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The use of microplates for fixation of mandibular fractures: a systematic review

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Abstract

Background

Microplates have thin diameter making them less palpable, more malleable, easily applied, and adaptable to fracture site. In the past, microplates were used in midface fractures only, but we can obtain their benefits in mandibular fractures as well.

Objective

The aim of this systematic review was to verify the efficiency of microplates either alone or in combination with miniplates for fixation of mandibular fractures in comparison with miniplates.

Materials and methods

A systematic review was conducted using electronic databases for collecting articles that met the inclusion and exclusion criteria. Data were extracted from each article, and the quality of studies was assessed by Jadad scale. Four articles were selected that met the inclusion and exclusion criteria.

Conclusion

Microplates have high holding power and were efficacious for internal fixation of simple, minimally displaced, isolated mandibular fractures, but to support this information safely, numerous future studies with sound method and larger sample size are needed to evaluate their use in the other forms of mandibular fractures.

Keywords: Fixation, mandibular fracture, microplates

Introduction

Managing mandibular fractures necessitate the restoration of esthetics and functions, and this can be achieved through the anatomic reduction of the fractured mandible and restoration of the original occlusion. Different fixation techniques have been developed passing from the historical era of external fixation to internal fixation [1].

Different means of fixation are available, for example, commonly miniplates and reconstruction plates used alone or together, to treat simple and comminuted mandibular fractures. However, these plates are of large size and may be palpable through the thin skin and the gingiva. The space available in the upper half of the mandible is limited for a large miniplate, which can result in many complications such as wound-healing problems and dental and neurovascular injuries [2].

In the literature, many cases are reported in which metal depositions were found in the tissues adjacent to titanium microplates and miniplates or in peripheral organs following osteosynthesis [3,4]. Size and amount of osteosynthesis material used should therefore be minimized as much as possible. It is difficult to calculate how much a reduction of the total amount of titanium used will decrease deposition of metal ions in the peripheral organs. Nevertheless, it should be the foremost aim to use as little osteosynthesis material as possible [5].

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Microplates are now commonly used to restore maxillofacial fractures because they require less manipulation, they are more malleable and easier to adapt to the shape of the bone, they are less likely to cause iatrogenic damage, and they are associated with a lower rate of major complications than miniplates [2].

Previously, microplates were used in non-stress-bearing areas such as midface. This may be because most surgeons do not believe that the microplate fixation system is strong enough to withstand the masticatory forces of the jaw during the formation of a stable bony union, but recent experimental and clinical studies have shown that microplates can be used efficiently in the stress-bearing areas of the mandible [1,2,5].

Using microplates allows less invasive surgery, higher degree of adaptability to the fracture site, and better occlusal self-adjustment [2]. The microplate technique is performed with minimal effort, more convenient access, and less stripping of the surrounding periosteum. The screw of the miniplate and microplate is identical, but the microplate screws are smaller in diameter and the risk of injuring the dental root or mandibular nerve is reduced [6].

Application of microplates is quick because little or no adaptation is necessary, which minimizes the time of surgery and effort of the surgeon. Microplates provide the surgeon with a viable option in the fixation of bony segments owing to their thinness and flexibility to adapt to the mandible by itself while tightening the screws, and minimum pressure is required during tightening of the screws as excessive pressure can lead to breaking of screw head [7].

In an experimental study, Feller *et al*. [5] found that treatment of fractures in the interforaminal region with a combination of microplate and miniplate will be stable enough for early mobilization. Moreover, Gupta *et al*. [1] concluded that the replacement of an upper miniplate by a microplate in the management of mandibular fractures is stable and adequately efficacious to withstand the masticatory and torsional forces acting in the anterior region of the mandible.

Ahmed *et al*. [7] recommend the use of microplates for treatment of mandibular fractures. As there is no significant difference in the bite force generated when microplates are used, in comparison with miniplates, and they provide adequate stability to fractured segment, their use may be recommended for routine use. Another important aspect is minimization of metal leaching in the adjacent tissues [7].

The purpose of this systematic review was to verify the efficiency of microplates either alone or in combination with miniplates for fixation of mandibular fractures in comparison with miniplates.

Materials and methods

Key words formulation and databases selection

Electronic databases including PubMed and Cochrane Database of Systematic Reviews, Cochrane central register of controlled trials (CENTRAL), and Wily online library were searched in April 2018 without date or language restrictions using the key words and combinations of these used in the search, which included the following:

(1) ‘Mandibular fracture’ or ‘Lower jaw fracture’ or ‘Parasymphyseal fracture’ or ‘Interforaminal mandibular fracture’ or ‘Mandibular body fracture’ or ‘Mandibular angle fracture’ or ‘Mandibular ramus fracture’ or ‘Mandibular subcondylar fracture’
(2) ‘Open reduction’ or ‘Internal fixation’ or ‘Direct fixation’ or ‘Titanium miniplates’ or ‘Titanium microplates’ or ‘Miniplates and microplates’
(3) ‘Proper reduction’ or ‘Rigid fixation’ or ‘Proper occlusion’ or ‘Biting force’ or ‘Fracture stability’ or ‘Plate palpability’ or ‘Plate dehiscence’ or ‘Paresthesia’
(4) ‘#1’ and ‘#2’, and ‘#3’.

Most popular oral and maxillofacial surgery-related journals were manually searched; furthermore, we also searched the gray literature (Google Scholar) and the reference lists of all studies identified as relevant reviews for possible additional studies. Duplicates were discarded. Hard copies of all relevant articles were retrieved after screening the titles and abstracts of each one and assessed for its eligibility. Inclusion criteria and exclusion criteria were determined, and all articles were independently assessed against these criteria. Disagreements concerning the selected studies were resolved by discussion.

Inclusion criteria were clinical studies with adult human participants including randomized controlled trials, controlled clinical trials, and nonrandomized clinical trials, with the aim of assessing the efficacy of microplates alone or in combination with miniplates for internal fixation of mandibular fractures in comparison with the common use of miniplates for internal fixation of mandibular fractures.

The exclusion criteria were review articles, case reports, case series, studies on children with mandibular fractures, and experimental studies on animals or models.

The quality assessment of the selected articles was done with the Jadad scale [8]. The maximum possible score was 13 points using an 11-item instrument (11 questions). This was considered to be good when the score was more than 9 points and poor when the score was equal to or less than 9 points. Three items related directly to the control of bias using the Jadad scale, and the other eight items were not related directly to the control of bias. Items were scored by giving either a score of 1 point for each ‘yes’ or 0 points for each ‘no’. There are no in-between marks. An additional point was given for question 1, if the method to generate the sequence of randomization was described and was appropriate (table of random numbers, computer generated, etc.), but we deduct 1 point if, for question 1, the method to generate the sequence of randomization was described and was inappropriate. Moreover, an additional point was given for question 2 if the method of double blinding was described and was appropriate, but we deduct 1 point for question 2 if the study was described as double blind but the method of blinding was inappropriate.

Results

Study selection

The systematic search displayed 761 results from PubMed, Cochrane Library databases, and hand searching. During the primary exclusion, the duplicated references were removed then all studies were screened, analyzing the titles and abstracts of each one. A total of 750 articles were excluded in the screening phase. Overall, 11 articles were assessed for eligibility. Studies that did not meet the aforementioned inclusion criteria were excluded in this phase ($n = 7$), although these seven studies were concerned with the evaluation of the efficacy of using the microplates for fixation of mandibular fractures, but there were different reasons for their exclusion (Table 1). At the end of this process, four randomized controlled trials were included in the review for qualitative and quantitative analyses (Fig. 1).

Characteristics of the included studies

Four studies [1,6,7,14] were included in this systematic review: three [1,7,14] were randomized controlled clinical trials and one study [6] was controlled clinical trial. The primary outcome of all studies was biting force measurement and its recovery to be normal or near normal throughout different follow-up visits. Detailed characteristics of the included studies are shown in Table 2. In the first study [1], 20 patients were treated for isolated mandibular fractures of the interforaminal region and randomly divided into two groups: the test group (group A: 10 patients) was managed by open reduction and internal fixation (ORIF) using a combination of 1.2 mm microplate at subapical region and 2.0 mm miniplate at the inferior border of the mandible, whereas the control group (group B: 10 patients) was managed by ORIF using two 2.0 mm miniplates.

In the second study of Kumar *et al.* [6], 10 patients with mandibular fractures were managed by ORIF using the microplates, whereas the control group consisted of 10 normal individuals for comparison with the study group through bite force measurement and determine the time at which the bite forces reach a functional range. In the third study, Ahmed *et al.* [7] randomly divided 40 patients with mandibular (symphyseal/parasymphyseal/body) fractures into two groups: group I consisted of 20 patients and managed by ORIF using 2.0 mm miniplates, and group II consisted of 20 patients managed by ORIF using 1.5 mm microplates. This was in addition to a third control group that consisted of 30 healthy volunteers to measure their normal functional range of the bite force. The last study included in this systematic review was conducted by Anand *et al.* [14] on 20 patients with mandibular fractures in the interforaminal region and randomly divided into two groups: group A consisted of 10 patients and were managed by ORIF using a combination of one microplate (1.2-mm screw diameter and plate thickness of 0.55 mm) placed subapically and one miniplate (2.0-mm screw diameter and plate thickness of 0.9 mm) placed at the inferior border, whereas group B consisted of 10 patients and were managed by ORIF using two 2.0 mm miniplates. Moreover, 10 healthy individuals were included in control group C to determine the normal range of the biting force in comparison with the study groups to evaluate their

Table 1: Excluded articles

References	Reason of exclusion
Sheta *et al*. [9]	Children patients
Song *et al*. [10]	Case series
Abdullah [11]	Case series and child patients
Ahmed *et al*. [12]	Experimental study
Feller *et al*. [5]	Experimental study
Burm *et al*. [2]	Case series
Zakaullah *et al*. [13]	Case series

Table 2: Characteristics of the included studies

References	Study design	Patients (*n*)	Site of fracture	Surgical approach	Method of fixation	Follow-up period
Gupta *et al*. [1]	RCT	P1=10 P2=10	Interforaminal region	Intraoral	P1:1.2 mm micoplate+2.0 mm miniplate P2: Two 2.0 mm miniplates	2 weeks, 6 weeks, 3 months, and 6 months
Kumar *et al*. [6]	CCT	P1=10 C=10	Any site	NM	P1: microplates	1, 2, 3, 4, 5, and 6 weeks
Ahmed *et al*. [7]	RCT	P1=20 P2=20 C=30	Symphysis: 7 Parasymphysis: 21 Body: 12	Intraoral or extraoral	P1: 1.5 mm microplates P2: 2.0 mm miniplates	1, 2, 4, and 6 weeks
Anand *et al*. [14]	RCT	P1=10 P2=10 C=10	Interforaminal region	NM	P1: 1.2 mm micoplate+2.0 mm miniplate P2: Two 2.0 mm miniplates	1 day, 7 days, 1 month, and 3 months

C, control group of healthy individuals; CCT, controlled clinical trial; NM, not mentioned; P1, microplate group; P2, miniplate group; RCT, randomized clinical trial.

extent of recovery. All studies did not use postoperative maxillomandibular fixation, except Anand *et al.* [14], who mentioned that mandibulomaxillary fixation was placed for ~2 weeks in cases associated with condylar fractures. Moreover, all patients did not complain of any associated fractures other than the mandibular fractures, which were simple and minimally displaced.

Quality assessment of the included articles

After evaluating the articles included in this systematic review with the Jadad scale, two articles represented a good score and the other two articles represented poor score (Table 3).

Biting force

Biting force measurement was the primary outcome of all studies included in this systematic review. Different bite force recorders (but of the same idea) were used to measure the bite force in Newton (N) in two studies [6,14] and in kilopound (kp) or kilogram force (kgf) in the other two groups of healthy volunteers to measure the normal biting force, which may be different among different races, but the population of all the included studies was the Indian people (Table 4).

Gupta *et al.* [1] found a statistically significant increase in the bite force recorded in the test groups from the preoperative to the postoperative follow-up visits, but statistically nonsignificant difference was found between both the microplate group and the miniplate group.

Kumar *et al.* [6] found that the rate of recovery of maximum bite force in a patient with a treated mandible fracture by microplates was steady over a 6-week period but not completely normal; hence, the week 1, bite forces of the patient group accounted for only 23% of the control group values. These values rose to 30% in week 2, 40% in week 3, 44% in week 4, 58% in week 5, and 66% at the end of week 6. Ahmed *et al.* [7] found that the bite forces progressively increased in each study group, and their comparative value remained insignificant throughout the phase of recovery. However, by the end of the sixth week, patients in either group regained 60% in molar region and 75% in anterior region. Anand *et al.* [14] recorded the bite force between the study groups at different regions at different time intervals. It showed increase in the bite force values, from postoperative day 1 to third month in both the groups, which was significant. However, bite force comparison between the study groups showed no significant difference.

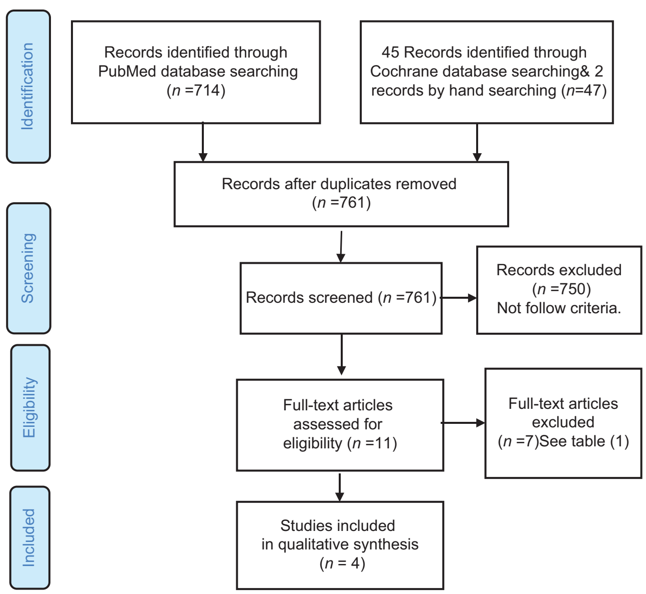

Figure 1: Selection of the studies for the systematic review.

Complications

Gupta *et al.* [1] reported that infection was seen in one (10%) patient in each group as the patient reported swelling and pus discharge on the fracture side which was managed and on exploration the fracture had united and the infection was

Table 3: Quality assessment of the included articles with the Jadad scale

No.	Items related directly to the control of bias using the Jadad scale	Gupta *et al*. [1]	Kumar *et al*. [6]	Ahmed *et al*. [7]	Anand *et al*. [14]
1	Was the study designed as randomized?	1	0	1	1
	Method of randomization (appropriate/inappropriate)	1	0	−1	1
2	Was the study designed as double blind?	0	0	0	1
	Method of double blinding (appropriate/inappropriate)		0		1
3	Was there a description of withdrawals and drop outs?	1	0	0	1
Other markers not related directly to the control of bias					
1	Were the objectives of the study defined?	1	1	1	1
2	Were the outcome measures defined clearly?	1	1	1	1
3	Was there a clear description of the inclusion and exclusion criteria?	1	1	0	1
4	Was the sample size justified (e.g. power calculation)?	0	0	0	0
5	Was there a clear description of the interventions?	1	0	1	1
6	Was there at least one control (comparison) group?	1	1	1	1
7	Was the method used to assess adverse effects described?	1	0	0	1
8	Were the methods of statistical analysis described?	1	1	1	1
Total score		10	5	5	12

Table 4: Biting force values of the included studies

Follow-up visit	Groups	Site	Gupta *et al*.[1] Kgf (N)	Kumar *et al*.[6] (N)	Ahmed *et al*.[7] Kgf (N)	Anand *et al*.[14] (*N*)
	Control group	Incisor	NM	186.8	16.3 (159.7)	144.02
		Right molar	NM	377.6	50.6 (496)	487.99
		Left molar	NM	361	52.1 (510.6)	494.98
Preoperative	Micoplate group	Incisor	1.9 (18.62)	NM	2.1 (20.58)	30.57
		Right molar	5.75 (56.35)	NM	4.4 (43)	55.92
		Left molar	5.11 (50)	NM	4.7 (46)	61.82
	Miniplate group	Incisor	2.1 (20.58)	NM	1.8 (17.6)	21.72
		Right molar	5.45 (53.41)	NM	5.4 (53)	35.09
		Left molar	4.75 (46.55)	NM	5.6 (55)	41.31
First week	Microplate group	Incisor	NM	44	2.8 (27.44)	48.9
		Right molar	NM	112	8.1 (79.4)	197.17
		Left molar	NM	112.9	9.7 (95)	180.8
	Miniplate group	Incisor	NM	NM	2.5 (24.5)	54.64
		Right molar	NM	NM	8.3 (81.4)	159.19
		Left molar	NM	NM	8.9 (87)	187.63
Second week	Microplate group	Incisor	5.9 (57.82)	57	4 (39)	NM
		Right molar	16.6 (162.68)	129.4	11.7 (114.6)	NM
		Left molar	16.63 (163)	127.1	12 (117.6)	NM
	Miniplate group	Incisor	6.2 (60.76)	NM	3.8 (37.2)	NM
		Right molar	17.7 (173.5)	NM	11.4 (111.7)	NM
		Left molar	17.63 (172.8)	NM	11.6 (113.6)	NM
Third week	Microplate group	Incisor	NM	79.3	NM	NM
		Right molar	NM	153.7	NM	NM
		Left molar	NM	154.1	NM	NM
	Miniplate group	Incisor	NM	NM	NM	NM
		Right molar	NM	NM	NM	NM
		Left molar	NM	NM	NM	NM
Fourth week (1 month)	Microplate group	Incisor	NM	99.2	10.6 (103.9)	55.91
		Right molar	NM	167.8	21.3 (208.7)	205.46
		Left molar	NM	168.1	20.2 (198)	218.54
	Miniplate group	Incisor	NM	NM	10.7 (105)	97.91
		Right molar	NM	NM	20.8 (204)	298.9
		Left molar	NM	NM	19.5 (191)	320.08
Sixth week	Microplate group	Incisor	9.55 (93.59)	127.8	12.5 (122.5)	NM
		Right molar	27.15 (266)	247.8	30.4 (298)	NM
		Left molar	27.21 (266.5)	250.3	31.3 (307)	NM
	Miniplate group	Incisor	10.3 (100.94)	NM	12.8 (125.4)	NM
		Right molar	28.71 (281.4)	NM	30.4 (298)	NM
		Left molar	29.94 (293.4)	NM	31.1 (305)	NM
3 months	Microplate group	Incisor	14.17 (138.9)	NM	NM	83.4
		Right molar	43.4 (425.3)	NM	NM	314.45
		Left molar	42.9 (420.4)	NM	NM	325.13
	Miniplate group	Incisor	14.8 (145)	NM	NM	107.15
		Right molar	44.54 (436.5)	NM	NM	373.16
		Left molar	44.23 (433.5)	NM	NM	379.06
6 months	Microplate group	Incisor	14.94 (146.4)	NM	NM	NM
		Right molar	47.95 (470)	NM	NM	NM
		Left molar	48.25 (475.5)	NM	NM	NM
	Miniplate group	Incisor	15.3 (150)	NM	NM	NM
		Right molar	47.46 (465)	NM	NM	NM
		Left molar	46.25 (453)	NM	NM	NM

NM, not mentioned, Kgf, kilogram force, N, Newton (9.80665N=1Kgf).

resolved in the two patients and no further complication was reported. Kumar *et al.* [6] were concerned only with their primary outcome to measure the biting force for patients with mandibular fracture and treated by ORIF using microplates and compared with the biting force of the normal individuals and to determine the time taken for the bite forces to return to the normal functional range. Kumar *et al.* [6] did not mention any secondary outcome or any associated complications. Ahmed *et al.* [7] reported that the overall complications were recorded in five (12.5%) patients in both the study groups. One patient required revision surgery, two patients had occlusal derangement, one had abscess in the fracture line, and one patient complained of dehiscence. The disturbed occlusion was seen in the microplate group and none in the miniplate group. In addition, one case of hypesthesia was seen in the microplate group and none in the miniplate group. Anand *et al.* [14] reported that the assessment of the fracture stability showed favorable results, whereas one (10%) patient from each study group had mild occlusal derangement; moreover, two patients in the miniplate group developed infection.

Discussion

Earlier microplates were used in non-stress-bearing areas such as midface, but recent experimental and clinical studies have shown that microplates can be used sufficiently in the stress-bearing areas of the mandible [2,5].

Bite force is considered as one of the indicators of the functional state of the masticatory system that results from the action of jaw elevator muscles modified by the craniomandibular biomechanics. The maximum occlusal force is reduced with fractures within the masticatory system, so the measurement of the biting force was used to compare between different plating systems in the management of mandibular fractures and to determine the rate of recovery of the biting force to the normal functional range [14,15].

Four studies were included in this review; all of them have shown progressive increase of the biting force in the study groups without significant difference between the microplate and miniplate groups. At 6-week postoperative follow-up visit, the biting force was ~60–75% of the control group, whereas Gupta *et al.* [1] and Anand *et al.* [14] have shown that the biting force reached the normal functional range at 3 and 6 months follow-up visits. This was in agreement with Kumar *et al.* [16]. The maximum voluntary bite force represents the greatest force an individual could voluntarily generate. The amount of force used during functional activities is probably much less. Hence, the fixation requirements based on the maximum voluntary bite force in noninjured participants may be inflated, and this is may be the reason the semirigid fixation was successful so we can use microplates as aform of semirigid fixation successfully [1,6].

Complications of the included studies were recorded within the acceptable level associated with the traditional techniques of ORIF [17], without significant difference between both the microplate and miniplate groups. Although the cost is the main disadvantage of titanium microplates, they have better mechanical properties and smaller dimension and less cost than resorbable plates. Cost-effectiveness studies should consider all the advantages of microplates regarding their smaller size, ease of application, greater malleability, less tissue stripping or nerve injury, and then little complications or need for second surgery [13,18,19].

Different limiting factors were present in this review, such as the diversity of the bite force measuring devices in addition to different measuring unit of the bite force; Gupta *et al.* [1] and Ahmed *et al.* [7] were measuring the biting force in kilogram force (kgf), whereas Kumar *et al.* [6] and Anand *et al.* [14] were measuring the biting force in Newton (N). Another limiting factor was the size of the microplate and whether used alone for fixation or used in a combination with a miniplate. Gupta *et al.* [1] and Anand *et al.* [14] used one 1.2 mm microplate in a combination with one 2.0 mm miniplate in comparison with two 2.0 mm miniplates, whereas Ahmed *et al.* [7] used two 1.5 mm microplates in comparison with two 2.0 mm miniplates, and also Kumar *et al.* [6] did not define the size of the microplates.

The site of the mandibular fracture was another limiting factor. Gupta *et al.* [1] and Anand *et al.* [14] have managed cases with isolated mandibular interforaminal fracture, except seven patients of 20 patients in the study of Anand *et al.* [14], who were associated with subcondylar fracture and kept in intermaxillary fixation for 2 weeks and consequently the biting magnitude was affected. The patients managed by Ahmed *et al.* [7] had isolated mandibular fracture either symphyseal, parasymphyseal, or body fracture, whereas Kumar *et al.* [6] did not define specific site in the mandible. There was a great diversity in the protocol of the follow-up visits in the included studies, as seen in Table 1; in addition, the whole period of follow-up was too short in the two studies [6,7], as 6 weeks were not enough for complete recovery to determine the time needed for patients to reach the normal functional range of the biting force.

Four articles in this systematic review are a limited number of articles, all of which were of small sample size, in addition to the individual variation in the biting force; all these limiting factors increased the heterogeneity in the review and did not allow doing a meta-analysis. Numerous future studies are needed to investigate the efficacy of using the microplates for mandibular fractures to determine their indications and contraindications and these studies should have some form of standardization regarding size of microplates, site of the fracture, presence of associated fractures, using an international bite force recorder, and the same follow-up protocol.

Conclusion

In light of the included studies, microplates have high holding power and were efficacious for internal fixation of simple, minimally displaced, isolated mandibular fractures, but there is still no sufficient evidence to support this information safely, so numerous future studies with sound methodology and larger sample size are needed to evaluate their use in the other forms of mandibular fractures.

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Conflicts of interest

There are no conflicts of interest.

References

1. Gupta A, Singh V, Mohammad S. Bite force evaluation of mandibular fractures treated with microplates and miniplates. J Oral Maxillofac Surg 2012; 70:1903–1908.
2. Burm JS, Hansen JE. The use of microplates for internal fixation of mandibular fractures. Plast Reconstr Surg 2010; 125:1485–1492.
3. Jorgenson DS, Mayer MH, Ellenbogen RG, Centeno JA, Johnson FB, Mullick FG, *et al*. Detection of titanium in human tissues after craniofacial surgery. Plast Reconstr Surg 1997; 99:976–981.
4. Schllephake H, Lehmann H, Kunz U, Schmelzelsen H. Ultrastructural findings in soft tissues adjacent to titanium plates used in jaw fracture treatment. Int J Oral Maxillofac Surg 1993; 22:20–25.
5. Feller KU, Richter G, Schneider M, Eckelt U. Combination of microplate and miniplate for osteosynthesis of mandibular fractures: an experimental study. Int J Oral Maxillofac Surg 2002; 31:78–83.
6. Kumar ST, Saraf S, Devi SP. Evaluation of bite force after open reduction and internal fixation using microplates. J Dent Univ Med Sci 2013; 10:478–489.
7. Ahmed S, Rehman S, Ansari M, Khan A, Farooq O, Khan A. A comparative study on evaluation of role of 1.5 mm microplates and 2.0 mm standard miniplates in management of mandibular fractures using bite force as indicator of recommendation. Natl J Maxillofac Surg 2016; 7:39.
8. Jadad AR, Moore RA, Carroll D, Jenkinson C, Reynolds DJ, Gavaghan DJMH. Assessing the quality of reports of randomized clinical trials: is blinding necessary? Control Clin Trials 1996; 17:1–12.
9. Sheta MS, Shoushan MM, Hussein MM, Abd Elaal SE. Evaluation of using microplates osteosynthesis for pediatric mandibular fractures. Tanta Dent J 2015; 12:149–155.
10. Song SW, Burm JS, Yang WY, Kang SY. Microplate fixation without maxillomandibular fixation in double mandibular fractures. Arch Craniofac Surg 2014; 15:53–58.
11. Abdullah WA. The use of a single titanium microplate in displaced pediatric parasymphysial mandibular fractures. Saudi Dent J 2009; 21:95–100.
12. Ahmed SS, Bhardwaj S, Ansari MK, Farooq O, Khan AA. Role of 1.5 mm microplates in treatment of symphyseal fracture of mandible: a stress analysis based comparative study. J Oral Biol Craniofac Res 2017; 7:119–122.
13. Zakaullah S, Kotrashetti SM, Maiya R. Management of mandibular fractures using 1.3 mm low profile titanium miniplates. Int J Dent Clin 2011; 3:24–25.
14. Anand D, Prasad K, Lalitha RM, Krishnappa R, Rajnikanth BR, Munoyath SK, *et al*. Bite force assessment of mandibular interforaminal fractures treated with combination of microplate and miniplate – a randomized control study. Craniomaxillofac Trauma Reconstr Open 2018; 2:e1–e8.
15. Koc D, Dogan A, Bek B. Bite force and influential factors on bite force measurements: a literature review. Eur J Dent 2010; 4:223–232.
16. Kumar S, Gattumeedhi SR, Sankhla B, Garg A, Ingle E, Dagli N. Comparative evaluation of bite forces in patients after treatment of mandibular fractures with miniplate osteosynthesis and internal locking miniplate osteosynthesis. J Int Soc Prev Community Dent 2014; 4:S26–S31.
17. Khaitab U, Khan A, Khan MT. Outcome of rigid internal fixation of mandibular fractures : a prospective study. Pakistan Oral Dent J 2009; 29:207–210.
18. Boss R. Treatment of pediatric facial fractures: the case for metallic fixation. J Oral Maxillofac Surg 2005; 63:382–384.
19. Muñante-Cárdenas JL, Asprino L, de Moraes M, Albergaria-Barbosa JR, Moreira RWF. Mandibular fractures in a group of Brazilian subjects under 18 years of age: a epidemiological analysis. Int J Pediatr Otorhinolaryngol 2010; 74:1276–1280.