grade B, Grade C

Scientific Significance: Grade B, Grade C

P-Reviewer: Elsheikh HAE

Received: May 28, 2024

Revised: September 19, 2024

Accepted: October 15, 2024

Published online: October 28, 2024

Processing time: 152 Days and 13.5 Hours

Han Liu, Fang Wang, Yan-Li Tang, Xing Yan, Department of Stomatology, Beijing Friendship Hospital, Capital Medical University, Beijing 100050, China

Corresponding author: Xing Yan, MD, Chief Physician, Department of Stomatology, Beijing Friendship Hospital, Capital Medical University, No. 95 Yongan Road, Xicheng District, Beijing 100050, China. happytooth@yeah.net

Abstract

BACKGROUND

The extraction of maxillary impacted teeth is a common procedure in oral surgery, frequently complicated by oroantral communications. For less-experienced clinicians, accurately assessing the difficulty and associated risks of maxillary third molar extractions remain a significant challenge.

CASE SUMMARY

We present a case involving disparate outcomes following bilateral extraction of maxillary third molars. Using cone-beam computed tomography and three-dimensional software, we conducted a digital assessment of the factors contributing to extraction difficulty and risk, controlling for potential confounders. Key variables analyzed included alveolar bone volume, bone quality, crown-root angulation, and maxillary sinus mucosal thickness. Additionally, we introduce the novel concept of "tegmen bone" to quantitatively evaluate the bone mass between the teeth and the maxillary sinus. This unique case, with differing outcomes on opposite sides of the same patient, provided an opportunity to minimize extraneous variables and focus on the local anatomical factors influencing the procedures, thereby improving the precision of our analysis.

CONCLUSION

This case highlights the potential utility of predictive analysis in guiding the management of complex tooth extractions.

Key Words: Cone-beam computed tomography; Maxillary third molar; Tegmen bone; Digital analysis; Predictive analysis; Case report

Core Tip: This case report presents unexpected findings in bilateral maxillary third molar extractions. Using cone-beam computed tomography (CBCT) and three-dimensional software, we digitally evaluated factors influencing extraction difficulty and risk, accounting for potential confounders. Key variables analyzed included alveolar bone volume, bone quality, crown-root angulation, and maxillary sinus mucosal thickness. Notably, variations in "tegmen bone" volume between the tooth and maxillary sinus emerged as a critical determinant. We propose a simplified CBCT-based measurement method to enhance risk assessment and extraction planning of impacted tooth.

Citation: Liu H, Wang F, Tang YL, Yan X. Asymmetric outcomes in bilateral maxillary impacted tooth extractions: A case report. *World J Radiol* 2024; 16(10): 608-615
URL: https://www.wjgnet.com/1949-8470/full/v16/i10/608.htm
DOI: https://dx.doi.org/10.4329/wjr.v16.i10.608

INTRODUCTION

In clinical practice, the extraction of maxillary impacted teeth is a common surgical procedure, with oroantral communication being the most frequent complication associated with maxillary third molar extraction[1,2]. While current research largely focuses on the management of these complications, such as maxillary sinus fistula and odontogenic maxillary sinusitis[3], there is a marked paucity of studies addressing preventive strategies. Experienced practitioners typically assess the complexity of tooth extraction by integrating clinical variables with data from cone-beam computed tomography (CBCT), allowing for a preliminary estimation of the procedure's difficulty and a structured approach to managing associated risks. However, for less-experienced clinicians, accurately evaluating the difficulty and risks of maxillary third molar extraction remains a significant challenge. Anticipating the risks and preparing both the clinician and patient accordingly are essential to optimizing outcomes[4].

Radiological variables are crucial for the analysis of third molar extractions[5]. Traditionally, the distance between the tooth root and the maxillary sinus is measured, but this approach is often inaccurate due to potential intermittent contact between the horizontally impacted tooth crown and the maxillary sinus mucosa[6]. The tegmen bone (TB) between the maxillary sinus floor and the tooth may fracture under the forces exerted during tooth extraction, making it essential to define and measure the TB region[7]. Studies have shown that alveolar bone stability is only maintained when bone thickness reaches 2 mm[8]. Sun *et al*'s research further suggests that the alveolar bone thickness should exceed 0.6 mm[9]; otherwise, CT values in this area reflect the average density of both the alveolar bone and the adjacent periodontal ligament, rather than the alveolar bone itself[9]. Establishing precise parameters and methodologies for quantifying TB mass remains a significant challenge in current research.

This article presents and compares the outcomes of bilateral maxillary impacted tooth extractions in a single case. We categorized the radiological variables into four groups: Alveolar bone quantity, alveolar bone quality, crown-root angle, and maxillary sinus mucosal condition (Figure 1). Through our analysis, we identified alveolar bone quantity as the primary radiological factor influencing the observed differences in risk in this case. Based on radiological data, we introduced the novel concept of TB quantity for quantitative analysis and comparison. In this case, the TB measurement was defined as a bone volume of less than 1 mm between the maxillary sinus floor and the tooth root. This method offers a practical approach for evaluating the complexity and risk of tooth extractions by utilizing CBCT-derived radiological data, thereby contributing to the scientific understanding of extraction procedures.

CASE PRESENTATION

Chief complaints

A 26-year-old woman was referred for the extraction of bilateral maxillary impacted third molars as part of her orthodontic treatment plan.

History of present illness

A 26-year-old woman was referred for the extraction of bilateral maxillary impacted third molars as part of her orthodontic treatment plan. There was no history of spontaneous pain, nocturnal pain, or pain caused by cold or hot stimulation.

History of past illness

The patient had no history of trauma, hypertension, or other medical conditions.

Personal and family history

Her history, personal history, and family history were unremarkable.

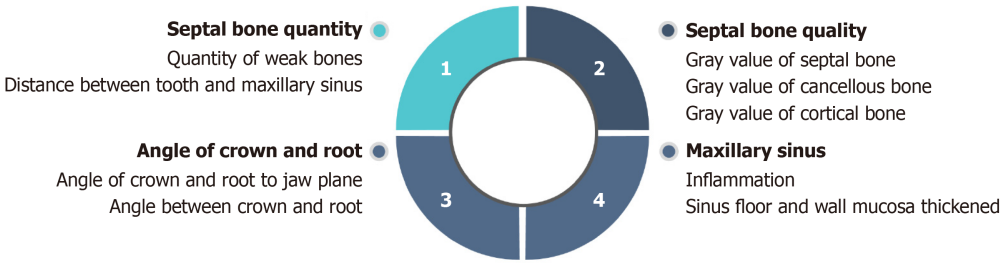


Figure 1 Radiologic data for evaluating the risk of maxillary third molar extraction.

Physical examination

The impacted teeth were not visible upon clinical examination.

Laboratory examinations

Laboratory examinations were normal.

Imaging examinations

CBCT (NewTom 5G Version FP, Italy) revealed that both teeth were deeply embedded in the maxilla and in close proximity to the maxillary sinus floor, exhibiting a mesial median impaction pattern (Figure 2).

FINAL DIAGNOSIS

Impacted teeth 18 and 28.

TREATMENT

Minimally invasive tooth extraction.

OUTCOME AND FOLLOW-UP

The same oral and maxillofacial surgeon employed a standardized extraction technique (Figure 3) for both teeth but encountered disparate outcomes. While the extraction of tooth 18 was uneventful, removal of tooth 28 resulted in the formation of an oroantral communication. This perforation was managed using collagen application and primary closure of the wound (Figure 3A). Two weeks postoperatively, complete mucosal healing was observed. Nevertheless, on the left side, a postoperative mucosal reaction was detected in the maxillary sinus. Despite the comparable difficulty of bilateral extractions, there is an imperative to develop more precise preoperative assessment tools to accurately gauge the risk of complications associated with tooth extraction (Figure 3).

A numerical analysis of preoperative CBCT was conducted to assess extraction risk. The NNT viewer 5.6.0 (NNT QR S.r.l, United States) was used for segmentation of the CBCT data, with an axial slice thickness of 1 mm (Figure 4A). The impacted maxillary teeth were divided into 15 Layers based on the sagittal plane. Numerical analysis was performed for each layer, and the central five layers were selected for detailed evaluation (Figure 4B). To quantify the bone separating the maxillary sinus from the teeth, we introduced the concept of TB, which represents the volume of bone measuring less than 1 mm between the maxillary sinus floor and the tooth root, illustrated as a circular shape in the diagram (Figure 4). For TB measurement, the parameter X was defined, representing the length of each sagittal TB. The TB measurement methodology and corresponding data are depicted in Figure 4C and D.

In addition to quantifying septal bone quantity, we assessed septal bone quality by analyzing the gray values of trabecular bone, cortical bone, and the alveolar bone septum. We also measured the angles between the crown and root relative to the jaw plane, and various parameters associated with the maxillary sinus mucosa (Figure 5).

The analysis revealed that the primary difference between the two impacted teeth was in septal bone quantity. As shown in the table in Figure 4D, the bone thickness at the thinnest point of both tooth 28 and tooth 18 is identical at 0 mm. The cross-sectional area of TB for tooth 18 was 25.8 mm^2, compared to 29.5 mm^2 for tooth 28, suggesting a lower risk of perforation for tooth 18. Further radiological assessment supported this finding. Additionally, the angle between the crown and root relative to the Frankfort plane differed, with tooth 28 exhibiting a smaller angle, thus increasing the extraction difficulty. No significant differences were observed in septal bone quality or maxillary sinus mucosa between the two sides.

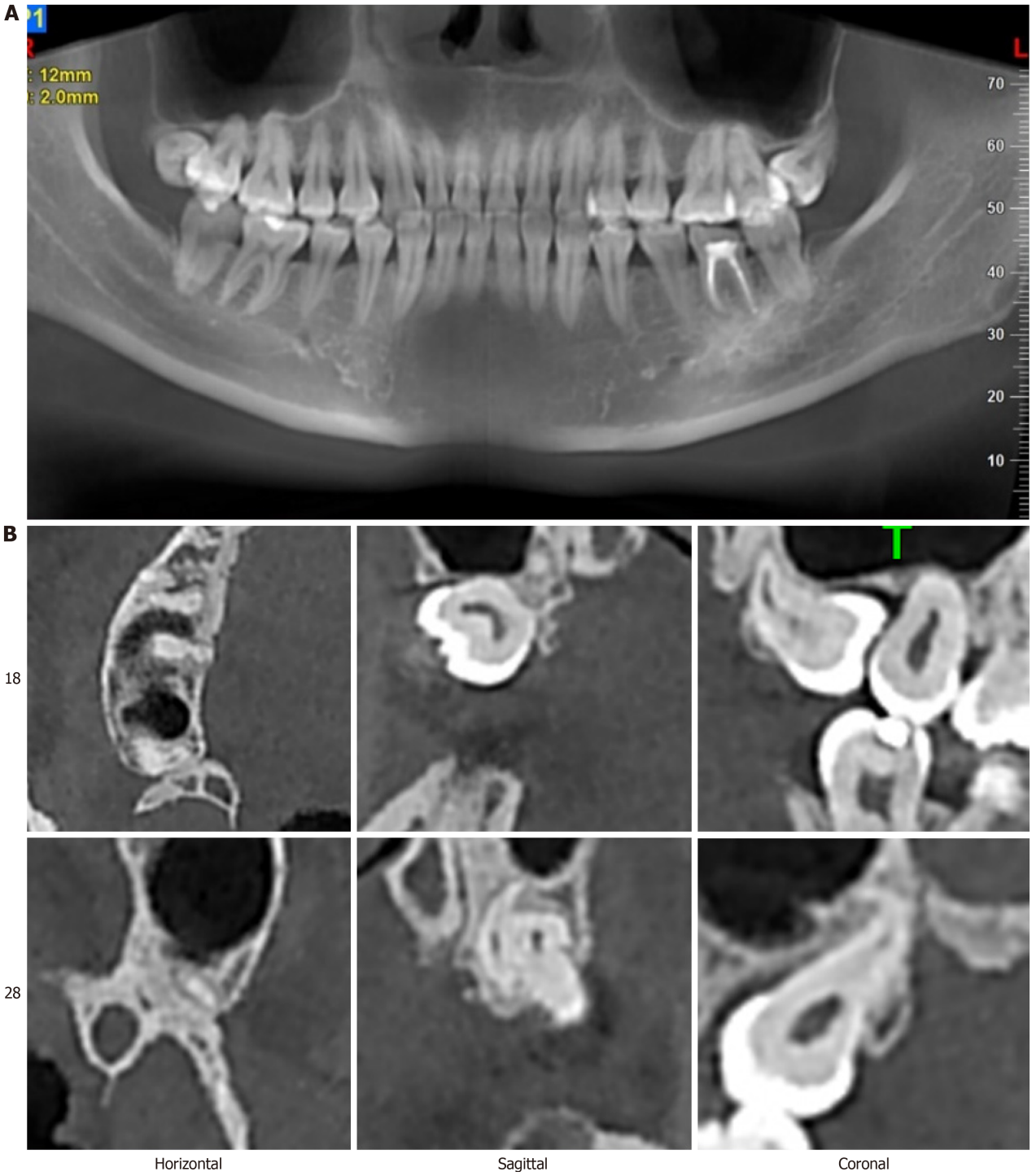


Figure 2 Preoperative imaging. A: Surface slice; B: Cone-beam computed tomography images at three levels. In the sagittal view, a portion of the crown of tooth 18 is in contact with the maxillary sinus, while in both sagittal and coronal views, part of the root of tooth 28 is seen to abut the maxillary sinus.

DISCUSSION

Several key factors influence the risk associated with maxillary third molar extractions[10,11]. First, the position of the maxillary third molars is determined by variables such as the depth within the alveolar bone, the angulation between the root and crown, and the proximity to the maxillary sinus floor. Second, the condition of the alveolar bone and maxillary sinus plays a critical role, including parameters like alveolar bone density, inflammation of the bone, maxillary sinus pathology, and the state of the maxillary sinus mucosa. The third factor is the surgeon's clinical expertise, which encompasses factors such as the direction and magnitude of the force applied during extraction, including the type of force used (*e.g.*, wedge force or axial force). Lastly, patient-specific clinical variables, including mouth opening capacity, age, sex, weight, the position of adjacent teeth, and the presence of dental caries, must be considered.

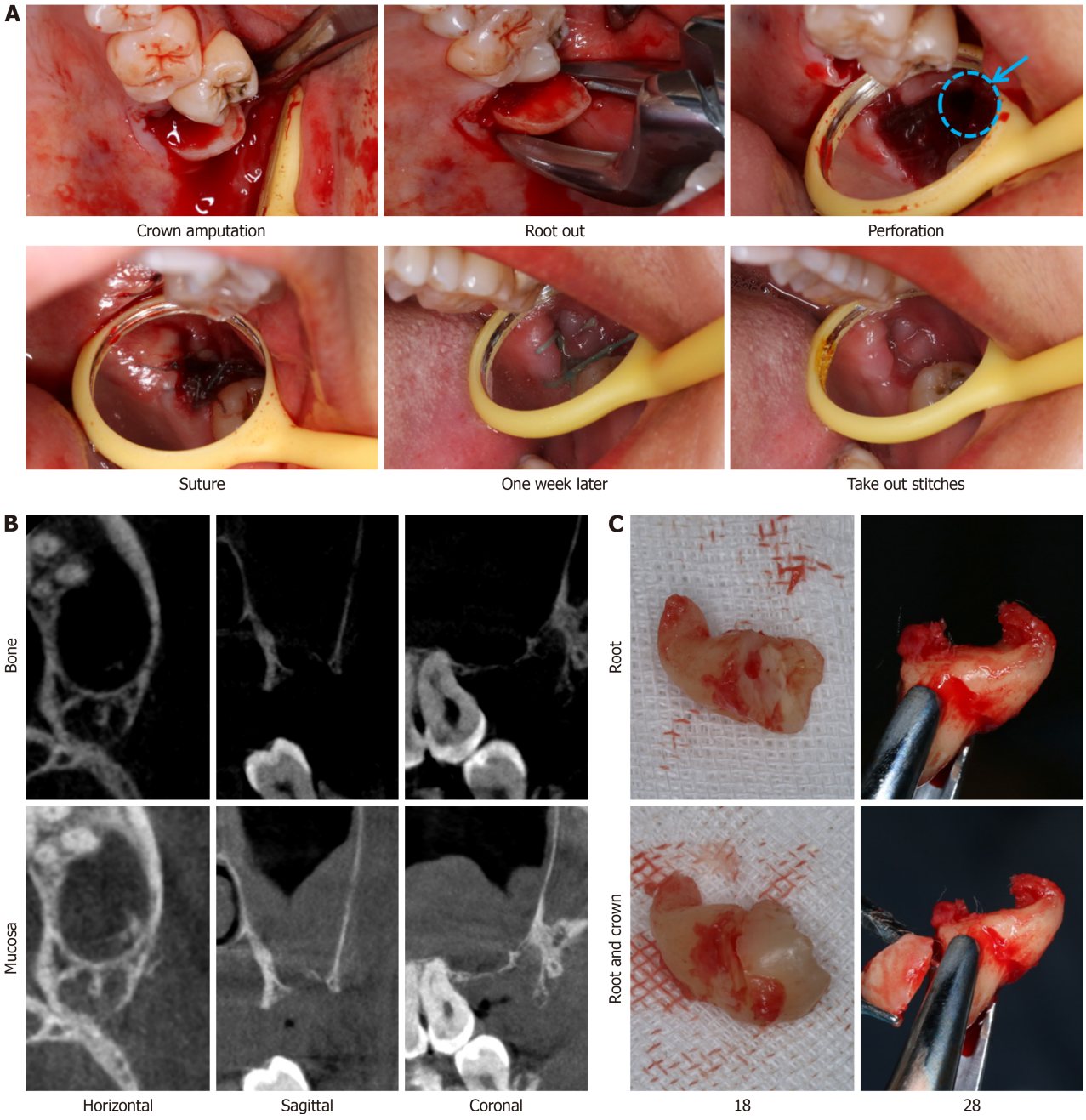
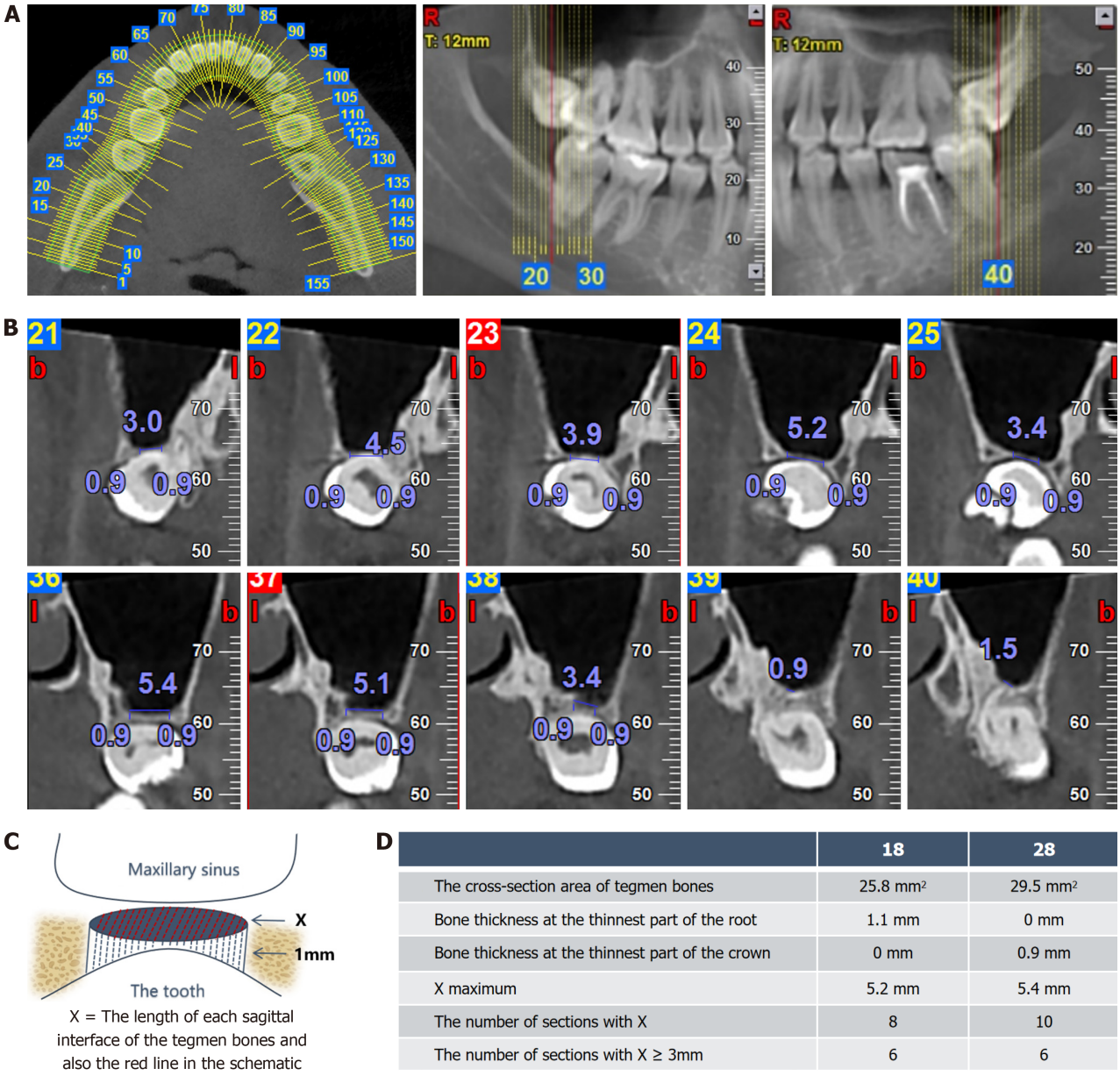


Figure 3 Intraoperative and postoperative imaging. A: Intraoral image showing a maxillary sinus perforation (blue circle); B: Radiographs obtained two weeks postoperatively; C: Extracted tooth showing the junction of the root and crown.

In this case, the comparison of the maxillary third molars on both sides of the same patient allows us to control for patient-specific factors. Moreover, as the extractions were performed by the same surgeon, potential variability due to operative technique was minimized. Consequently, the primary determinant of extraction difficulty and postoperative risk in this case was the position of the maxillary third molars within the alveolar bone. To quantify the minimal bone volume between the maxillary sinus and the teeth, we introduce the concept of the TB, which refers to the bone volume less than 1 mm between the floor of the maxillary sinus and the tooth roots. The shape of TB is irregular, making it difficult to calculate quantitatively. To address this, we introduced the concept of X, which involves dividing the irregular shape into small rectangles. As the number of subdivisions increases, the sum of the rectangular areas more closely approximates the actual area of the shape. In this case, we used a 1 mm width for the subdivisions to ensure calculability. The X measurement was taken directly from the sagittal plane of the segmented sections. TB has proven to be a precise and valuable tool for predicting the surgical difficulty of maxillary third molar extraction in this case, offering a practical reference for assessing the complexity and risks associated with such procedures. However, further validation across a larger cohort is required.

The data obtained in this study necessitated extensive manual post-processing, introducing challenges such as subjectivity and reproducibility concerns. Thus, exploring the use of computer algorithms to enhance data consistency and to advance CT data segmentation and measurement toward automation and greater precision remains a worthwhile



	18	28
The cross-section area of tegmen bones	25.8 mm^2	29.5 mm^2
Bone thickness at the thinnest part of the root	1.1 mm	0 mm
Bone thickness at the thinnest part of the crown	0 mm	0.9 mm
X maximum	5.2 mm	5.4 mm
The number of sections with X	8	10
The number of sections with X ≥ 3mm	6	6

Figure 4 Digital imaging analysis of key factors in cone-beam computed tomography.

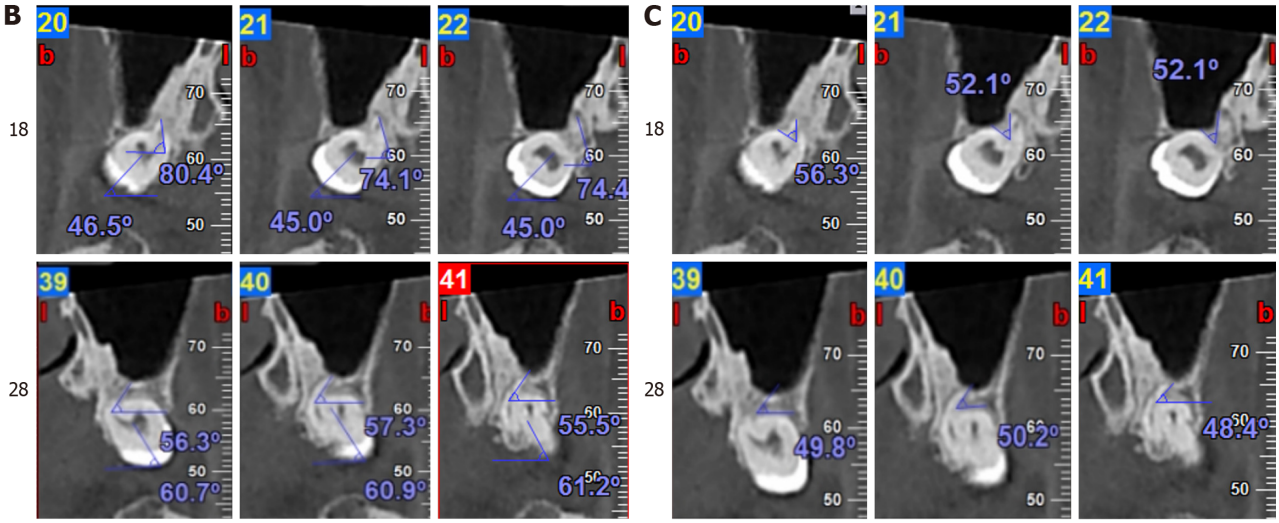
endeavor[12,13]. Additionally, there is a need for further refinement in stress analysis of the alveolar bone during tooth extraction[14]. As research progresses, measurement accuracy will continue to improve.

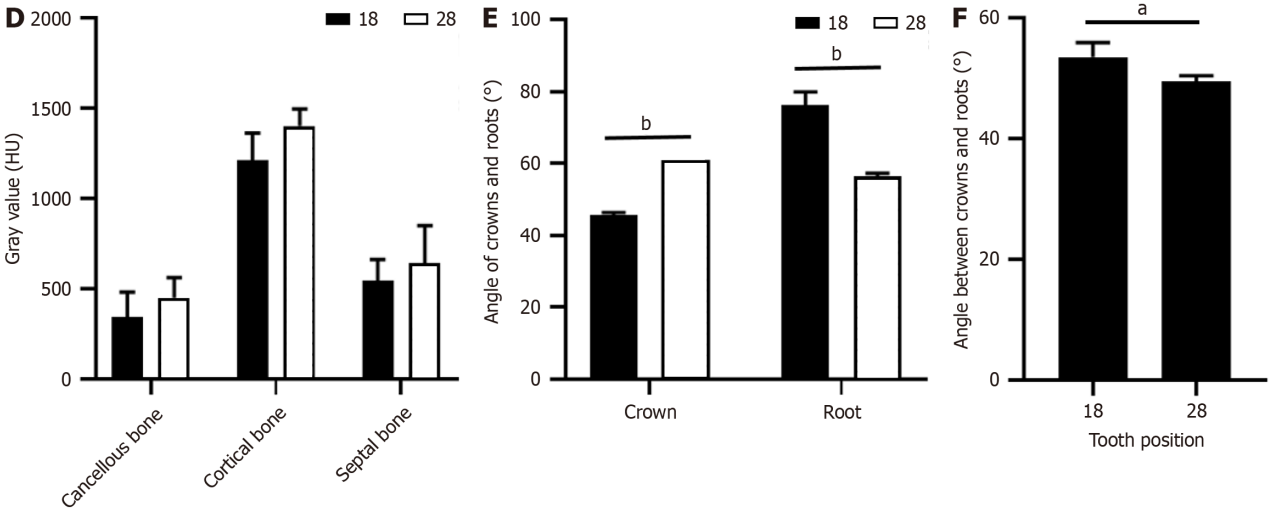
CONCLUSION

In summary, this article presents an intriguing case report. The experienced clinician initially assessed the CBCT scans and concluded that tooth 18 was more likely to perforate, yet the outcome revealed no perforation in tooth 18, but rather in tooth 28. We find this paradox particularly interesting: Why did tooth 18, which appeared to have a greater degree of curvature, not perforate? Were there radiographic data that we overlooked, leading to an incorrect prediction? Given that this case rules out variations in patient anatomy and operator skill, we conducted a thorough analysis of all potential factors evident in the CBCT scans and compared them. Our findings suggest that the critical determinant was the tegmental bone volume between the tooth and the floor of the maxillary sinus. Additionally, we propose a simplified measurement method, aiming to provide a feasible approach for evaluating extraction risks and difficulty based on radiographic data.

A

	18 (HU)			28 (HU)		
Cancellous bone	494	313	219	569	435	350
Cortical bone	1356	1049	1223	1508	1373	1329
Septal bone	457	493	680	520	884	523





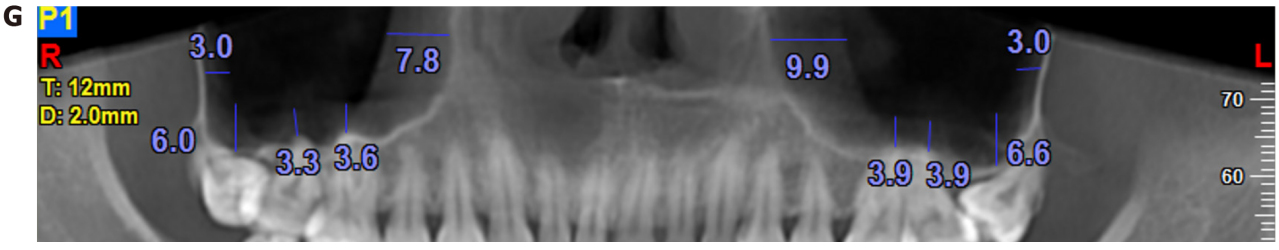


Figure 5 Digital imaging analysis of secondary factors in cone-beam computed tomography. A: Measurement of gray values; B: Angle measurement between the crown and root relative to the jaw plane; C: Angle measurement between crowns and roots; D: Statistical analysis of gray values at different positions; E: Statistical analysis of the angle between the crown and root relative to the Frankfort plane; F: Statistical analysis of the angle between crowns and roots; G: Measurement of maxillary sinus mucosa. $^{a}P < 0.05$, $^{b}P < 0.001$.

FOOTNOTES

Author contributions: Liu H drafted the manuscript; Liu H and Yan X conducted the research; Wang F and Tang YL revised the language. All authors reviewed and edited the entire manuscript.

Informed consent statement: All involved persons gave their informed consent prior to study inclusion.

Conflict-of-interest statement: The authors declare that they have no conflicts of interest concerning this article.

CARE Checklist (2016) statement: The authors have read the CARE Checklist (2016), and the manuscript was prepared and revised according to the CARE Checklist (2016).

Country of origin: China

ORCID number: Han Liu 0000-0003-2675-8744; Xing Yan 0009-0000-0507-1025.

S-Editor: Liu H
L-Editor: A
P-Editor: Xu ZH

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