



Asymmetric Displacement in a Maxillary Alveolar Fracture: A Two-Year CBCT-Documented Healing Case Report

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Abstract

Accurate characterization of dentoalveolar trauma remains challenging when conventional radiography underestimates the spatial behavior of alveolar fracture segments. This case report introduces a previously underemphasized phenomenon of asymmetric displacement within a single alveolar fracture segment and its implications for biological healing under conservative management. A 26-year-old female patient presented one week after trauma to the maxillary anterior region. Initial clinical and periapical radiographic evaluation suggested a luxation injury of both maxillary central incisors; however, cone-beam computed tomography (CBCT) subsequently revealed a displaced alveolar fracture with buccal cortical plate displacement involving both teeth, with marked intra-segmental asymmetry, demonstrating approximately 1 mm displacement in one incisor region and 3 mm in the adjacent region within the same fracture unit. Management included continued stabilization, occlusal adjustment, and endodontic treatment initiated during the early post-traumatic phase because of concern regarding pulpal compromise associated with dentoalveolar injury. Calcium hydroxide was used as an intracanal medicament followed by definitive obturation. No surgical repositioning was performed. At the two-year follow-up, both teeth were asymptomatic and functionally stable. Radiographic and CBCT evaluation demonstrated complete osseous remodeling, restoration of normal periodontal architecture, and absence of pathological sequelae. This case suggests that asymmetric displacement within a single alveolar fracture segment may be compatible with favorable healing when adequate segmental stability is maintained. This observation also highlights the value of three-dimensional characterization of displacement patterns that may not be apparent on conventional radiography.

Keywords: Calcium Hydroxide; Cone-Beam Computed Tomography; Dentoalveolar Trauma; Endodontics; Mineral Trioxide Aggregate; Periodontal Ligament; Root Canal Obturation; Sodium Hypochlorite; Tooth Pulp Disease; Tooth Resorption

Introduction

Traumatic injuries to the maxillary anterior region are among the most frequent dental emergencies in children and young adults and may result in complex combinations of hard and soft tissue damage, including luxation injuries and alveolar bone fractures [1-3]. These injuries not only compromise esthetics and function but also present significant diagnostic and therapeutic challenges due to variability in clinical presentation and healing responses.

Conventional periapical radiography remains the initial imaging modality in dental trauma; however, its diagnostic limitations in detecting alveolar fractures and three-dimensional displacement patterns are well documented. Superimposition of anatomical structures and the inability to accurately assess buccal and palatal cortical plates may lead to underestimation of injury severity, particularly in cases with subtle clinical findings. As a result, clinically “mild-appearing” trauma may conceal more extensive structural damage [4].

Cone-beam computed tomography (CBCT) has been increasingly recognized as a valuable adjunct in the assessment of maxillofacial trauma due to its ability to provide high-resolution three-dimensional visualization of dentoalveolar structures [5]. Previous studies have demonstrated that CBCT offers superior diagnostic accuracy compared with conventional radiography in detecting root fractures, alveolar bone fractures, and complex luxation injuries, particularly when clinical and radiographic findings are incongruent [6]. Accordingly, CBCT is recommended in selected cases where conventional imaging does not adequately explain clinical signs and symptoms.

In addition to diagnostic imaging considerations, management of displaced alveolar fractures remains clinically challenging. While repositioning and stabilization are generally recommended for displaced alveolar/root fractures [1, 7, 8], delayed presentation may complicate conventional acute management. Treatment decisions in such cases should be individualized and based on a combination of clinical findings, imaging data, and patient-specific factors, rather than radiographic appearance alone [1].

Furthermore, assessment of pulpal status following luxation injuries remains challenging in the acute phase. Loss of response to pulp sensibility testing is common immediately after trauma due to transient neural impairment and does not necessarily indicate irreversible pulp necrosis [9]. Therefore, serial clinical and radiographic evaluations are essential before definitive endodontic diagnosis and treatment decisions are made.

The present case report describes the management of a luxation injury with a displaced alveolar fracture involving both maxillary central incisors in a young adult patient, in which CBCT played a decisive role in revealing the true extent of injury and guiding a conservative treatment approach. The case highlights the limitations of conventional imaging, the importance of CBCT in trauma diagnosis, and the potential for favorable long-term outcomes following non-surgical management combined with appropriate endodontic intervention. Particular attention is given to the unequal displacement observed across adjacent regions of the same fractured alveolar segment and its subsequent structural remodeling.

Case Presentation

A healthy (non-smoker) 26-year-old female was referred to a private endodontic practice approximately one week after sustaining traumatic injury to the maxillary anterior region. According to the patient's report, the injury occurred following a fall onto a hard surface, resulting in direct impact to both maxillary central incisors. Immediately after the trauma, the

patient experienced severe pain in the affected region and sought emergency dental care, where a rigid splint was placed as an initial management measure before referral for definitive evaluation and treatment. The splint was a wire-composite rigid splint (0.032-inch stainless steel round orthodontic wire) extending from canine to canine in the maxillary anterior region. No repositioning of the displaced dentoalveolar segment had been performed at the emergency visit.

At the time of presentation, the patient's chief complaint was persistent post-traumatic pain and discomfort in the maxillary anterior region. Clinical examination revealed both maxillary central incisors stabilized with a previously placed rigid splint. No pathological mobility was detected; the traumatized segment was stable en bloc under the splint without evidence of increased physiological or pathological mobility (Grade 0 mobility). No crown fractures were detected. Periodontal probing depths were within normal limits, and no soft tissue laceration or swelling was observed. Occlusal analysis revealed slight premature contacts associated with the traumatized dentoalveolar segment.

A baseline periapical radiograph obtained with the splint in place demonstrated no definitive pathological findings; however, a subtle widening of the periodontal ligament space was observed in the apical region of the right maxillary central incisor. Given the discrepancy between clinical symptoms and inconclusive two-dimensional imaging findings, cone-beam computed tomography (CBCT) was prescribed for further evaluation [10]. High-resolution CBCT images were obtained using a NewTom VGi CBCT unit (Verona, Italy) with a 6×6 cm field of view, 0.1-mm voxel size, 110 kVp, and 0.56 mA.

CBCT imaging revealed a displaced alveolar fracture involving both maxillary central incisors. Three-dimensional reconstruction demonstrated disruption of the labial cortical plate and fracture of the anterior maxillary alveolar process. Sagittal sections revealed approximately 1 mm displacement in the right central incisor region and approximately 3 mm displacement in the left central incisor region. Axial sections confirmed a fracture line traversing the alveolar process with loss of continuity of the buccal cortical plate. These findings indicated a more extensive injury than was evident on conventional radiography. No attempt at fracture-segment repositioning had been made during the initial emergency visit, where management consisted of stabilization alone. At presentation one week after trauma, the fractured segment was clinically stable en bloc under the existing splint; therefore, delayed manipulation and repositioning were not undertaken, and conservative management with continued stabilization was selected.

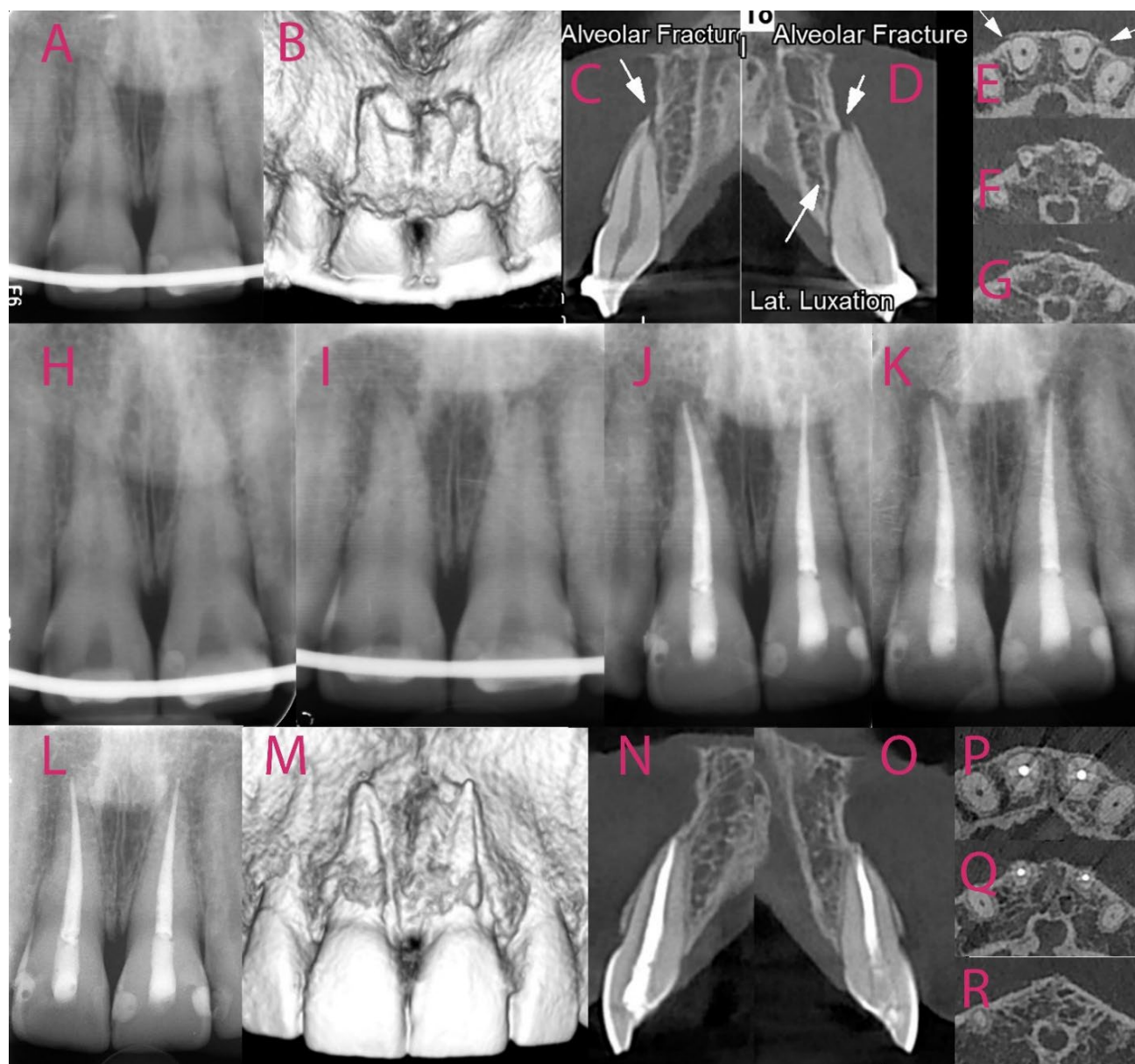


Figure 1. Clinical, radiographic, and CBCT assessment and management of a displaced alveolar fracture involving both maxillary central incisors. A) Initial periapical radiograph obtained with the rigid splint in place, demonstrating subtle widening of the PDL space in the apical region of the right maxillary central incisor; B) Three-dimensional CBCT reconstruction illustrating a fracture of the anterior maxillary alveolar process involving both central incisors; C) Sagittal CBCT section of the right maxillary central incisor showing an alveolar fracture with approximately 1 mm separation of the fractured segment; D) Sagittal CBCT section of the left maxillary central incisor demonstrating a more pronounced displacement of the alveolar segment, measuring approximately 3 mm; E) Axial CBCT section at the mid-root level showing a fracture line traversing the alveolar process; F) Axial CBCT section at the apical level demonstrating displacement of the fractured alveolar segment and associated apical structures; G) More apical axial CBCT section showing loss of continuity between the fractured alveolar bone and the external cortical plate; H) Postoperative periapical radiograph obtained after endodontic access preparation, placement of calcium hydroxide intracanal medicament, and occlusal adjustment; I) Five-week follow-up radiograph demonstrating absence of pathological changes; J) Post-obturation radiograph following completion of root canal treatment and splint removal; K) One-year follow-up radiograph showing stable periapical conditions and absence of pathology; L) Two-year follow-up radiograph confirming sustained healing and functional stability; M) Two-year follow-up CBCT three-dimensional reconstruction demonstrating complete osseous remodeling and absence of visible fracture lines; N, O) Sagittal CBCT sections demonstrating re-establishment of normal PDL and restoration of alveolar bone architecture; P–R) Axial CBCT sections at the mid-root, apical, and infra-apical levels confirm complete healing of the alveolar fracture with restoration of normal trabecular bone pattern and surrounding structures.

Based on the combined clinical and CBCT findings, a diagnosis of luxation injury associated with a displaced alveolar fracture was established. Initial pulp sensibility testing had revealed no response in either tooth; however, these findings were interpreted cautiously in the context of recent trauma and were not considered definitive for pulp necrosis at that stage.

Considering the extent of luxation and alveolar displacement, disruption of cortical bone, and concern regarding pulpal vascular compromise, endodontic treatment was initiated approximately one week after trauma. Under local anesthesia and rubber dam isolation, access cavities were prepared in both maxillary central incisors. Working lengths were determined using an electronic apex locator. Chemomechanical preparation was performed using a step-back instrumentation technique with copious irrigation with 5.25% sodium hypochlorite. Upon access cavity preparation, no bleeding was observed from the pulp chamber in either tooth, which was considered an additional clinical indicator of compromised pulpal vitality when interpreted together with the preceding clinical findings and severity of the dentoalveolar injury.

Calcium hydroxide was placed as an intracanal medicament to enhance disinfection and create a favorable biological environment for periradicular healing. The rigid splint was left in situ during the entire endodontic procedure to maintain segmental stability and prevent any iatrogenic mobility. A postoperative radiograph was obtained.

The patient received detailed postoperative instructions, including maintenance of oral hygiene, use of a soft toothbrush, chlorhexidine mouth rinse twice daily for two weeks, adherence to a soft diet, avoidance of anterior biting, and prompt reporting of any new symptoms.

At the five-week follow-up, the patient was completely asymptomatic. Clinical examination revealed the absence of pain, tenderness to percussion, swelling, sinus tract formation, or abnormal mobility. Radiographic assessment showed no evidence of progressive pathology. Given the favorable clinical and radiographic response, calcium hydroxide was removed, final irrigation was performed, and root canal obturation was

completed using gutta-percha (Ariadent, Tehran, Iran) and zinc-oxide sealer (Roth International LTD- USA) with a lateral condensation technique. At the same visit, the splint was removed, as it had been maintained for approximately five weeks and was no longer required. A postoperative radiograph confirmed adequate obturation. The patient tolerated the staged treatment without reported complications.

At the one-year follow-up, both teeth remained asymptomatic and fully functional. The clinical examination revealed normal periodontal parameters, absence of mobility, and no tenderness to percussion or palpation. Radiographic evaluation revealed stable periapical conditions without evidence of inflammatory or replacement resorption.

At the two-year follow-up, the patient reported complete comfort and normal function. Radiographic examination confirmed maintenance of healthy periapical structures. Follow-up CBCT was obtained to assess three-dimensional healing of the initially displaced alveolar fracture, using the same imaging protocol. CBCT imaging demonstrated complete osseous remodeling and restoration of alveolar architecture, with re-establishment of normal periodontal ligament space and lamina dura. No evidence of root resorption, ankylosis, persistent fracture lines, or periodontal defects was observed. No adverse or unanticipated clinical events or need for additional treatment occurred during the two-year follow-up period.

At the final follow-up, two years after treatment, both maxillary central incisors remained clinically and radiographically healthy, demonstrating successful long-term healing following CBCT-guided conservative management combined with timely endodontic intervention. Clinical course and chronological findings are summarized in [Table 1](#).

The patient reported high satisfaction with the functional and esthetic outcomes and complete relief from the pre-treatment pain and discomfort. She reported restored chewing function and improved confidence in the anterior esthetic zone. She also reported adherence to the postoperative instructions, with no treatment-related difficulties or intolerance during follow-up.

Table 1. Clinical timeline of diagnosis, treatment, and follow-up

Time Point	Clinical Findings	Radiographic Findings	Intervention
Day 0 (Trauma)	Severe pain, splinted by emergency care	No CBCT available	Rigid splint placement; no fracture-segment repositioning
Day 7 (Presentation)	Persistent pain, no response to the sensibility test	CBCT: asymmetric alveolar fracture (1 mm / 3 mm displacement)	Endodontic access initiated, Ca(OH) ₂ placed, occlusal adjustment
Week 5	Asymptomatic	No progression of pathology	Calcium hydroxide removal, obturation completed, splint removed
1 Year	Functionally normal, asymptomatic	Stable PDL and lamina dura	Follow-up only
2 Years	Normal function, no symptoms	CBCT: complete osseous remodeling	Final evaluation

Discussion

This case offers an additional consideration of alveolar fracture management by highlighting an underreported phenomenon: asymmetric displacement within a single fracture segment involving adjacent teeth in the same alveolar unit. Unlike previously reported cases that generally describe displacement at the level of the fractured segment, the present case demonstrates that spatial displacement may vary significantly within a continuous fracture segment, with differential movement observed between adjacent central incisors [7, 11]. However, the observed intra-segmental asymmetry should be interpreted cautiously, as it may have resulted from a combination of the initial trauma mechanics and subsequent post-traumatic factors. In particular, the lack of immediate repositioning of the displaced alveolar segment at the emergency visit and the presence of premature occlusal contacts during the first week after trauma may have contributed to the differential displacement observed at the time of CBCT evaluation. Since the patient presented one week after injury, and the fractured segment was clinically stable en bloc under the existing splint, delayed repositioning was not undertaken, and management was based on the stability and functional condition of the traumatized segment at that stage.

The clinical relevance of this observation lies in its potential biomechanical and biological implications. Although tooth #8 exhibited minimal displacement (~1 mm), tooth #9 within the same fractured segment demonstrated significantly greater displacement (~3 mm), yet both teeth demonstrated complete osseous remodeling under conservative management. This finding may suggest that displacement magnitude alone may not fully explain healing outcomes, provided that segmental stability is maintained. Importantly, this observation does not establish a threshold of acceptable displacement; rather, it documents favorable healing across regions with unequal displacement within the same stabilized fracture segment.

Conventional periapical radiography failed to accurately depict this intra-segmental heterogeneity, reinforcing the role of CBCT in identifying three-dimensional fracture behavior rather than merely confirming fracture presence [12]. In this case, the primary contribution of CBCT was not only the confirmation of fracture involvement but also the detailed characterization of the spatial relationship between the fractured segment and adjacent structures, which provided additional information for clinical decision-making. However, the decision to continue conservative management was

primarily based on the clinical stability of the traumatized segment, occlusal conditions, and absence of progressive displacement rather than CBCT findings alone.

From a therapeutic standpoint, conservative management was selected based on the clinical stability of the fractured alveolar segment, acceptable occlusal conditions, and the absence of progressive displacement at the time of presentation [7]. Although repositioning of the fractured segment would generally be considered during the acute management of displaced alveolar fractures, no repositioning had been performed initially, and at the delayed presentation the segment was stable en bloc under the existing splint; consequently, delayed manipulation was not undertaken. The stabilization period was extended to five weeks, slightly beyond the four weeks commonly recommended for alveolar fractures, due to the presence of a displaced fracture segment with asymmetric displacement (up to approximately 3 mm), the absence of initial repositioning, and the intention to allow additional time for osseous consolidation before functional loading. This represents a case-specific modification of the conventional protocol, and the favorable two-year outcome suggests that adequate stabilization was achieved despite this deviation. The outcome should not be interpreted as evidence against acute repositioning of displaced alveolar fractures, but rather as documentation of the healing observed in this delayed-presenting, clinically stable case.

Endodontic decision-making also warrants careful interpretation. In light of the alveolar fracture pattern, including loss of buccal cortical plate continuity and the presence of asymmetric displacement within the fractured segment, together with absent pulp sensibility responses and concern regarding vascular compromise, endodontic treatment was initiated in the early post-traumatic phase. A negative sensibility response shortly after trauma is not, by itself, diagnostic of pulp necrosis [9]. In the present case, this finding was considered together with the severity of the injury and the subsequent absence of intracanal bleeding at access. The treatment decision therefore reflects the circumstances of this individual case and should not be interpreted as supporting routine prophylactic endodontic treatment after alveolar fracture.

The biological considerations underlying endodontic management are also relevant when interpreting healing after traumatic dental injuries. Calcium-based and calcium-silicate endodontic biomaterials have been investigated in experimental and clinical studies addressing biocompatibility,

tissue responses, vital pulp therapy, and apical procedures [13-18]. Additional studies have characterized the tissue responses to calcium-based pulp-capping materials and the chemical composition of calcium-silicate biomaterials [13, 14, 16, 19]. These findings provide broader biological context for endodontic treatment; however, the present case involved calcium hydroxide as an intracanal medicament, and the cited studies addressed different materials and clinical indications. Therefore, direct extrapolation to the healing outcome observed in this case is not warranted.

Long-term follow-up demonstrated complete structural recovery without evidence of ankylosis, resorption, or periodontal breakdown. These findings support the hypothesis that healing potential in alveolar fractures may be influenced not only by displacement magnitude but also by relative stability within the fractured segment, a factor that has received limited attention in existing literature. This hypothesis requires evaluation in larger clinical series with standardized three-dimensional assessment and prospectively defined outcomes.

This case, therefore, may indicate a clinically relevant observation that asymmetric displacement within a single alveolar fracture segment does not preclude favorable healing under conservative management, provided that functional stability is achieved.

This report is limited by its single-case design, and the findings cannot be generalized or used to establish causal relationships regarding the observed healing pattern of asymmetric displacement. In addition, because the first CBCT examination was obtained one week after trauma, the observed displacement cannot be attributed exclusively to the initial traumatic event; post-traumatic mechanical factors during the intervening period may also have contributed.

Conclusion

Within the limitations of a single case report, this case demonstrates that CBCT can reveal clinically relevant three-dimensional characteristics of an alveolar fracture that may remain inconspicuous on conventional radiography. Markedly asymmetric displacement within a continuous fracture segment was followed by favorable two-year osseous remodeling in this clinically stable, conservatively managed case. The finding supports consideration of fracture configuration together with segmental stability and clinical conditions rather than displacement magnitude in isolation.

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Conflict of interest

None.

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Authors' contributions

Conceptualization: SA/MF/MJE; Methodology: SA/MF/MJE; Formal Analysis/Investigation: SA/MF; Writing-Original draft preparation: SA; Writing-review/editing: SA/MF/MJE; Supervision: SA/MJE. All authors read and approved the final manuscript.

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