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Research Paper

Evaluation of Hardware complications Associated with Open Reduction and internal fixation of Mandibular Fractures: A retrospective Study.

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Abstracts
Background-Mandibular fractures, accounting for 50% of facial fractures, the fracture can be treated with close or open reduction. Open reduction fixation using titanium hardware's has gained increasing acceptance for the treatment of fractures including mandibular fracture. The main advantages of internal fixation are prompt stabilization and pain-free mastication. Complications associated with the use of mini plates are artifacts formation on imaging, Screw loosening, palpable plate, and plate fracture.
Aim-To evaluate retrospectively complications associated with the use of hardware's in the treatment of different type of mandibular fractures treated at a tertiary Hospital in Lagos Nigeria.
Methods- Sixty cases of respondents with trauma treated with open reduction and using titanium plates was retrieved and information's like gender, age, etiology of trauma, fracture diagnosis, and nature of treatment performed was imputed into proforma for analysis
Result- Forty-two males and eighteen females have a different form of mandibular fractures with a mean distribution of 35.17 ± 8.05 and 34.94 ± 7.65 respectively. Motor Bike is the major cause of fracture sustained by the majority of Male and Female Patients 13(31.0%) and 8 (44.4%), followed by Tricycle and auto crashes. Mandibular body fracture accounted for the largest pattern of injury, neurological injury, pain and plate infection are also commonly associated plate complications (11(18.3%), 16(26.7) &10(16.7))
Conclusion-, this study recorded low hardware failure, sixteen respondents have no complications, and thirty-two out of the respondent with complications resolved satisfactorily. The use of mini plate is effective in managing mandibular fractures and the associated complications can successfully be managed
Keywords- *mandibular fractures, hardware/miniplate, complications*

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I. Introduction

Mandibular fractures, accounting for 50% of facial fractures, play a significant role in craniofacial trauma. They can be treated with closed reduction methods such as intermaxillary fixation (IMF) or open reduction and internal fixation (ORIF)[1,2]Owing to disadvantages reported with IMF, ORIF has gained increasing acceptance for the treatment of fractures including mandibular fractures. The available types of plates for internal fixation methods are macro plates, mini plates, and microplates. The materials used for mini plates are either titanium or stainless steel[3]. The main advantages of internal fixation are prompt stabilization and pain-free mastication [1,4]Titanium miniplates when used to treat mandibular fractures not without complications. It's been reported that titanium metal plates can cause artifacts formation on imaging when left in place[3].Screw loosening, palpable plate, and plate fracture can occur and will require a second surgical procedure for plate removal[5,6]. Other forms of complications like malocclusion, infection, wound dehiscence, and nerve injuries by ORIF can also occur.[1]Hardware problems can present inform of discomfort and this discomfort from titanium plates spans a wide range of severities such as simple palpability over sensitive areas of the face to cold intolerance and pain, especially in cooler climates[3].Titanium and its alloy have the highest biocompatibility, excellent ductility, tensile strength, nontoxic, and resistance to corrosion than other metals[1,7]. However, stainless steel or cobalt chrome plates had been reported to cause corrosion, metal allergy, toxicity, or malignant transformation[4,5].Infected hardware is populated with bacterial colonies. On the contrary, with hardware exposure, the patient may not experience signs of infection[3,8], Culturing exposed hardware will not lead to bacterial growth, It is widely believed that hardware infection should be treated by debridement of necrotic and infected tissue, and antibiotic administration.[4] However, no specific guideline onwhether an infected or exposed hardware needs to be removed or if it is removed, whether it can be immediately replaced with repeat ORIF[9]. The early expert opinion suggested that ORIF for mandibular fractures should be performed within 72 hours of injury to reduce complication rate[9]This study,therefore, aims to evaluate the complications associated with the centre mandibular open reduction and internal fixation.

Methods- Sixty cases of respondents with trauma treated with open reduction and using titanium plates of 2.0mm and 1.5mm dimension at the Maxillofacial department of Lagos state university teaching Hospital Lagos was evaluated in this study. Sociodemographic information such as sex, age, etiology of trauma, fracture diagnosis, and nature of treatment performed was imputed into proforma. Other data also included in the study are the treatment outcome, duration of postoperative follow-up, and various forms of associated complications with the implants were recorded.

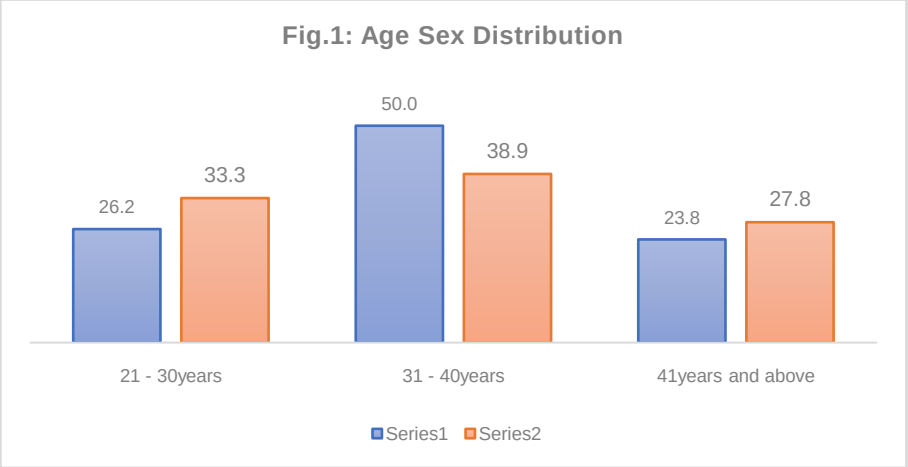
Analysis- analysis of the obtained continuous and categorical variables was done using SPSS. Frequencies of the variables were determined, tables wereformed, and cross-tabulations weredone using Chi-square to determine the level of significance of the variables. Significance level maintained at $P \leq 0.05$.

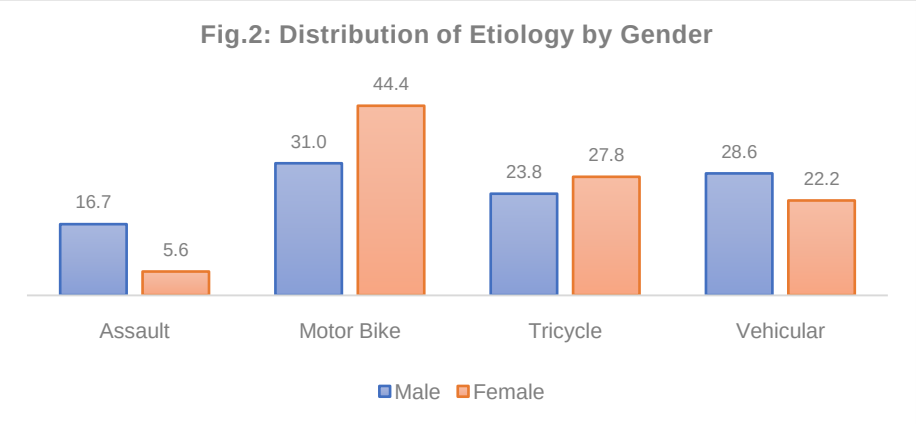
II. Result

A total of sixty respondents are retrospectively recruited using their cases file

Figure 1 shows that the highest number of Male and Female Patients are withinthe age range of 31- 40years (50.0% & 38.9%). Forty-two males and eighteen females have different form of mandibular fractures with a mean distribution of 35.17 ± 8.05 and 34.94 ± 7.65 respectively. A quarter of the total number of patients is 41years old and above. No statistically significant difference between the Age of Male and Female Patients ($P>0.05$).

Figure 2 shows that Motor Bike is the major cause of fracture sustained by the majority of Male and Female Patients13(31.0%) and 8 (44.4%), followed by Tricycle and Vehicle crashes. Assault for Male Patients 7 (16.7%) is higher than that of Female Patients 1(5.6%). No Statistical relationship between the gender and the Aetiology ($P>0.05$).





The Outcome of the management shows that 53.3% of the complications were resolved, three cases still persist (5.0%) and nine plates were surgical removed 14.0%. No significant relationship observed between gender and the outcome (p=0.14). All patients were treated by open reduction and internal fixation using Titanium Plates.

Table 1 shows the Diagnosis of Mandibular Fractures by Gender. Body fractures either (bilateral or occurring on right & left) are common mandibular fractures diagnosed among Male patients while Symphysial 4 (22.2%) and Right mandibular Body fractures 4 (22.2%) are common among Female Patients.

Mandibular Body fractures (Bilateral and right or left) are the highest diagnosed fractures due to assault while mandibular fractures due to Motor Bike has Symphysia, Parasymphysial, and Right Body fracturesmore in occurence. Lastly, mandibularfracture experienced from Tricycle and auto crasheshas more of body fractures either occurring bilaterally, on the right or left side of the bone as shown in Table 2

Pain was the major Post-Operative Complication that Male and Female Patients had. Other pronounced Post-Operative Complications observed in this study are; Neurological, Wound Breakdown, Plate Exposure, Plate Infection, and Functional complications.

Pain and Plate Infection are major Post-Operative Complications due to Assault, Functional Complications and Pain are prominent complications due to Motor Bike while Pain, Neurological, and Plate exposure are major Post-Operative Complications due to Tricycle and Vehicular aetiology. None of the factors contributed to the duration of Post-Operative Follow upstatistically.

Table 1: Diagnosis of Mandibular Fractures by Gender

Diagnosis Mandibular Fractures	Gender		Total
	Male	Female	
Lt parasymphysial and body	2 (4.8)	1 (5.6)	3 (5.0)
Lt angle	3 (7.1)	1 (5.6)	4 (6.7)
Rt parasymphysial and body	0 (0.0)	1 (5.6)	1 (1.7)
Symphysial	3 (7.1)	4 (22.2)	7 (11.7)
Rt parasymphysial and Lt body	1 (2.4)	0 (0.0)	1 (1.7)
Rt Body	11 (26.2)	4 (22.2)	15 (25.0))
Bilateral angle and body	1 (2.4)	0 (0.0)	1 (1.7)
Bilateral body	7 (16.7)	3 (16.7)	10 (16.7)
Comminuted Body	2 (4.8)	0 (0.0)	2 (3.3)
Lt Body	7 (16.7)	1 (5.6)	8 (13.3)
Rt parasymphysial	0 (0.0)	3 (16.7)	3 (5.0)
Lt Condyle	2 (4.8)	0 (0.0)	2 (3.3)
Lt parasymphysial	2 (4.8)	1 (5.6)	3 (5.0)
Rt Angle	2 (4.8)	0 (0.0)	2 (3.3)
Rt Condyle	1 (2.4)	0 (0.0)	1 (1.7)

Table 2: Diagnosis of Mandibular Fractures by Aetiology

Diagnosis Mandibular Fractures	Etiology				Total
	Assault	Motor Bike	Tricycle	Vehicular	
Lt parasymphysial and body	0 (0.0)	2 (9.5)	0 (0.0)	1 (6.3)	3 (5.0)
Lt angle	0 (0.0)	2 (9.5)	1 (6.7)	1 (6.3)	4 (6.7)
Rt parasymphysial and body	0 (0.0)	1 (4.5)	0 (0.0)	0 (0.0)	1 (1.7)
Symphysial	1 (12.5)	3 (14.3)	2 (13.3)	1 (6.3)	7 (11.7)
Rt parasymphysial and Lt body	0 (0.0)	0 (0.0)	0 (0.0)	1 (6.3)	1 (1.7)
Rt Body	3 (37.5)	3 (14.3)	3 (20.0)	6 (37.5)	15 (25.0))
Bilateral angle and body	0 (0.0)	0 (0.0)	0 (0.0)	1 (6.3)	1 (1.7)
Bilateral body	2 (25.5)	2 (9.5)	4 (26.7)	2 (12.5)	10 (16.7)
Comminuted Body	0 (0.0)	1 (4.5)	1 (6.7)	0 (0.0)	2 (3.3)
Lt Body	1 (12.5)	1 (4.5)	3 (20.0)	3 (18.8)	8 (13.3)
Rt parasymphysial	0 (0.0)	3 (14.3)	0 (0.0)	0 (0.0)	3 (5.0)
Lt Condyle	0 (0.0)	0 (0.0)	1 (6.7)	1 (6.3)	2 (3.3)
Lt parasymphysial	1 (12.5)	2 (9.5)	0 (0.0)	0 (0.0)	3 (5.0)
Rt Angle	0 (0.0)	2 (9.5)	0 (0.0)	0 (0.0)	2 (3.3)
Rt Condyle	0 (0.0)	1 (4.5)	0 (0.0)	0 (0.0)	1 (1.7)
Total	8 (100.0)	21 (100.0)	15 (100.0)	16 (100.0)	3 (5.0)

Table 3: Patients' Treatment and outcome by Gender

Outcome	Gender		Total	Chi-Square	P-Value
	Male (n %)	Female (n %)			
Persisted	3 (7.1)	0 (0.0)	3 (5.0)	6.875	0.143
Plate removed	9 (21.4)	0 (0.0)	9 (14.0)		
Resolved	19 (45.2)	13 (72.2)	32 (53.3)		
None	11 (26.2)	5 (27.8)	16 (26.7)		
				t-value	P-Value
Post-Operative follow-up (in months)	11.50 ± 4.85	10.72 ± 4.90		0.568	0.572
Treatment					
Open reduction and internal fixation using titanium plates	42 (100.0)	18 (100.0)	60 (100.0)		
Total	42 (100.0)	18 (100.0)	60 (100.0)		

Table 4: Postoperative Complications by Gender

Post-Operative Complications	Gender		Total
	Male	Female	
Neurological	7 (16.7)	4 (22.2)	11 (18.3)
Functional Complications	5 (11.9)	4 (22.2)	9 (15.0)
Pain	11 (26.2)	5 (27.8)	16 (26.7)
Wound breakdown	7 (16.7)	2 (11.1)	9 (15.0)
Plate exposure	7 (16.7)	2 (11.1)	9 (15.0)
Palpable plate	4 (9.5)	0 (0.0)	4 (6.7)
Plate Infection	6 (14.3)	4 (22.2)	10 (16.7)
Other Complications	1 (2.4)	1 (5.6)	2 (3.3)
None	12 (28.6)	5 (27.8)	17 (28.3)
Total	42 (100.0)	18 (100.0)	60 (100.0)

Table 5: Postoperative Complications by Aetiology

	Etiology				Total
	Assault	Motor Bike	Tricycle	Vehicular	
Neurological	0 (0.0)	3 (14.3)	3 (20.0)	5 (31.3)	11 (18.3)
Functional Complications	0 (0.0)	5 (23.8)	1 (6.7)	3 (18.8)	9 (15.0)
Pain	2 (25.0)	5 (23.8)	6 (40.0)	3 (18.8)	16 (26.7)
Wound breakdown	0 (0.0)	3 (14.3)	3 (20.0)	3 (18.8)	9 (15.0)
Plate exposure	1 (12.5)	1 (4.8)	4 (26.7)	3 (18.8)	9 (15.0)
Palpable plate	1 (12.5)	0 (0.0)	0 (0.0)	3 (18.8)	4 (6.7)
Plate Infection	2 (25.0)	3 (14.3)	3 (20.0)	2 (12.5)	10 (16.7)
Other Complications	0 (0.0)	1 (4.8)	1 (6.7)	0 (0.0)	2 (3.3)
None	4 (50.0)	6 (28.6)	4 (26.7)	3 (18.8)	17 (28.3)
Total	8 (100.0)	21 (100.0)	15 (100.0)	16 (100.0)	60 (100.0)

Table 6: Relationship of Post-operative follow-up duration with Gender, Age, Aetiology, and Outcome

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	3.970	4.837		.821	.415
Gender	-1.250	1.386	-.119	-.902	.371
Age of Patients	.047	.080	.076	.582	.563
Etiology	1.057	.622	.224	1.699	.095
Outcome	1.134	.701	.220	1.618	.111

III. **Discussion**

Mandibular fracture in this study involves the different parts and sides. Though there may be no difference in the anatomy, the frequency of fractures on one side may differ and the pattern presented in the same individual with the same aetiology can also present asa different pattern of fracture seen affecting the parts of the mandible[10]There is a male preponderance in the study compared to that of the female, most of the respondent falls within the 2nd and 3rd decade of life[11]. This concurred with the findings of several local and international studies reported[10–12]. Men are known to be more active, engage more in activities that exposed them to trauma such as transportation business, and use of heavy industrial machinery, and are more likely to be involved in domestic violence[13].The study is thus in line with Olojede et al[13] in which mandibular fractures accounted for 33% of all the assault-related fractures recorded.

Several studies have also reported mandibular body fractures either alone or in association with other parts to be more common[11,14]. This is not different from what obtains in this study.

Road traffic crashes (which include vehicular, motorbike, and tricycle accidents) and arecent increase in domestic-associated violence injuries have emerged as the etiological factors in mandibular fractures in developing countries like Nigeria[10,11,13,14]. Furthermore, there is an increase in the proportion of adolescents and young adults sustaining these injuries. In the developed nations of the world assault is the leading cause of maxillofacial injuries and mandibular fractures inclusive[10,12]victims of automobile and motorcycle accidents based on documented study tend to have multiple mandibular fractures, unlike those involved in altercations usually/often present with single non-displaced fractures[13].

Plating systems were designed to give several points of bone fragment fixation thereby maintaining facial dimensions, preventing rotational migration of fragments, and providing interfragmentary stability. Rigid internal fixation contributes to rapid bone healing and accelerates convalescence after craniofacial bone

surgery[15]. Pain, nerve injury, and plate infection accounted for the largest complication observed in the study. Pain can be a result of nerve compression, secondary to plate infection, or the effect of thermal sensitivity of the plates to environmental temperature changes. Nerve injury in the form of anesthesia or local paresthesia of an area could result if plates are placed close or impinged on the nerve. The nerve injury could also be a result of the direct or initial trauma to the mandible, a likely probability in the case of this study[3,4,6]. Plate infection is very common and far above that of other posttraumatic complications recorded by several studies.[2,5,9] Several studies conducted to estimate risk factors for the development of infection have proved that early and proper immobilization followed by antibiotic prophylaxis couldsignificantly diminish the infection rate. Contributing factors to plate infection in the mandibular region can be the mobility of the mandible which interferes with the stability of the prosthesis, inability to maintain proper oral hygiene, collection of saliva or food in the vestibule, proximity to tooth roots, constant irritation to the surrounding tissues, trauma due to continuous masticatory forces anddelayedmedicalcare.[2,5]. All these can cause infections and failure of hardware in this region. The mandibular body region is more associated with complications recorded in the study. This may be a result of a heavy masticatory load this area is constantly subjected to which can give rise to plate flexibility and breakage.Chaushu et al[16] documented more associated complications at the body and angle of the mandible, this was said to be a result of the load-bearing effect of these areas and therefore, are prone to screw loosening and infection.The study also documents thatPatients with comminuted and multifocal mandible fractures were found to be at higher risk of developing complications, including infection[6]

Other complications recorded in this study are plate exposure, plate breakage/fracture, and functional complications which include jaw deviation, wound breakdown, and scar formation.

Plate breakage/fracture accounted for the major reasons for plate removal in this study, several of the exposed hardware are closed with raised flaps and medications except for those with recurrent wound breakdown and prolonged plate exposure.The infected plates are managed with antibiotics in which several resolved. Only three cases of complications persist till the time of this study, while all others resolved.The rates of plate removal in craniofacial surgery vary from 12 % to 18 %. The most common reason for removal is an infection, accounting for approximately half of all plate removals cited in other studies. Discomfort/palpability is the next most commonly cited reason for plate removal, accounting for approximately a sixth of all plate removals[6]Plates is either exposed or overtly infected, clinical management depends on criteria that include duration of exposure, hardware loosening, fracture location, and whether the bone is healed (stable)[4,5].

patient factors could also increase complication rates, Malanchuk and Kopchak[2]demonstrated that age was a significant predictor of infection for tooth-bearing mandible fractures treated with open or closed reduction, with patients less than 20 years old and greater than 60 years old. Another significantcontributor to developing complications in patients with traumatic mandible fractures is substance use like alcohol abuse[2].Study has reported that drug users sustaining mandibular fractures developed surgical site infections.[17] This could relatively be due to poor nutrition, wound healing, and poor compliance with postoperative oral care.[18] Smoking has also been reported to increase post-ORIF complication rates 4-fold and infection rates 6-fold, as compared with non-smokers receiving ORIF. The controversy regarding the non-removal of asymptomatic bone plates is ongoing, there is no doubt that symptomatic plates should be removed[17].

In conclusion, this study recorded low hardware failure, sixteen respondents have no complications, and thirty-two out of the respondent with complications resolved satisfactorily.
This shows that complications with titanium implant is low and can successfully be managed.

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Conflict of interest
The authors declare no conflict of interest.

References

1. Aramanadka C, Kamath AT, Srikanth G, et al. Hardware Removal in Maxillofacial Trauma: A Retrospective Study. *Scientific World Journal*. 2021;2021. doi:10.1155/2021/9947350

2. MALANCHUK VO, KOPCHAK A v. Risk factors for development of infection in patients with mandibular fractures located in the tooth-bearing area. *Journal of Cranio-Maxillofacial Surgery*. 2007;35(1):57-62. doi:10.1016/j.jcms.2006.07.865
3. Chaushu G, Shoshani Y, Taicher S. *Risk Factors Contributing to Symptomatic Plate Removal in Maxillofacial Trauma Patients*.
4. Cahill TJ, Gandhi R, Allori AC, et al. Hardware removal in craniomaxillofacial trauma a systematic review of the literature and management algorithm. *Annals of Plastic Surgery*. 2015;75(5):572-578. doi:10.1097/SAP.0000000000000194
5. Aramanadka C, Kamath AT, Srikanth G, et al. Hardware Removal in Maxillofacial Trauma: A Retrospective Study. *Scientific World Journal*. 2021;2021. doi:10.1155/2021/9947350
6. Al-Hammami AR, Al-Anee AM, Lateef TA, Al-khayat A. Complications of Bone Plating Following Different Facial Bones Fractures. *European Scientific Journal, ESJ*. 2018;14(6):351. doi:10.19044/esj.2018.v14n6p351
7. Cahill TJ, Gandhi R, Allori AC, et al. Hardware removal in craniomaxillofacial trauma a systematic review of the literature and management algorithm. *Annals of Plastic Surgery*. 2015;75(5):572-578. doi:10.1097/SAP.0000000000000194
8. Campbell CA, Lin KY. Complications of Rigid Internal Fixation. doi:10.1055/s-0029-1202596
9. Stone N, Corneman A, Sandre AR, Farrokhyar F, Thoma A, Cooper MJ. Treatment delay impact on open reduction internal fixation of mandibular fractures: A systematic review. *Plastic and Reconstructive Surgery - Global Open*. 2018;6(6). doi:10.1097/GOX.0000000000001829
10. Barde D, Madan R, Mudhol A. Prevalence and pattern of mandibular fracture in Central India. *National Journal of Maxillofacial Surgery*. 2014;5(2):153. doi:10.4103/0975-5950.154818
11. Kuye OF, Olufemi O. Epidemiology of Maxillofacial Injuries: A Single-Center Prospective Study. *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS) e-ISSN*. 2022;21:17-22. doi:10.9790/0853-2104101722
12. Chaurasia A, Katheriya G. Prevalence of mandibular fracture in patients visiting a tertiary dental care hospital in North India. *National Journal of Maxillofacial Surgery*. 2018;9(2):123. doi:10.4103/njms.njms_8_18
13. Sab O. *PATTERN OF ASSAULT-RELATED MAXILLOFACIAL INJURIES TREATED AT THE GENERAL HOSPITAL, LAGOS, NIGERIA SCHÉMA DES VOIES CONNEXES-MAXILLO-FACIALE BLESSURES TRAITÉES À L'HÔPITAL GÉNÉRAL, LAGOS, NIGÉRIA 1 1 2 5 *OLOJEDE ACO , GBOTOLORUN OM , OGUNDANA OM , EMEKA IC , 3 4 4 EMMANUEL MM , OLUSEYE SAB , RUNSEWE O. *Olojede ACO , Gbotolorun OM , Ogundana OM , Emeka IC , 3 4 4 Emmanuel MM*. Vol 6.
14. Anyanechi CE. Number 4 GHANA MEDICAL JOURNAL. 2010;44.
15. Campbell CA, Lin KY. Complications of Rigid Internal Fixation. *Craniomaxillofacial Trauma & Reconstruction*. 2009;2(1):41-47. doi:10.1055/s-0029-1202596
16. Chaushu G, Shoshani Y, Taicher S. *Risk Factors Contributing to Symptomatic Plate Removal in Maxillofacial Trauma Patients*.
17. Iizuka T, Lindqvist C, Hallikainen D, And $, Paukku P. ..*I Oral Maxillofac Surg Infection After Rigid Internal Fixation of Mandibular Fractures: A Clinical and Radiologic Study*.

18. Gokkulakrishnan S, Singh S, Sharma A, Kumar Shahi A. An analysis of postoperative complications and efficacy of 3-D miniplates in fixation of mandibular fractures. *Dental Research Journal*. 2012;(2). Accessed July 23, 2022. www.drj.ir