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Management of Dentoalveolar trauma with surgical repositioning and orthodontic splinting

Dr. Sanjay Jasuja[1*], Dr. Sanjay Talnia[2], Dr. Adit Arora[3], Dr. Rajat Swami[4], Dr. Esha Sangwan[5], Dr. Vikash[6], Dr. Kunal Raj[7]

[1]Associate Professor, Department of Orthodontics & Dentofacial Orthopedics, Maharaja Ganga Singh Dental College & Research Centre, Sri Ganganagar, Rajasthan

[2]Associate Professor, Department of Dentistry, Adesh Medical College and Hospital, Kurukshetra, Haryana

[3]Professor & HOD, Department of Orthodontics & Dentofacial Orthopedics, Maharaja Ganga Singh Dental College & Research Centre, Sri Ganganagar, Rajasthan

[4]Post Graduate Student, Department of Oral & Maxillofacial Surgery, Maharaja Ganga Singh Dental College & Research Centre, Sri Ganganagar, Rajasthan

[5]Post Graduate Student, Department of Oral & Maxillofacial Surgery, Maharaja Ganga Singh Dental College & Research Centre, Sri Ganganagar, Rajasthan

[6]Post Graduate Student, Department of Oral & Maxillofacial Surgery, Maharaja Ganga Singh Dental College & Research Centre, Sri Ganganagar, Rajasthan

[7]Post Graduate Student, Department of Oral and Maxillofacial Pathology & Oral Microbiology, Maharaja Ganga Singh Dental College & Research Centre, Sri Ganganagar, Rajasthan

****Corresponding author: Dr. Sanjay Jasuja, jasujatooth@gmail.com***

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ABSTRACT

Background: Dentoalveolar trauma may involve the teeth, periodontal ligament, alveolar bone, and surrounding soft tissues, leading to pain, mobility, malocclusion, pulpal injury, and long-term complications. Prompt repositioning and stabilization are important for restoring function and promoting periodontal and pulpal healing. Aim: To evaluate the clinical and radiographic outcomes of dentoalveolar trauma managed with surgical repositioning followed by orthodontic splinting. Material and Methods: This prospective observational study included 40 patients with dentoalveolar trauma treated at a tertiary care hospital. Patients with luxation injuries, displaced teeth, and dentoalveolar segment fractures requiring repositioning and stabilization were included. Clinical and radiographic parameters included injury type, tooth mobility, pain, tenderness, occlusal disturbance, pulp sensibility, periodontal ligament changes, alveolar fracture, and root fracture. Displaced teeth or dentoalveolar segments were surgically repositioned and stabilized using a passive flexible orthodontic wire-composite splint. Outcomes and complications were assessed during follow-up. Data were analyzed using IBM SPSS Statistics version 27.0, with $p<0.05$ considered statistically significant. Results: The mean age was 24.85 ± 9.63 years, and 67.50% were males. Lateral luxation was the most common injury (32.50%), while 37.50% had alveolar bone fracture. Mean pain score decreased from 5.18 ± 1.47 to 0.68 ± 0.76 and mean mobility grade from 2.30 ± 0.69 to 0.15 ± 0.43 (both $p<0.001$). Anatomical position was maintained in 92.50%, adequate stability in 90.00%, and satisfactory periodontal healing in 87.50%. Overall treatment success was 85.00%. Early presentation within 24 hours ($p=0.014$), involvement of one or two teeth ($p=0.026$), and absence of alveolar fracture ($p=0.021$) were significantly associated with better outcomes. Conclusion: Surgical repositioning with orthodontic splinting provided favorable functional and clinical outcomes in dentoalveolar trauma. Early treatment and limited injury extent were associated with improved prognosis.

Keywords: Dentoalveolar trauma, Surgical repositioning, Orthodontic splinting, Luxation injury, Dental trauma

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INTRODUCTION

Dentoalveolar trauma represents an important component of oral and maxillofacial injuries and may involve the teeth, periodontal ligament, gingiva, alveolar bone, and surrounding soft tissues. The consequences of such injuries extend beyond immediate pain and functional impairment because trauma to permanent teeth can influence aesthetics, mastication, speech, periodontal health, pulpal vitality, and long-term tooth survival. Dentoalveolar injuries may occur following falls, road traffic accidents, sports-related incidents, interpersonal violence, occupational accidents, and other forms of direct facial trauma. Depending on the direction and magnitude of the traumatic force, the resulting injury may range from a minor periodontal insult to severe displacement or loss of teeth and fracture of the supporting alveolar process. Prompt recognition and appropriate management are therefore essential for preserving the injured teeth and minimizing long-term functional and psychological consequences.[1] Traumatic dental injuries comprise several distinct clinical entities, including concussion, subluxation, lateral luxation, extrusion, intrusion, avulsion, crown and root fractures, and fractures involving the alveolar process. Luxation injuries are particularly important because they affect the periodontal ligament and neurovascular

supply of the pulp in addition to producing varying degrees of tooth displacement. Alveolar fractures may involve a group of adjacent teeth that move together as a single segment and are frequently associated with occlusal disturbance and soft-tissue injury. Accurate diagnosis requires systematic clinical examination, assessment of tooth mobility and displacement, evaluation of occlusion and soft tissues, pulp sensibility testing, and appropriate radiographic examination. Multiple radiographic projections and cone-beam computed tomography may be required in selected patients when conventional imaging does not adequately demonstrate the extent of the injury.[2] The management of dentoalveolar injuries is determined by the type and severity of trauma, degree and direction of displacement, presence of alveolar fracture, stage of root development, condition of the periodontal tissues, associated soft-tissue injuries, and interval between trauma and treatment. Dentoalveolar fractures require careful evaluation because injuries to the supporting bone may compromise tooth stability and alter normal occlusion. Treatment may involve repositioning of displaced teeth or fractured alveolar segments followed by stabilization using an appropriate splint. The principal objective is to restore the anatomical relationship of the teeth and supporting structures while creating conditions that permit periodontal and osseous healing. In more extensive injuries, management may require coordination between oral and maxillofacial surgeons, orthodontists, endodontists, restorative dentists, and other dental specialists.[3] Surgical repositioning is an important treatment approach for displaced permanent teeth when spontaneous or orthodontic repositioning is unsuitable or when immediate correction of significant displacement is required. The procedure aims to return the traumatized tooth or dentoalveolar segment to its anatomically appropriate position with minimal additional injury to the periodontal ligament. Re-establishment of proper alignment and occlusal relationship is followed by stabilization to protect the injured supporting tissues during the initial healing phase. Careful manipulation is essential because excessive force during repositioning may cause additional periodontal and pulpal damage. The subsequent prognosis depends not only on anatomical repositioning but also on the original severity of trauma, stage of root development, condition of the periodontal ligament, and biological response of the dental pulp.[4] Splinting is an integral component of the management of many luxation injuries, root fractures, and dentoalveolar fractures. The purpose of splinting is to provide adequate stabilization while permitting a degree of physiological tooth mobility that supports periodontal healing. Flexible or semi-flexible splints are generally preferred for appropriate traumatic injuries because excessive rigidity may interfere with physiological stimulation of the periodontal ligament. Orthodontic wire secured with composite resin provides a practical method for stabilizing repositioned teeth and allows the clinician to maintain the affected teeth in the desired position while facilitating oral hygiene and clinical monitoring. The duration and nature of splinting should be selected according to the type of injury, fracture location, stability of the affected segment, and healing requirements of the supporting tissues.[5] Orthodontic considerations are particularly relevant when traumatized teeth require stabilization or subsequent controlled movement. Teeth that have sustained significant periodontal or pulpal injury require careful assessment before the application of orthodontic forces. The orthodontic appliance used for splinting should remain passive so that it stabilizes the repositioned tooth without producing unwanted active movement. Following the healing period, continued clinical and radiographic assessment is necessary before initiating or resuming active orthodontic treatment. Multidisciplinary coordination is especially valuable when dentoalveolar trauma occurs in patients who already require orthodontic treatment, as treatment planning must consider periodontal healing, pulpal status, root development, root resorption, and the possibility of post-traumatic complications.[6]

MATERIALS AND METHODS

This prospective observational study was conducted at a tertiary care hospital and included 40 patients presenting with dentoalveolar trauma requiring surgical repositioning followed by orthodontic splinting. Patients were evaluated in the Department of Dentistry/Oral and Maxillofacial Surgery in coordination with the Department of Orthodontics. The study was conducted after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all patients or from parents/guardians in case of minors before enrolment and treatment. A total of 40 consecutive patients with traumatic injuries involving the teeth and supporting dentoalveolar structures were included. Patients of either sex presenting with luxation injuries, displacement of teeth, alveolar process fractures, or dentoalveolar segment displacement that required active repositioning and stabilization were considered eligible. Detailed demographic and clinical information, including age, sex, mechanism of injury, time elapsed between trauma and presentation, site of injury, number of teeth involved, and associated soft-tissue injuries, was recorded using a predesigned proforma.

Inclusion and Exclusion Criteria

Patients with permanent teeth affected by lateral luxation, extrusive luxation, intrusive luxation suitable for surgical repositioning, displacement associated with dentoalveolar fracture, or mobile dentoalveolar segments requiring repositioning and splinting were included. Patients who were willing to comply with treatment and follow-up were also included. Patients with severely comminuted maxillofacial fractures requiring extensive open reduction and internal fixation, teeth with gross pre-existing periodontal disease, non-restorable crown-root fractures, advanced dental caries compromising prognosis, uncontrolled systemic illness, or incomplete clinical records were excluded.

METHODOLOGY

A comprehensive intraoral and extraoral examination was performed at presentation. Clinical parameters included tooth displacement, mobility, tenderness to percussion, gingival or mucosal laceration, bleeding from the gingival sulcus, occlusal disturbance, crown fracture, root exposure, and presence of alveolar segment mobility. Tooth mobility was graded clinically, and pulp sensibility was assessed whenever feasible. Preoperative radiographic assessment was performed using intraoral periapical radiographs, occlusal radiographs, orthopantomography, or cone-beam computed tomography when clinically indicated. Radiographs were evaluated for root fracture, alveolar bone fracture, periodontal ligament space alteration, displacement of teeth, and associated bony injury.

Surgical Repositioning Procedure: All procedures were performed under appropriate local anaesthesia with strict aseptic precautions. Following adequate anaesthesia, displaced teeth or dentoalveolar segments were gently manipulated and repositioned into their anatomically correct position using controlled digital pressure and suitable dental instruments where required. Proper alignment was verified clinically by comparison with adjacent teeth and by restoration of the pre-traumatic occlusal relationship. Any associated soft-tissue wounds were irrigated thoroughly, debrided when required, and sutured using appropriate suture material. Care was taken to minimize additional trauma to the periodontal ligament and surrounding tissues during repositioning.

Orthodontic Splinting: Following successful repositioning, the affected teeth were stabilized with a passive flexible orthodontic splint. An orthodontic stainless-steel wire was adapted across the injured teeth with involvement of adequate healthy teeth on either side and was secured using light-cured composite resin. The splint was checked to ensure adequate stabilization without exerting active orthodontic force or interfering with normal occlusion. The stability of the splint, gingival condition, oral hygiene, and occlusion were assessed during subsequent follow-up visits. Splint removal was undertaken according to the type and severity of dentoalveolar injury and evidence of satisfactory clinical healing.

Postoperative Management: All patients received standardized postoperative instructions regarding oral hygiene, soft diet, avoidance of biting on the traumatized region, and prevention of

further injury. Analgesics and antibiotics were prescribed when clinically indicated. Patients were advised to maintain oral hygiene with gentle tooth brushing and appropriate antiseptic mouth rinse. Endodontic assessment and treatment were performed when indicated on the basis of pulpal status, development of symptoms, radiographic changes, or evidence of pulp necrosis.

Outcome Assessment: Patients were assessed clinically and radiographically during follow-up. The primary outcome parameters included successful anatomical repositioning, stabilization of the traumatized teeth, maintenance of normal occlusion, reduction in pathological mobility, and periodontal healing. Secondary parameters included pain, tooth mobility, gingival inflammation, pulp vitality or pulp necrosis, discoloration, root resorption, periapical pathology, ankylosis, infection, loss of tooth, and requirement for endodontic treatment. Treatment was considered successful when the repositioned tooth or dentoalveolar segment remained stable in a satisfactory functional and aesthetic position without progressive mobility, infection, severe root resorption, or other complications necessitating extraction.

Data Collection and Statistical Analysis: All clinical and radiographic findings were entered into a structured data collection sheet and subsequently entered into Microsoft Excel. Statistical analysis was performed using IBM SPSS Statistics for Windows, version 27.0. Continuous variables were expressed as mean ± standard deviation, whereas categorical variables were presented as frequencies and percentages. The Shapiro–Wilk test was used to assess normality of continuous data. The paired t-test or Wilcoxon signed-rank test was used for comparison of paired continuous variables, as appropriate. The chi-square test or Fisher's exact test was used to determine associations between categorical variables and treatment outcomes. Associations of factors such as age, type of injury, number of teeth involved, time of presentation, initial mobility, and presence of alveolar fracture with clinical outcome were evaluated. A p value of <0.05 was considered statistically significant.

RESULTS

A total of 40 patients with dentoalveolar trauma who underwent surgical repositioning followed by orthodontic splinting were included in the study.

Demographic and Trauma-Related Characteristics of the Study Patients

Characteristic	Number (n=40)	Percentage (%)
Age group (years)		
≤15	6	15.00
16–25	17	42.50
26–35	10	25.00
>35	7	17.50
Mean age (years)	24.85 ± 9.63	—
Sex		
Male	27	67.50
Female	13	32.50
Mechanism of injury		
Road traffic accident	17	42.50
Fall	11	27.50
Sports-related injury	7	17.50
Assault/other trauma	5	12.50
Time from injury to presentation		
≤24 hours	26	65.00
>24 hours	14	35.00
Site predominantly involved		
Maxillary anterior region	28	70.00
Mandibular anterior region	8	20.00
Posterior region	4	10.00
Number of teeth involved		
One tooth	14	35.00
Two teeth	16	40.00
≥3 teeth	10	25.00
Associated soft-tissue injury	23	57.50

The mean age of the study patients was 24.85 ± 9.63 years. The largest proportion of patients belonged to the 16–25-year age group, accounting for 17 (42.50%) patients. Males constituted 27 (67.50%) of the study population, while 13 (32.50%) were females. Road traffic accidents were the most frequent mechanism of injury, observed in 17 (42.50%) patients, followed by falls in 11 (27.50%). Twenty-six (65.00%) patients presented within 24 hours of trauma. The maxillary anterior region was involved in 28 (70.00%) patients. Two teeth were involved in 16 (40.00%) patients, while 23 (57.50%) patients had associated soft-tissue injuries.

Baseline Clinical and Radiographic Characteristics of Dentoalveolar Trauma

Parameter	Number (n=40)	Percentage (%)
Type of dentoalveolar injury		
Lateral luxation	13	32.50
Extrusive luxation	8	20.00
Intrusive luxation	6	15.00
Dentoalveolar segment fracture/displacement	9	22.50
Combined injury	4	10.00
Initial tooth mobility		
Grade I	5	12.50
Grade II	18	45.00
Grade III	17	42.50
Tenderness to percussion	31	77.50
Bleeding from gingival sulcus	30	75.00
Occlusal disturbance	29	72.50
Gingival/mucosal laceration	23	57.50
Crown fracture	8	20.00
Alveolar segment mobility	15	37.50
Positive pulp sensibility at presentation	18	45.00
Negative pulp sensibility at presentation	22	55.00
Radiographic findings		
Periodontal ligament space alteration	27	67.50
Alveolar bone fracture	15	37.50
Root fracture	5	12.50

Lateral luxation was the most common injury pattern and was observed in 13 (32.50%) patients. Dentoalveolar segment fracture or displacement was present in 9 (22.50%), while extrusive and intrusive luxation were observed in 8 (20.00%) and 6 (15.00%) patients, respectively. Grade II mobility was present in 18 (45.00%) patients and Grade III mobility in 17 (42.50%). Tenderness to percussion and bleeding from the gingival sulcus were observed in 31 (77.50%) and 30 (75.00%) patients, respectively. Radiographically, periodontal ligament space alteration was present in 27 (67.50%) patients, alveolar bone fracture in 15 (37.50%), and root fracture in 5 (12.50%).

Comparison of Clinical Parameters before Treatment and at Final Follow-up

Clinical parameter	Before treatment	Final follow-up	P value
Mean pain score (VAS)	5.18 ± 1.47	0.68 ± 0.76	<0.001*
Mean mobility grade score	2.30 ± 0.69	0.15 ± 0.43	<0.001†
Pathological mobility, n (%)	35 (87.50%)	1 (2.50%)	<0.001‡
Tenderness to percussion, n (%)	31 (77.50%)	5 (12.50%)	<0.001‡
Occlusal disturbance, n (%)	29 (72.50%)	3 (7.50%)	<0.001‡
Gingival/sulcular bleeding, n (%)	30 (75.00%)	4 (10.00%)	<0.001‡

*Paired t-test; †Wilcoxon signed-rank test; ‡McNemar test.

The mean pain score decreased from 5.18 ± 1.47 before treatment to 0.68 ± 0.76 at final follow-up, and the difference was statistically significant (p<0.001). The mean mobility grade also decreased significantly from 2.30 ± 0.69 to 0.15 ± 0.43 (p<0.001). Pathological mobility decreased from 35 (87.50%) patients at presentation to 1 (2.50%) patient at final follow-up. Tenderness to percussion decreased from 31 (77.50%) to 5 (12.50%), while occlusal disturbance decreased from 29 (72.50%) to 3 (7.50%). All these changes were statistically significant (p<0.001).

Final Treatment Outcomes and Complications

Outcome/complication	Number (n=40)	Percentage (%)
Anatomical position maintained	37	92.50
Stable tooth/dentoalveolar segment	36	90.00
Normal functional occlusion achieved	37	92.50
Satisfactory periodontal healing	35	87.50
Positive pulp sensibility	31	77.50
Pulp necrosis	9	22.50
Required endodontic treatment	9	22.50
Tooth discoloration	4	10.00
Root resorption	3	7.50
Periapical pathology	2	5.00
Post-treatment infection	2	5.00
Ankylosis	1	2.50
Tooth loss/extraction	2	5.00
Overall successful outcome	34	85.00
Unsuccessful outcome	6	15.00

At final assessment, anatomical position was maintained in 37 (92.50%) patients and adequate stability of the treated tooth or dentoalveolar segment was observed in 36 (90.00%). Normal functional occlusion was achieved in 37 (92.50%) patients, while satisfactory periodontal healing was recorded in 35 (87.50%). Positive pulp sensibility was present in 31 (77.50%) patients. Pulp necrosis requiring endodontic treatment occurred in 9 (22.50%) patients. Root resorption was observed in 3 (7.50%), periapical pathology in 2 (5.00%), infection in 2 (5.00%), and ankylosis in 1 (2.50%) patient. An overall successful treatment outcome was achieved in 34 (85.00%) patients, while 6 (15.00%) had an unsuccessful outcome.

Association of Selected Factors with Overall Treatment Outcome

Factor	Successful outcome n (%)	Unsuccessful outcome n (%)	P value
Age			
≤25 years (n=23)	20 (86.96%)	3 (13.04%)	1.000
>25 years (n=17)	14 (82.35%)	3 (17.65%)	
Sex			
Male (n=27)	23 (85.19%)	4 (14.81%)	1.000
Female (n=13)	11 (84.62%)	2 (15.38%)	
Time to presentation			
≤24 hours (n=26)	25 (96.15%)	1 (3.85%)	0.014
>24 hours (n=14)	9 (64.29%)	5 (35.71%)	
Injury pattern			
Isolated luxation injury (n=27)	25 (92.59%)	2 (7.41%)	0.075
Dentoalveolar segment/combined injury (n=13)	9 (69.23%)	4 (30.77%)	
Number of teeth involved			

Factor	Successful outcome n (%)	Unsuccessful outcome n (%)	P value
1–2 teeth (n=30)	28 (93.33%)	2 (6.67%)	0.026
≥3 teeth (n=10)	6 (60.00%)	4 (40.00%)	
Alveolar fracture			
Present (n=15)	10 (66.67%)	5 (33.33%)	0.021
Absent (n=25)	24 (96.00%)	1 (4.00%)	
Initial mobility			
Grade I–II (n=23)	22 (95.65%)	1 (4.35%)	0.067
Grade III (n=17)	12 (70.59%)	5 (29.41%)	

Fisher's exact test was used because of the small expected frequencies in individual cells. A p value <0.05 was considered statistically significant.

Treatment success was observed in 25 of 26 (96.15%) patients who presented within 24 hours compared with 9 of 14 (64.29%) patients presenting after 24 hours, with a statistically significant association (p=0.014). Among patients with involvement of one or two teeth, 28 of 30 (93.33%) had a successful outcome compared with 6 of 10 (60.00%) patients with involvement of three or more teeth (p=0.026). Successful outcome was recorded in 10 of 15 (66.67%) patients with an alveolar fracture compared with 24 of 25 (96.00%) without an alveolar fracture (p=0.021). Age, sex, injury pattern, and initial mobility grade did not show statistically significant associations with overall treatment outcome (p>0.05).

DISCUSSION

The present study included 40 patients with a mean age of 24.85 ± 9.63 years, and the largest proportion, 42.50%, belonged to the 16–25-year age group. Males constituted 67.50% of the patients. Road traffic accidents were the commonest mechanism of injury (42.50%), followed by falls (27.50%). These findings were comparable with those of Shinde et al. (2024), who evaluated 437 patients with oral and maxillofacial traumatic injuries and reported a male predominance of 84.20%, with 56.80% of patients belonging to the 21–40-year age group. They observed road traffic accidents in 50.30% of cases and falls in 26.50%. Thus, although the proportion of males and road traffic accidents was somewhat lower in the present study, the predominance of young adults and road traffic accidents followed by falls was similar.[7] In the present study, the maxillary anterior region was affected in 70.00% of patients, while the mandibular anterior and posterior regions were involved in 20.00% and 10.00%, respectively. Two teeth were involved in 40.00% of patients, and associated soft-tissue injuries were present in 57.50%. Andreasen et al. (2015), in their analysis of 299 patients with alveolar process fractures involving 815 permanent teeth, reported that 74.00% of fractures occurred in the maxilla and 26.00% in the mandible. Two teeth were involved in 57.00% of their cases, and concomitant soft-tissue injuries were present in 73.00%. They also found the highest frequency of alveolar fractures among patients aged 15–25 years (43.00%), which closely corresponded with the 42.50% of patients aged 16–25 years in the present study.[8] Regarding the clinical characteristics of trauma, lateral luxation was the most frequent injury in the present study (32.50%), followed by dentoalveolar segment fracture/displacement (22.50%), extrusive luxation (20.00%), intrusive luxation (15.00%), and combined injury (10.00%). Grade II and Grade III mobility were observed in 45.00% and 42.50% of patients, respectively; tenderness to percussion occurred in 77.50%, and crown fracture was present in 20.00%. Pedrini et al. (2018), in 137 patients with 301 traumatized permanent teeth, reported that 75.10% of affected teeth were upper anterior teeth. Mobility was recorded in 27.20% of their concussion/subluxation injuries, sensitivity to percussion in 28.90%, and associated crown fractures in 21.00% of concussion and 34.70% of subluxation cases. The higher frequencies of mobility and percussion tenderness in the present study were consistent with the inclusion of more severe displacement injuries such as lateral, extrusive, and intrusive luxations.[9] At initial examination, positive pulp sensibility was observed in 45.00% of patients, whereas 55.00% showed a negative response. At final follow-up, however, 77.50% demonstrated positive pulp sensibility and pulp necrosis was identified in 22.50%, indicating that an initial negative sensibility response did not invariably represent irreversible pulp necrosis. Guan et al. (2008), in a retrospective evaluation of 157 patients with 238 luxated permanent teeth, reported pulp survival in 81.90%, pulp necrosis in 16.00%, and pulp calcification in 2.10%. They further observed the highest frequency of pulp necrosis following intrusive luxation, at 66.70%, and identified injury type and stage of root development as significant determinants of pulp healing. The final pulp survival in their study was therefore comparable with the 77.50% positive pulp sensibility observed in the present study, although the present pulp-necrosis rate was slightly higher at 22.50%.[10] Surgical repositioning followed by orthodontic splinting produced marked clinical improvement in the present study. The mean pain score decreased from 5.18 ± 1.47 to 0.68 ± 0.76, while the mean mobility grade decreased from 2.30 ± 0.69 to 0.15 ± 0.43 (both p<0.001). Pathological mobility decreased from 87.50% to 2.50%, tenderness to percussion from 77.50% to 12.50%, and occlusal disturbance from 72.50% to 7.50%. At final assessment, 92.50% maintained satisfactory anatomical position, 90.00% achieved adequate stability, and 92.50% had normal functional occlusion. Ferrazzini Pozzi et al. (2008) similarly treated 47 laterally luxated permanent teeth by repositioning followed by a titanium trauma splint/composite splint for four weeks and reported survival of all 47 teeth during four-year follow-up. Among 37 teeth not receiving immediate prophylactic root-canal treatment, 51.40% maintained pulp survival, 24.30% developed pulp canal calcification, and 24.30% developed pulp necrosis. These findings supported the favorable structural and functional outcomes following timely repositioning and splint stabilization observed in the present study.[11] Intrusive luxation represented 15.00% of injuries in the present study. Despite the inclusion of such severe injuries, ankylosis was observed in only 2.50%, root resorption in 7.50%, and tooth loss in 5.00% of the total study population. Tsilingaridis et al. (2012) evaluated 60 intruded permanent incisors in 48 patients, of which 31 teeth underwent surgical repositioning, 12 orthodontic extrusion, and 17 spontaneous re-eruption. They recorded ankylosis-related resorption with pulp necrosis in 20 of 60 teeth (33.33%), pulp necrosis without ankylosis-related resorption in 23 teeth (38.33%), and pulp revitalization in 15 teeth (25.00%). Root development and degree of intrusion were both significantly associated with outcome (p=0.03). The lower frequencies of ankylosis and resorption in the present series may partly reflect the inclusion of several types of dentoalveolar injuries rather than exclusively intrusive luxations.[12] The present study recorded satisfactory periodontal healing in 87.50% of patients, while complications included pulp necrosis in 22.50%, tooth discoloration in 10.00%, root resorption in 7.50%, periapical pathology in 5.00%, post-treatment infection in 5.00%, ankylosis in 2.50%, and tooth loss in 5.00%. Hermann et al. (2012) studied 82 extrusively luxated and 179 laterally luxated permanent teeth and found relatively low rates of severe periodontal complications. Among mature teeth with extrusive luxation, repair-related resorption occurred in 15.60% and infection-related resorption in 5.10%, while no ankylosis-related resorption or tooth loss occurred. Among mature laterally luxated teeth, repair-related

resorption occurred in 29.50%, infection-related resorption in 2.60%, and ankylosis-related resorption in only 0.80%. The 7.50% overall root-resorption rate and 2.50% ankylosis rate in the present study were therefore within the spectrum of reported periodontal complications following luxation injuries.[13] Time from trauma to treatment demonstrated an important association with outcome in the present study. Of the 26 patients treated within 24 hours, 25 (96.15%) achieved a successful outcome compared with only 9 of 14 (64.29%) patients who presented after 24 hours, and this difference was statistically significant (p=0.014). Lima et al. (2017) evaluated 133 permanent teeth with severe luxation injuries and reported pulp necrosis in 78.90%. External inflammatory root resorption occurred in 17.80% of extrusive luxations, 15.90% of lateral luxations, and 25.00% of intrusive luxations. Importantly, delayed attendance significantly influenced inflammatory root resorption following lateral luxation (p=0.0174), and patients beginning treatment 45 days after trauma had a 3.4-fold greater risk of developing external inflammatory root resorption. Their findings were consistent with the significantly better outcome among patients receiving earlier management in the present study.[14] Overall treatment success in the present study was 85.00%. Involvement of one or two teeth was associated with a significantly higher success rate than involvement of three or more teeth (93.33% versus 60.00%; p=0.026). Similarly, patients without an alveolar fracture achieved a 96.00% successful outcome compared with 66.67% among those with an alveolar fracture (p=0.021). Age, sex, and initial mobility were not significantly associated with outcome. Lauridsen et al. (2016), in a cohort of 91 patients involving 223 teeth with alveolar process fractures, reported an estimated 10-year pulp-necrosis risk of 56.00% among mature teeth, while infection-related resorption, ankylosis-related resorption, and tooth loss occurred in 2.50%, 2.10%, and 7.80%, respectively. Displacement greater than 2 mm increased the risk of pulp necrosis (HR 1.8; p=0.03), while incomplete repositioning increased it approximately twofold (HR 2.1; p=0.003). These observations supported the present finding that more extensive dentoalveolar involvement, particularly alveolar fracture and involvement of multiple teeth, was associated with a less favorable overall outcome.[15]

CONCLUSION

Surgical repositioning followed by orthodontic splinting was found to be an effective approach for the management of dentoalveolar trauma, with an overall successful outcome in 85.00% of patients. Significant improvement was observed in pain, tooth mobility, tenderness, and occlusal disturbance after treatment. Early presentation, involvement of fewer teeth, and absence of alveolar fracture were associated with better treatment outcomes. Careful repositioning, adequate stabilization, and regular clinical and radiographic follow-up were important for minimizing complications and preserving the affected teeth.

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