

Effect of Early Versus Delayed Treatment on Clinical Outcomes of Mandibular Fractures: A Prospective Observational Study

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Abstract

Background

The optimal timing of definitive treatment for mandibular fractures remains debated. Although early intervention may facilitate fracture stabilization and functional recovery, treatment may be delayed because of associated injuries, medical conditions, patient-related factors, or limited surgical resources. This study evaluated the clinical outcomes of early versus delayed treatment of mandibular fractures and assessed the factors contributing to treatment delays.

Methods

This prospective observational study included 100 dentulous patients with mandibular fractures who presented to the Department of Oral and Maxillofacial Surgery, Government Dental College, Thiruvananthapuram, and the dental casualty of Government Medical College, Thiruvananthapuram. Patients were divided into an early-treatment group, consisting of patients treated within three days, and a delayed-treatment group, consisting of patients treated on or after the fourth day. Clinical outcomes including infection, malocclusion, paresthesia, trismus, and tenderness were assessed at the initial postoperative visit, one week, and four weeks. The causes of treatment delay and type of intervention were also recorded. Statistical analysis was performed using nonparametric tests, with $p < 0.05$ considered statistically significant.

Results

Of the 100 patients, 50 received definitive treatment within three days of injury and 50 on or after day four. Initial infection rates were 16% and 8%, respectively ($p = 0.218$), with no infections in either group at four weeks. Malocclusion decreased from 96% to 24% in the early-treatment group and from 86% to 54% in the delayed-treatment group; the four-week difference was statistically significant ($p = 0.002$). Paresthesia showed no significant between-group differences (four-week $p = 0.488$). At four weeks, trismus and tenderness were absent in the early-treatment group but persisted in 27 patients in the delayed-treatment group for each outcome ($p < 0.001$). Neurological observation was the leading reason for delay (24 cases), followed by unsatisfactory closed reduction (nine), hospital referral (five), patient noncompliance (four), intensive care requirements (three), orthopedic intervention (three), and operating theatre unavailability (two).

Conclusion

Early treatment of mandibular fractures was associated with more rapid resolution of malocclusion, trismus, and tenderness during follow-up. Infection and paresthesia did not differ significantly between treatment groups. The findings emphasize the potential importance of timely definitive management while recognizing that treatment timing must be considered in the context of associated injuries and other clinical factors.

Categories: Trauma, Epidemiology/Public Health, Dentistry

Keywords: delayed treatment, early treatment, fracture healing, malocclusion, mandibular fracture, paresthesia, trismus

Introduction

Trauma is a major cause of morbidity and mortality among young adults, and maxillofacial injuries constitute an important component of trauma-related injuries. Mandibular fractures are among the most frequently encountered facial fractures and commonly result from road traffic accidents, interpersonal violence, occupational injuries, falls, and sports-related trauma [1]. Management of mandibular fractures requires careful assessment of the airway, cervical spine, neurological status, and associated injuries before

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definitive fracture treatment. Restoration of mandibular continuity, occlusion, mastication, speech, facial form, and function are important goals of treatment. The timing of definitive fracture management may be influenced by the patient's general condition, associated injuries, fracture characteristics, availability of surgical facilities, and patient-related factors.

The optimal timing of treatment for mandibular fractures remains controversial. Some authors have advocated early intervention, particularly within the first 72 hours, because early stabilization may reduce the duration of pain, facilitate functional recovery, and potentially decrease complications [2–5]. In contrast, other studies have reported that delayed repair may not necessarily result in poorer outcomes, particularly when delay is required for stabilization of associated injuries or reduction of facial edema [6–9]. Treatment delays may occur for several reasons. Patients with concomitant neurological, thoracic, orthopedic, or other systemic injuries may require stabilization before definitive mandibular fracture treatment. Delays may also occur because of patient noncompliance, referral from other institutions, failure of conservative treatment, or limited operating-room availability [10–12].

Previous studies have reported conflicting findings regarding the relationship between treatment delay and postoperative complications. Some studies have identified increased complications with prolonged treatment delay, whereas others have found no significant association between treatment timing and infection or other complications [4,5,13–16]. These differences indicate that the relationship between treatment timing and clinical outcomes following mandibular fracture management remains clinically relevant. The present study focused exclusively on mandibular fractures to evaluate the association between treatment timing and specific clinical outcomes, including malocclusion, trismus, tenderness, infection, and paresthesia. Restricting the study to mandibular fractures also allowed these outcomes to be assessed within a more clinically comparable group, avoiding the additional heterogeneity that could arise from including fractures of different facial bones.

The primary objective of this study was to compare the clinical outcomes of early and delayed definitive treatment of mandibular fractures, with early treatment defined as intervention within 72 hours of injury and delayed treatment as intervention on or after the fourth day following injury. The clinical outcomes assessed included malocclusion, trismus, tenderness, infection, and paresthesia at the initial assessment, one-week follow-up, and four-week follow-up. The secondary objective was to identify the factors contributing to delays in definitive treatment.

Materials And Methods

Study design and setting

This prospective observational study was conducted over a period of 18 months in the Department of Oral and Maxillofacial Surgery, Government Dental College, Thiruvananthapuram, and the dental casualty of Government Medical College, Thiruvananthapuram. The study was conducted over a period of 18 months, from May 25, 2023, to November 24, 2024, following approval from the Institutional Ethics Committee (Approval No. IEC/T/23/07; dated May 25, 2023).

Study population

Patients presenting with mandibular fractures who were willing to participate and fulfilled the inclusion and exclusion criteria were enrolled consecutively until the required sample size was achieved. The inclusion criteria were patients with fractures involving the body, symphysis, parasymphysis, angle, ramus, or condylar region requiring active intervention. Patients with mandibular fractures associated with other injuries or fractures elsewhere in the body were also eligible for inclusion.

Patients were excluded if they were edentulous, had an associated craniofacial fracture affecting occlusion other than the mandibular fracture, had disorders affecting bone healing or bone turnover, were receiving bisphosphonate therapy, had pathological fractures, or were unwilling to provide informed consent.

Sample size

The sample size was calculated based on previously published findings by Biller et al. [4]. Considering a 5% alpha error and 80% statistical power, the estimated minimum sample size was 45.47 patients per group. The sample size was therefore rounded to 50 patients in each group, resulting in a total sample size of 100 patients.

Classification according to treatment timing

Patients were categorized according to the interval between the date of injury and definitive treatment. Patients who received definitive treatment within zero to three days of injury were classified as the early-treatment group, whereas those treated on or after the fourth day following injury were classified as the delayed-treatment group.

Data collection

Sociodemographic characteristics, medical history, mechanism of injury, fracture location, treatment timing, cause of treatment delay, and type of intervention were recorded using a semi-structured proforma. Clinical findings were assessed at the patient's first OPD visit, which could coincide with the date of injury or occur later, and at one-week and four-week follow-up assessments.

Infection was defined as clinical evidence of infection, including erythema, swelling, or purulent discharge at the surgical site during follow-up. Malocclusion was defined as alteration of occlusion associated with the fracture or its treatment. Paresthesia was defined as altered sensation in the distribution of the mental or inferior alveolar nerve. Tenderness was defined as pain or discomfort elicited on gentle palpation over the suspected mandibular fracture site. Trismus was defined as limitation of mouth opening associated with the mandibular fracture or its treatment. Although the same examiner performed all assessments using a standardized protocol, formal examiner calibration and inter- or intra-examiner reliability testing were not undertaken, which may represent a methodological limitation.

Treatment

Patients were managed according to the fracture characteristics and clinical requirements. Treatment modalities included closed reduction, open reduction and internal fixation, and circummandibular wiring. The choice of treatment was determined by the treating surgical team according to fracture characteristics, occlusion, associated injuries, and clinical circumstances.

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics, version 27 (IBM Corp., Armonk, NY, USA). Categorical outcomes were compared between the early-treatment and delayed-treatment groups separately at the initial assessment, one-week follow-up, and four-week follow-up using Pearson's chi-square test or Fisher's exact test, as appropriate based on the expected cell frequencies. The tests compared the proportions of patients with each clinical finding between the two independent groups at each assessment. All tests were two-sided, and a p-value of less than 0.05 was considered statistically significant. Baseline age was compared between the two groups using an independent-samples t-test, while sex distribution was compared using Pearson's chi-square test or Fisher's exact test, as appropriate.

Ethical considerations

Institutional ethics committee clearance was obtained before commencement of the study. Written informed consent was obtained from all participants after providing information regarding the study. Participation was voluntary, and participants were free to withdraw from the study at any stage. Patient privacy and confidentiality were maintained throughout the study.

Results

A total of 100 patients with mandibular fractures were included in the study. Fifty patients received definitive treatment within three days and were classified as the early-treatment group, while 50 patients received treatment on or after the fourth day and were classified as the delayed-treatment group.

The study population comprised 86 males (86%) and 14 females (14%). The early-treatment group included 42 males (84%) and eight females (16%), while the delayed-treatment group included 44 males (88%) and six females (12%). The mean age was 32.24 ± 15.26 years in the early-treatment group and 34.84 ± 15.23 years in the delayed-treatment group, with an overall mean of 33.54 ± 15.22 years. Patients aged 21–30 years constituted the largest age category, accounting for 33 patients (33%) overall. There were no statistically significant differences between the groups in mean age ($p = 0.396$) or sex distribution ($p = 0.774$). Baseline demographic characteristics are summarized in Table 1.

Characteristic	Early treatment (n = 50)	Delayed treatment (n = 50)	Total (N = 100)	p-value
Age (years), mean $\pm$ SD	32.24 $\pm$ 15.26	34.84 $\pm$ 15.23	33.54 $\pm$ 15.22	0.396
Age group (years), n (%)				
0–10	1 (2)	0 (0)	1 (1)	—
11–20	11 (22)	10 (20)	21 (21)	—
21–30	18 (36)	15 (30)	33 (33)	—
31–40	7 (14)	10 (20)	17 (17)	—
41–50	6 (12)	5 (10)	11 (11)	—
51–60	4 (8)	7 (14)	11 (11)	—
61–70	3 (6)	2 (4)	5 (5)	—
71+	0 (0)	1 (2)	1 (1)	—
Sex, n (%)				
Male	42 (84)	44 (88)	86 (86)	0.774
Female	8 (16)	6 (12)	14 (14)	—

TABLE 1: Baseline demographic characteristics of patients in the early- and delayed-treatment groups.

Causes of treatment delay

Several factors contributed to delayed treatment. Neurological observation was the most frequently documented reason, accounting for 24 cases. Failure of closed reduction to achieve satisfactory results accounted for nine cases. Five patients were referred from local hospitals. Patient noncompliance contributed to four cases, while intensive care-related requirements and orthopedic intervention accounted for three cases each. Non-availability of the operating theatre accounted for two cases.

Timing of Intervention

Definitive treatment was performed between the day of injury and 60 days after injury. Twelve patients underwent treatment on the first day, 22 on the second day, and 14 on the third day. Additionally, two patients underwent treatment on the day of injury (day 0). Thus, 50 patients received treatment within the first three days and were classified into the early-treatment group. Thirteen patients underwent treatment on the fifth day, while the remaining patients received treatment at other intervals, including after the first week (Figures [1](#), [2](#)).

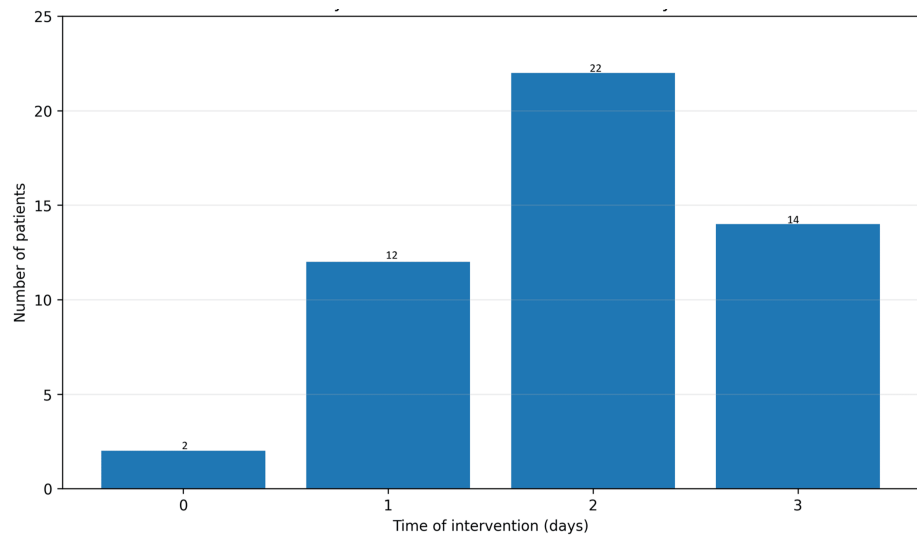


FIGURE 1: Distribution of patients according to timing of intervention in the early-treatment group.

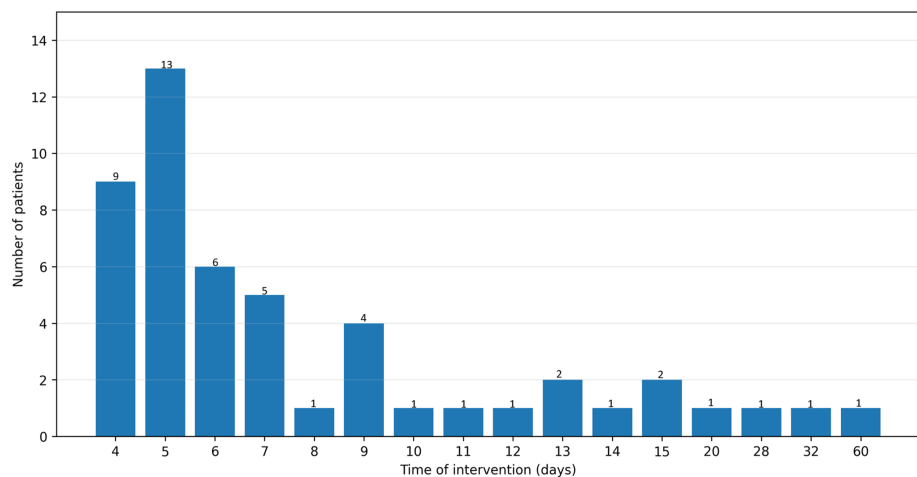


FIGURE 2: Distribution of patients according to timing of intervention in the delayed-treatment group.

Clinical findings during follow-up

Infection

At the initial assessment, infection was observed in eight patients (16%) in the early-treatment group and four patients (8%) in the delayed-treatment group. The difference was not statistically significant (Pearson chi-square statistic = 1.515, $df = 1$, $p = 0.218$). At one week, infection was observed in two patients (4%) in the early-treatment group and five patients (10%) in the delayed-treatment group, with no statistically significant difference between the groups (Fisher's exact test, $p = 0.436$). No infection was recorded in either group at four weeks. Overall, infection decreased during follow-up in both groups, with no statistically significant difference between the treatment groups at the assessed visits (Figure 3).

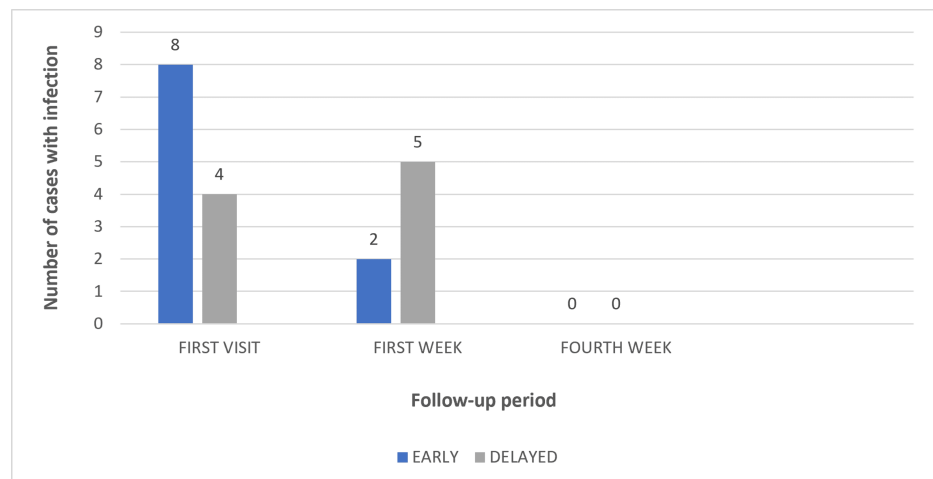


FIGURE 3: Comparison of infection between early- and delayed-treatment groups at initial assessment, one-week follow-up, and four-week follow-up.

Malocclusion

At the initial assessment, malocclusion was observed in 48 patients (96%) in the early-treatment group and 43 patients (86%) in the delayed-treatment group. The difference was not statistically significant (Fisher's exact test, $p = 0.160$). At one week, malocclusion was observed in 25 patients (50%) in the early-treatment group and 23 patients (46%) in the delayed-treatment group, with no statistically significant difference between the groups (Pearson chi-square statistic = 0.160, $df = 1$, $p = 0.689$). At four weeks, malocclusion was observed in 12 patients (24%) in the early-treatment group and 27 patients (54%) in the delayed-treatment group. This difference was statistically significant (Pearson chi-square statistic = 9.458, $df = 1$, $p = 0.002$), with a higher proportion of patients exhibiting malocclusion in the delayed-treatment group (Figure 4).

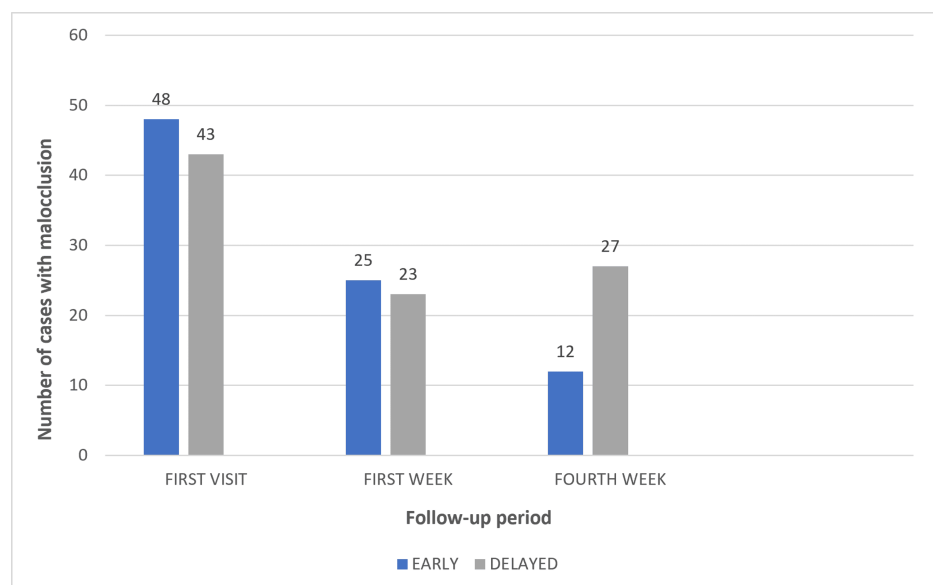


FIGURE 4: Comparison of malocclusion between early- and delayed-treatment groups at initial assessment, one-week follow-up, and four-week follow-up.

Paresthesia

At the initial assessment, paresthesia was observed in 14 patients (28%) in the early-treatment group and 12

patients (24%) in the delayed-treatment group. The difference was not statistically significant (Pearson chi-square statistic = 0.208, $df = 1$, $p = 0.648$). At one week, paresthesia was recorded in 15 patients (30%) in the early-treatment group and 14 patients (28%) in the delayed-treatment group, with no statistically significant difference between the groups (Pearson chi-square statistic = 0.049, $df = 1$, $p = 0.826$). At four weeks, paresthesia persisted in 14 patients (28%) in the early-treatment group and 11 patients (22%) in the delayed-treatment group. The difference remained statistically insignificant (Pearson chi-square statistic = 0.480, $df = 1$, $p = 0.488$). Overall, no statistically significant differences in the prevalence of paresthesia were observed between the treatment groups at any of the assessed visits (Figure 5).

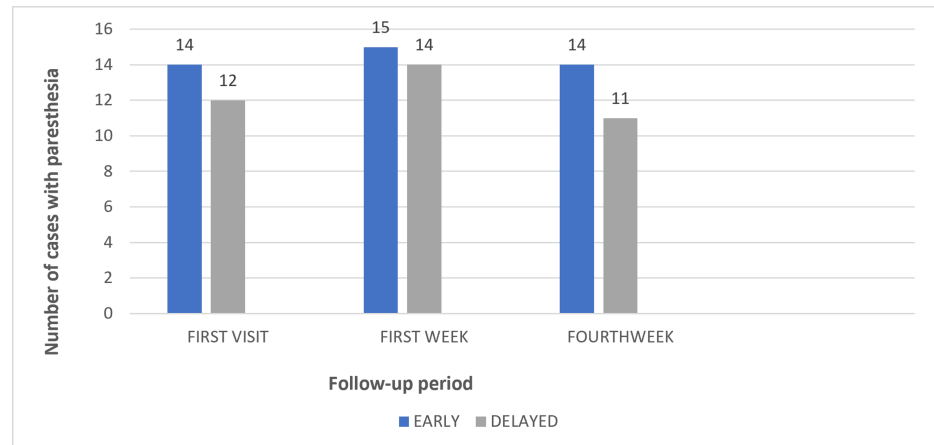


FIGURE 5: Comparison of paresthesia between early- and delayed-treatment groups at initial assessment, one-week follow-up, and four-week follow-up.

Trismus

At the initial assessment, trismus was observed in 37 patients (74%) in both the early-treatment and delayed-treatment groups. The difference was not statistically significant (Pearson chi-square statistic = 0.000, $df = 1$, $p = 1.000$). At one week, trismus was recorded in 18 patients (36%) in the early-treatment group and 25 patients (50%) in the delayed-treatment group, with no statistically significant difference between the groups (Pearson chi-square statistic = 1.999, $df = 1$, $p = 0.157$). At four weeks, trismus was absent in the early-treatment group but persisted in 27 patients (54%) in the delayed-treatment group. This difference was statistically significant (Fisher's exact test, $p < 0.001$). Overall, a statistically significant difference in the prevalence of trismus was observed between the treatment groups only at the fourth-week assessment (Figure 6).

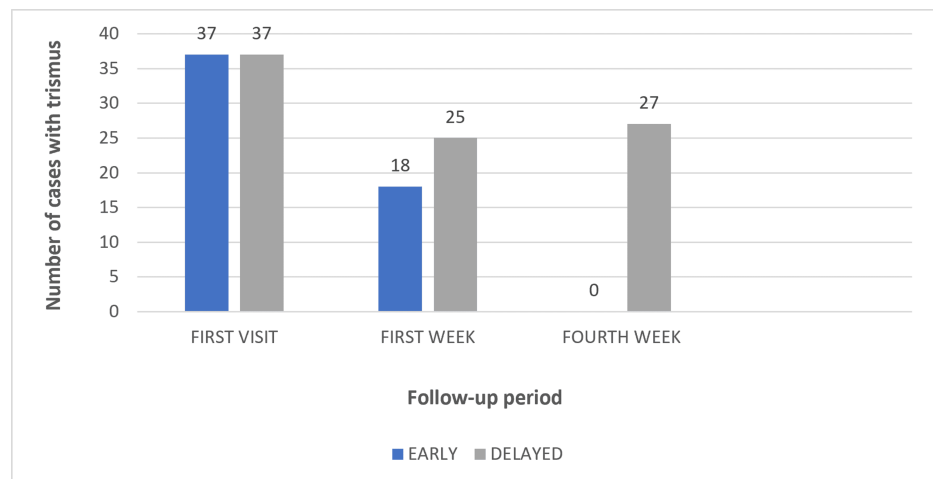


FIGURE 6: Comparison of trismus between early- and delayed-treatment groups at initial assessment, one-week follow-up, and four-week follow-up.

Tenderness

At the initial assessment, tenderness was observed in 47 patients (94%) in the early-treatment group and 42 patients (84%) in the delayed-treatment group. The difference was not statistically significant (Pearson chi-square statistic = 2.554, $df = 1$, $p = 0.110$). At one week, tenderness was recorded in 27 patients (54%) in the early-treatment group and 20 patients (40%) in the delayed-treatment group, with no statistically significant difference between the groups (Pearson chi-square statistic = 1.967, $df = 1$, $p = 0.161$). At four weeks, tenderness was absent in the early-treatment group but persisted in 27 patients (54%) in the delayed-treatment group. This difference was statistically significant (Fisher's exact test, $p < 0.001$). Overall, a statistically significant difference in the prevalence of tenderness was observed between the treatment groups only at the fourth-week assessment (Figure 7).

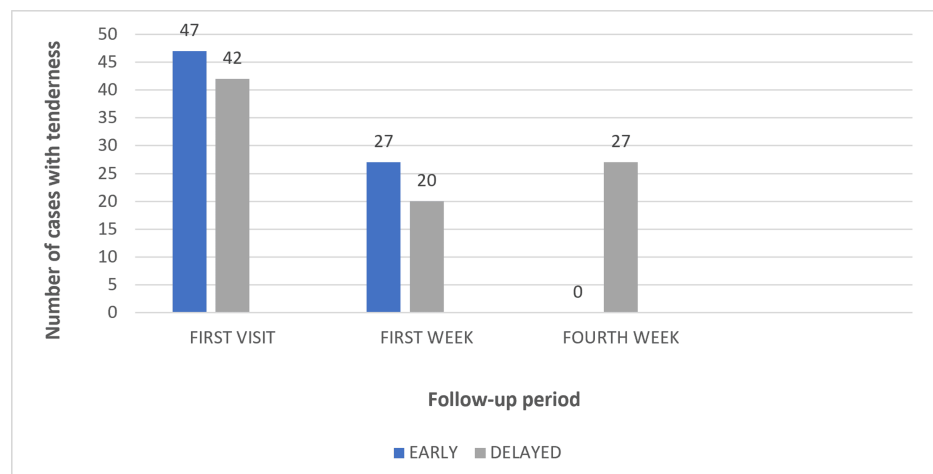


FIGURE 7: Comparison of tenderness between early- and delayed-treatment groups at initial assessment, one-week follow-up, and four-week follow-up.

Treatment modalities

Closed reduction was the most frequently performed treatment modality (61 patients), followed by open reduction and internal fixation (38 patients) and circummandibular wiring (one patient). In the early-treatment group, 30 patients underwent closed reduction, 19 underwent open reduction and internal fixation, and one underwent circummandibular wiring. In the delayed-treatment group, 31 patients underwent closed reduction, and 19 underwent open reduction and internal fixation (Figure 8).

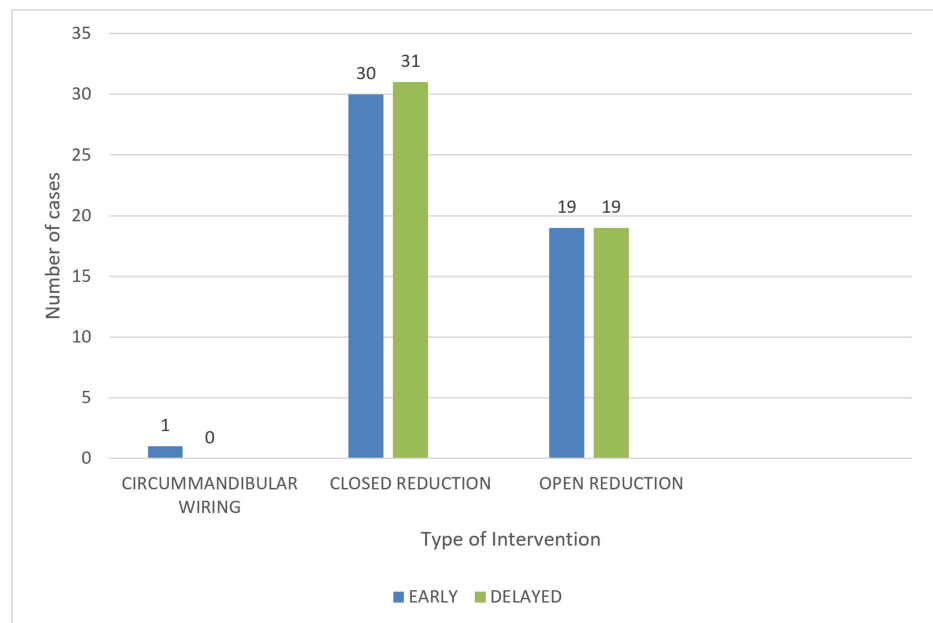


FIGURE 8: Bar chart representing the distribution of type and count of each interventions done to treat mandibular fracture.

Discussion

The timing of definitive treatment for mandibular fractures remains an important consideration in maxillofacial trauma management. The present prospective observational study evaluated 100 patients and compared clinical outcomes between early- and delayed-treatment groups. The study focused on clinically relevant complications assessed at the initial visit, one week, and four weeks.

The causes of treatment delay identified in this study demonstrate that delayed treatment was not attributable to a single factor. Neurological observation was the most frequently documented reason for delay. This is clinically relevant because patients with associated neurological or systemic injuries may require stabilization before definitive facial fracture management. Similar concerns regarding treatment prioritization in patients with multiple injuries have been reported previously [10,17].

Failure of closed reduction to achieve satisfactory results was another important reason for delayed definitive management. This finding suggests that treatment planning may evolve during management, with some patients requiring a change in the initial treatment approach before definitive intervention. Referral from local hospitals and limited operating-theatre availability were additional factors contributing to delay.

The prevalence of infection decreased during follow-up, from 12 cases at the initial assessment to seven cases at one week, with no cases recorded in either group at four weeks. No statistically significant difference between the early- and delayed-treatment groups was observed at the assessed visits. These findings are consistent with a prospective observational study by Sundheepkumar et al., which found no statistically significant association between delayed open reduction and internal fixation and surgical-site infection in compound mandibular fractures ($p = 0.7$) [18]. Previous studies have similarly reported variable associations between treatment delay and postoperative infection [4,5,13,14]. Infection following mandibular fracture treatment is multifactorial and may be influenced by fracture contamination, oral hygiene, smoking or substance use, fracture pattern, fixation technique, and patient compliance, in addition to treatment timing.

Malocclusion demonstrated a different pattern. Although malocclusion was common at the initial assessment in both groups, the number of affected patients decreased during follow-up. At four weeks, 12 patients (24%) in the early-treatment group had malocclusion compared with 27 patients (54%) in the delayed-treatment group. This difference was statistically significant ($p = 0.002$). Restoration and maintenance of pre-injury occlusion are central objectives in mandibular fracture treatment. Persistent malocclusion may indicate inadequate reduction, fracture displacement, fixation-related problems, or delayed functional recovery [19,20]. A retrospective study by Hassan et al. involving 226 patients who underwent open reduction and internal fixation also reported an association between treatment delayed beyond seven days and higher odds of malocclusion [21]. Although the treatment thresholds and study designs differed, these findings support the importance of considering treatment timing when evaluating occlusal outcomes. The findings of the present study suggest an association between treatment timing and

occlusal status at four weeks; however, the observational design does not establish a causal relationship.

Paresthesia did not demonstrate a statistically significant difference between the two groups at any assessed visit. At four weeks, paresthesia persisted in 14 patients (28%) in the early-treatment group and 11 patients (22%) in the delayed-treatment group. Inferior alveolar and mental nerve disturbances are recognized complications of mandibular fractures and may result from the initial trauma itself or from subsequent surgical manipulation [22]. The persistence of altered sensation at four weeks in a proportion of patients indicates that sensory disturbances may remain evident even when other clinical findings improve. Longer follow-up would be required to evaluate subsequent neurological recovery.

Trismus also showed a difference between the groups at the four-week assessment. Although 37 patients (74%) in each group had trismus at the initial assessment, no patient in the early-treatment group had persistent trismus at four weeks, compared with 27 patients (54%) in the delayed-treatment group. This difference was statistically significant ($p < 0.001$). A similar pattern was observed for tenderness. At four weeks, no patient in the early-treatment group had tenderness, whereas 27 patients (54%) in the delayed-treatment group continued to exhibit this finding. These results indicate more favorable clinical findings in the early-treatment group at four weeks. Nevertheless, differences in injury characteristics, associated injuries, treatment modality, and other patient-related factors may have contributed to these outcomes.

Closed reduction was the most frequently used intervention in the study, followed by open reduction and internal fixation. Treatment modality was determined by fracture characteristics and clinical circumstances. The findings should therefore not be interpreted as a direct comparison of the effectiveness of open versus closed treatment, as treatment allocation was not randomized and the groups may have differed in fracture severity and pattern.

The results should be interpreted in view of the observational design. Treatment timing was determined by clinical circumstances rather than random allocation. Patients requiring neurological observation or management of other injuries were more likely to experience delayed treatment, creating the possibility of confounding by indication. Differences in fracture pattern, treatment modality, associated injuries, and patient-related factors may also have influenced clinical recovery. Consequently, the observed associations between treatment timing and clinical outcomes should not be interpreted as evidence of causation.

Another limitation is the relatively short follow-up period of four weeks, which is insufficient to assess definitive bony union, long-term nerve recovery, or sustained occlusal stability. Although early clinical outcomes such as malocclusion, trismus, tenderness, infection, and paresthesia can be assessed during this period, longer follow-up is required to evaluate definitive fracture healing and functional recovery. Clinical outcomes were assessed using categorical findings rather than standardized quantitative instruments, limiting the assessment of the severity and magnitude of improvement. In addition, formal examiner calibration was not documented, which may limit the reproducibility of clinical assessments. Radiographic assessment of fracture union and standardized quantitative measurements of mouth opening and sensory recovery could provide additional information in future studies. The potential influence of associated injuries and differences in treatment modality should also be considered in future research.

Despite these limitations, the present study provides prospective clinical data on the association between treatment timing and early clinical outcomes following mandibular fracture management. The early-treatment group demonstrated a lower prevalence of malocclusion, trismus, and tenderness at the four-week assessment, whereas infection and paresthesia did not show statistically significant differences between the groups at the assessed visits. These findings suggest that early definitive treatment may be associated with more favorable short-term clinical outcomes. However, further studies with longer follow-up and appropriate adjustment for potential confounding factors are needed to clarify the relationship between treatment timing and recovery following mandibular fractures.

Conclusions

In this prospective observational study, early treatment of mandibular fractures was associated with a greater reduction in the prevalence of malocclusion, trismus, and tenderness at four weeks compared with delayed treatment. No statistically significant between-group differences were observed in infection or paresthesia. These findings should be interpreted cautiously, as potential confounding factors, including trauma severity and associated injuries, may have influenced clinical recovery.

Treatment delays were attributed to several factors, most commonly neurological observation, followed by unsatisfactory outcomes with closed reduction, inter-hospital referral, patient-related factors, associated orthopedic management, and operating theatre unavailability. These findings emphasize the importance of individualized treatment planning that considers both timely fracture management and the patient's overall clinical condition. Further prospective studies with longer follow-up, radiographic assessment of fracture union, standardized quantitative outcome measures, and appropriate adjustment for potential confounders are warranted to clarify the relationship between treatment timing and clinical outcomes following mandibular fractures.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Institutional Ethics Committee, Government Dental College, Thiruvananthapuram issued approval IEC/T/23/07; dated May 25, 2023. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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