Treatment of Mandibular Fractures Using Intermaxillary Fixation and Vacuum Forming Splints: A Comparative Study

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Abstract

Objective The study was done to compare the clinical efficacy of vacuum formed splints and arch bar in treating minimally displaced mandibular fractures.

Method Forty patients were included in two groups. Group 1 was treated with custom made splints and group 2 with conventional arch bar. Patients were recalled on 3rd, 7th, 14th day and on the day of removal of the appliance. Periodontal status, stability of appliance and chair side time were evaluated.

Results The mean chair side time taken by vacuum formed splint was 18.05 min and conventional arch bar fixation was 68.25 min. 8.3 % of patients with vacuum formed splints had poor oral hygiene in comparison with 25 % of patients with conventional arch bar. 70 % of patients with vacuum formed splints and 60 % of the patients with conventional arch bars were comfortable in mastication during treatment.

Conclusion Vacuum formed splints has better advantages over arch bar with respect to chair side time, periodontal health, patient's compliance of maintaining oral hygiene, mastication and speech. Vacuum formed splints avoid needle stick injuries. So, they can be used for intermaxillary fixation in minimally displaced mandibular fractures.

Keywords Vacuum formed splints · Arch bars · Intermaxillary fixation · Mandibular fractures

Introduction

Mandibular fractures are one of the frequently occurring injuries of the facial skeleton. Road traffic accidents, interpersonal violence, industrial accidents are some of the common reasons. From the time of Hippocrates, physicians described many different techniques for treating mandibular fractures, the principle of which was repositioning and immobilisation of the bony fragments [1].

Intermaxillary fixation is a method of treating mandible fractures [2]. Newer techniques used for intermaxillary fixation are self drilling screws which prevents binding in the bone [3] and dimac wires which demonstrate less needle stick injuries in comparison with arch bar [4].

The newer method of intermaxillary fixation has been described recently. Vacuum formed splints are made from thermoplastic clear foil and constructed for both the jaws and fixed with glass ionomer cement (GIC).

Use of vacuum formed splints in the treatment of minimally displaced mandibular fractures might be more advantageous than arch bar fixation with ligature wires in relation to periodontal health, cost, chair side time and patient comfort.

The purpose of this study was to compare the clinical efficacy of vacuum formed splints and arch bar fixation in treating minimally displaced mandibular fractures (Fig. 1).

Materials and Methods

The study was done on patients who reported to the department of Oral and Maxillofacial Surgery,

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Fig. 1 Orthopantomogram showing symphysis fracture

Rajarajeswari Dental College and Hospital, Bangalore. Twenty patients were treated with vacuum formed splints (Group I) and 20 patients (Group II) with arch bar fixation.

Age group selected was in the range of 18–55 years with acceptable number of teeth present for occlusion and minimally displaced mandibular fractures (Fig. 1, 2).

Fig. 2 Orthopantomogram showing left parasymphysis fracture

Materials used for the study were 1.5 mm thermoplastic sheets, 0.7 mm stainless steel wire cleats, Biostar machine, G.I.C, heavy elastics, Erich arch bars, 26 gauge stainless steel wires and after the informed consent all the patients were examined and treated. For preparing the vacuum formed splints, alginate impressions of both the arches were taken and the models prepared. Occlusal splints with 1.5 mm thermoplastic sheet, using the biostar machine were prepared for both the arches. Six to eight custom made cleats which were made from 0.7 mm hard stainless steel wire were fixed at regular intervals to each splint (Fig. 3). Splints were trimmed and the occlusal contact areas were removed. The splints were then polished with pumice. Using glass ionomer cement, the splints were cemented intraorally (Fig. 3). The time taken for the splint fixation was recorded in minutes. Orthodontic elastic traction was given to achieve the occlusion (Fig. 4).

In group II patients, after the oral prophylaxis Erich arch bar fixation was done (Fig. 5). The study was done for a period of 3–6 weeks with 2 months follow-up. The patients were recalled on 3rd, 7th, 14th day and on the day of appliance removal. Each patient was reviewed for the periodontal status and stability of appliance.

Results

The study group consisted of 40 patients who reported to the department of Oral and Maxillofacial Surgery, Rajarajeswari Dental College and Hospital requiring treatment of mandibular fractures. The patients were divided into two groups. Group I consisted of 20 patients and were treated with vacuum formed splints. Group II consisted of 20 patients who were treated with arch bar fixation.

The patients were evaluated for the periodontal status and stability of appliance. Periodontal status was evaluated

Fig. 3 Vacuum formed splints made for both the arches using Biostar machine. Here aluminium foil was used as spacer

Fig. 4 Fixation of vacuum formed splints with GIC and intermaxillary fixation done using elastics

Fig. 5 Conventional arch bar fixation done

using gingival index and oral hygiene index. Stability of appliance was assessed clinically. Chair side time taken was measured in minutes. The patients were assessed for mastication, maintenance of oral hygiene and speech using questionnaire.

The mean chair side time taken by vacuum formed splint fixation was 18.05 min and that of conventional arch bar fixation was 68.25 min and the fixation of conventional arch bar was more time consuming than that of the vacuum formed splint (Table 1). The gingival index was assessed for vacuum formed splint and conventional arch bar group on 3rd day, 7th day and the day of removal of appliances. 100 % cases showed mild gingivitis in vacuum formed splint group whereas 75 % showed moderate gingivitis in conventional arch bar group at the end of 3rd day. 85 %

Table 1 Chair side time taken for fixation of Vacuum forming splint and Conventional Arch bar

Treatment	n	Mean	SD	SE mean
VFS	20	18.05	3.034	0.679
CAB	20	68.25	16.802	3.757

showed mild gingivitis in vacuum formed splint group, 100 % moderate gingivitis in conventional arch bar group at the end of 7th day. On the day of removal, vacuum formed splint group showed moderate gingivitis in 75 % cases. Severe gingivitis was seen in 60 % cases of conventional arch bar group. On an average, there was 70 % of mild gingivitis and 30 % of moderate gingivitis in relation to the vacuum formed splints. But only 8.3 % of the conventional arch bar group had mild gingivitis, 71.7 % had moderate gingivitis and 20 % had severe gingivitis.

Table 2 shows that the treatment modality had two different opinions on the status of gingiva following the fixation of the appliances. With increase in time, the conventional arch bar group showed severe gingivitis.

From Table 3 it is observed that at the end of 3rd day, 95 % of the patients with vacuum formed splints, had good oral hygiene and 5 % had fair oral hygiene and in the patients with conventional arch bar, 100 % of the patients had good oral hygiene. At the end of 7th day, 30 % had good oral hygiene and 70 % had fair oral hygiene in patients with vacuum formed splint group whereas in patients with conventional arch bars, 5 % had poor oral hygiene and rest had fair oral hygiene. On the day of removal of the appliances, the patients with vacuum formed splints group had 75 % fair oral hygiene and 25 % of poor oral hygiene whereas in the patients with

Table 2 Condition of gingiva after insertion of Vacuum forming splint and Arch bar

Time	Pearson Chi square		
	Value	df	P value
3rd day	24.000	1	0.000
7th day	29.565	1	0.000
Day of removal	19.130	2	0.000

The strong evidence that the two treatments have different opinions on the status on gingiva following the fixation of the appliances. With increase in time, the conventional arch bar group shows severe form of gingivitis and the difference is statistically significant (P value (0.000) is less than 0.05 at 5 % level of significance)

Table 3 Oral hygiene condition after fixation of Vacuum forming splints and conventional Arch bar

Time	Pearson Chi square		
	Value	df	P value
3rd day	36.190	1	0.000
7th day	7.786	2	0.021
Day of removal	8.120	1	0.004

P value (0.000) is less than 0.05 at 5 % level of significance, it rejects the null hypothesis and concludes that the two treatments have different opinions on the status of oral hygiene following the fixation of the appliances

Table 4 Patients opinion about speech after fixation of Vacuum forming splints and conventional Arch bar

Treatment	Speech			Total
	Can understand with some difficulty	Cannot understand on phone	Not able to speak	
Percentage of patients' opinion about speech				
VFS	55.0	35.0	10.0	100.0
CAB	25.0	55.0	20.0	100.0
Total	40.0	45.0	15.0	100.0
	Value	df	P value	
Chi square test for speech assessment				
Pearson Chi square	3.806	2	0.149	

conventional arch bar, 70 % had poor oral hygiene and the rest had fair oral hygiene. On an average, in patients with vacuum formed splints, 41.7 % had good oral hygiene, 50 % had fair oral hygiene and 8.3 % had poor oral hygiene whereas in patients with conventional arch bars, 75 % had fair oral hygiene and the rest had poor oral hygiene. In 95 % patients with conventional arch bar, it was found on 3rd day and 7th day, that the stability of the appliance was maintained and on the day of removal 85 % patients had maintained stability of the appliance.

Table 4 depicts that in patients with vacuum formed splints, the speech could be understood in 55 % cases, the speech could not be understood on phone in 35 % of cases and 10 % of cases were unable to speak. In the patients with conventional arch bars, the speech could be understood in 40 % of cases, the speech could not be understood on phone in 45 % cases and 15 % of cases were not able to speak.

From Table 4 it was inferred that since the *P* value (0.149) is greater than 0.05, at 5 % level of significance, there is no strong evidence that the two treatments have different opinions on the speech.

Table 5 depicts 60 % of the patients with vacuum formed splints had slight difficulty in maintaining oral

hygiene, 35 % had moderate difficulty and 5 % had severe difficulty in maintaining oral hygiene. In patients with conventional arch bars, 30 % of the patients had slight difficulty, 55 % had moderate difficulty and 10 % had severe difficulty in maintaining oral hygiene. The depiction was based on the questionnaire prepared for the patients. Here, the conventional arch bar group reported a greater difficulty in maintaining oral hygiene but the difference was not statistically significant.

Discussion

The treatment of jaw fractures has a long history, from ancient Egypt to the present. Different methodologies have been executed and controversies still exist. The improved results were derived from a better scientific approach to the biomechanics underlying the function of the jaw and of new techniques to these principles [1].

In the study, chair side time was measured in minutes by considering the average time taken for the arch bars fixation which was 68.25 min and that of the vacuum formed splints along with the initial time taken for impression of both the arches which was 18.05 min. Lloyd et al. [2] has described the advantages of vacuum formed splints over other methods of IMF which included the fact that clinical work was completed entirely without the need for anesthesia and the chair side time was minimum. Ayub et al. in a study where the two methods used for interdental immobilization were compared concluded that the average time taken for arch bar fixation was 35 min and that for the dimac wires was 20 min. The author also compared the two methods used for interdental immobilization and the damage to the periodontium surrounding the teeth. After removal of interdental devices, more marginal periodontitis was noticed in patients who had arch bar fixation compared to the other group [4]. In the present study, an objective measurement was done using gingival index to measure the severity of gingivitis and on the day of removal of the

Table 5 Patients opinion regarding maintenance of oral hygiene after fixation of vacuum forming splints and Arch bar

Treatment	Maintenance of oral hygiene			Total
	Slightly difficult	Difficult	Very difficult	
Percentage of patients' opinion about maintenance of oral hygiene				
VFS	60.0	35.0	5.0	100.0
CAB	30.0	55.0	15.0	100.0
Total	54.0	45.0	10.0	100.0
Value		df	P value	
Chi square test for assessment of maintaining oral hygiene among patients				
Pearson Chi square	3.889	2	0.143	

appliances, it was recorded that there were significantly more number of patients with severe gingivitis in the arch bar group patients than among the patients in vacuum formed splints group. Ayub et al. [4] also found that in their study, patients reported considerable difficulty in maintaining oral hygiene measures with arch bar fixation, leading to associated periodontal problems. Poor oral hygiene was reported in many patients in a study on patients with mandibular fractures by Eid et al. [5]. In our study, it was found that there was considerably good oral hygiene on the day of removal in the vacuum formed splints group compared to that of arch bar group where the oral hygiene index was recorded poor in 25 % cases. The better oral hygiene index in patients with vacuum formed splints may be due to better maintenance of oral hygiene by the patients. In case of arch bar group, it may be difficult to maintain oral hygiene due to the comparative difficulty in brushing due to lodging of food and debris on the wires and the arch bar.

Terai and Shimahara [6] reported that since the fixation strength was less than that of wiring, closed treatment of condyle fractures by intermaxillary fixation with thermoforming plates were contraindicated in bilateral condylar fractures with open bites.

Yamada et al. [7] conducted a study in which one cast splint extending from the first molar to the first premolar in each arch was used. The teeth to which the splint was bonded were etched. Splints were attached to the teeth by adhesive resin. It was concluded that the use of cast splints reduced the surgical time significantly. This study correlates with that of the present study in relation to the chair side time taken for the vacuum formed splints group in relation to arch bar group. The author also reported that oral hygiene was markedly improved during the period of IMF since no ligatures was present. In his study, the cast splint was extending from first molar to first premolar in each arch which was used for the treatment of facial fractures by intermaxillary fixation. According to the authors, therefore the gingival health of the patients was also not compromised. They also found that the adhesive cast splints used for the intermaxillary fixation proved to be sufficiently stable without surgery when elastic intermaxillary fixation was applied [7]. Stability of the appliances following its fixation was measured on 3rd, 7th, and on the day of removal in the present study on the basis of whether the appliance was maintained or not. It was observed that till the day of removal of appliance in vacuum formed splints group, the stability of the appliance was maintained in 85 % patients. In the patients with conventional arch bars, at the end of 3rd day and the 7th day, in 95 % patients the stability of the appliance was maintained and on the day of removal, in 85 % patients, the appliance had maintained its stability. Hence there was no significant difference between the

stability of the appliances in both the groups. The loosening of arch wires was a frequent occurrence which often requires tightening thus increasing number of appointments. There was a slight increase in stability of arch bars compared to vacuum formed splints. This may be due fixation of arch bars by interdental wiring around each tooth and hence leading only to loosening of these interdental wiring or tie wires.

Seventy per cent of the patients with vacuum formed splints and 60 % of the patients with conventional arch bars were comfortable in consumption of diet during the treatment which was a subjective assessment in the present study. The overall incidence of perforation was especially high when a wiring technique was used according to Avery and Johnson [8, 9]. The majority of reported needle stick injuries occurred whilst passing wire interproximally, by snagging a glove upon exposed wire in the forceps or upon an inadequately positioned interproximal wire.

This problem does not exist with vacuum formed splints because they have smooth surface and wires were not used for the fixation. Method of firm and resilient temporary inter-maxillary fixation using readily available orthodontic elastomeric chain has been described by Smith [10]. Advantages lie in reduced time taken for achieving IMF, relative safety compared to tie-wiring techniques, flexibility of the direction of pull, and the care and rapidity with which it can be removed. Similarly in vacuum formed splints, the orthodontic elastic bands were used which eliminates the chance of needle stick injuries.

In the study, the displaced cases of mandibular fractures were not included because vacuum formed splints may not provide enough stability to hold the fracture segments unlike arch bars.

The periodontal status in the patients was evaluated using the gingival index and the oral hygiene index on both the groups. On an average, there was 70 % mild gingivitis and 30 % moderate gingivitis in relation to vacuum formed splints. But only 8.3 % of the conventional arch bar group had mild gingivitis, 71.7 % had moderate gingivitis and 20 % had severe gingivitis. And the severity of the gingivitis in both the groups increased with the increase in time period. A study was conducted involving 17 patients on the influence of arch bar splinting on periodontium and mobility of fixed teeth by Oikarinen and Nieminen [11]. They found that CPITN index for periodontium worsened at the time of arch bar removal but returned to original level at control examination of 5 months. This study correlates with the present study in relation to the increase in severity of the gingivitis in proportion to elapse of time. The increase in the severity of gingivitis in the arch bar group may be due to the trauma from wires used interdentally for the fixation and removal of arch bars. This also leads to the difficulty in brushing and thus accumulation of debris and plaque. There is less amount of gingivitis in the

patients with vacuum formed splints as there is no trauma created to the adjacent tissues during the fixation or removal of the splints. The gingival tissue is free for cleaning with this appliance.

Lello and Lello [12] reported in their work on interdental continuous loop wire splinting and inter-maxillary fixation effects on marginal gingival tissue that despite a standard oral hygiene regime, gingival inflammation occurred during the period of splinting and reversed 2 weeks after splint removal. This study correlates with the present study that the gingival inflammation was recorded in both the groups during the treatment period and it increased in both the groups as the treatment period elapsed.

David et al. found that after 48 h, gingivitis had developed in both type of splints in their work on the influence of Obwegeser and Merkx splints on the periodontium. After 6 weeks, gingivitis had become more severe and periodontitis had set in. In Merkx splints the gingivitis appeared particularly more severe but periodontal ligament appeared somewhat less affected [13]. Fordyce reported that in his study on intermaxillary fixation with arch bar or eyelet wires, the time taken for fixation was minimum of 40 min [14]. Aldegheri and Blanc reported the wiring technique using pearl steel wire which required less than 5 min. The appliance proved to be safe for the periodontium compared to arch bars [15]. In our study, the severity of gingivitis increased in case of both the groups with the elapse of time and reached the maximum on the day of removal. The severity of gingivitis in vacuum formed splints group was considerably less when compared to that of the arch bar group. Moreover, wired arch bars may damage gingival and periodontal structures because the wires tend to move apically, which results in inflammation.

In our study, on patients with vacuum formed splints, 41.7 % had a good oral hygiene, 50 % had fair oral hygiene and 8.3 % had a poor oral hygiene whereas in patients with conventional arch bars, 75 % had fair oral hygiene and the rest had poor oral hygiene.

Conclusion

Vacuum formed splints for intermaxillary fixation is one of the newer methods described recently. Vacuum formed splints were made of thermoplastic clear foil and constructed for both the jaws, fixed with GIC. The advantages of vacuum formed splints over the other methods of IMF include the fact that clinical work was completed entirely without the need for general/local anesthesia with minimum chair side time. Patient discomfort was minimal and the materials were cheap. The smooth surface makes their wear comfortable without the risk of operator's skin puncture or injury to the periodontal tissue. The present

study concludes that the time required was significantly less with fixation of vacuum formed splints than that of the arch bars, the periodontal status of the patient was better in vacuum formed splints group than arch bars. Stability of the vacuum formed splints was similar to that of the arch bars and there was no statistically significant difference between the two groups. Patient compliance was proved to be better than those in the arch bar group. There were no cases with needle stick injuries as there were no sharp wires used in the fixation of vacuum formed splints.

Thus, the vacuum formed splints have advantages over the arch bar. It can be used as an alternative to arch bars for IMF in mandibular fractures.

Conflict of interest None.

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