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SYMPTOMATIC PLATE REMOVAL IN MANAGEMENT OF FACIOMAXILLARY FRACTURES – OUR EXPERIENCE IN TERTIARY CARE HOSPITAL OF NORTH INDIA.

Surgery

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ABSTRACT

Background: The use of metallic screws and plates has become the standard of care in the operative management of faciomaxillary fractures. The currently available plates and screws are well tolerated in majority of the patients and are generally not removed unless indicated. The hardware may need to be removed because of subjective discomfort felt by the patient or because of infective complications or because of the hardware getting exposed. The present study was undertaken to determine the incidence of plate removal and to find out the commonest reasons for the plate removal.

Materials and Methods: In a prospective cum retrospective study over a period of 18 months, 290 patients were recruited in the study. A total of 1157 plates were placed in these patients at various locations. 39 plates (3.37%) were removed subsequently from 18 patients (6.20%) secondary to objective and subjective reasons. The type (metal) of material used, the number of plates used, the location of the plates, and the route of insertion of the hardware was also studied. The time interval between the placement and removal of the plates was also studied.

Results: 1157 plates were placed in 290 facio-maxillary cases operated in this study. 39 plates (3.37%) were removed subsequently from 18 patients (6.20%) secondary to objective and subjective reasons, and majority of plates removed were from the mandible (69.23%).Majority of patients (67.24%) had two to four osteosynthesis plates inserted. The stainless steel plates had a very high rate of plate removal in our study.

Conclusion: There will always be a need for hardware removal in a portion of patients treated with metallic osteosynthesis devices. Approximately one in sixteen patients eventually undergo plate removal because of hardware-related objective signs or subjective symptoms.

KEYWORDS

Faciomaxillary trauma, titanium plates and screws; stainless plates and screws; wound infection; exposure of plates; removal of hardware

INTRODUCTION

Rigid internal fixation is the standard of care for treating facial fractures.[1] Although good outcomes have been reported in many cases, some studies have reported high complication rates with up to 30% of patients requiring a revision procedure.[2] Recently published studies on facial trauma patients reveal that 20-30% of patients eventually have their plates removed,[3,4,5] primarily because of infections or other complications in surgical area.[2,3,5,6] However there are studies from Canada and Finland that showed that great majority of plate were removed because of subjective discomfort, possibly provoked by cold climate.[4,7]

This study was undertaken to evaluate the cross section of patients wherein plate removal was necessitated following ORIF in maxillofacial fractures.

Aims and Objectives

1. To determine rate of plate removal in facial fractures that are managed by open reduction and internal fixation (ORIF).
2. To determine reasons of plate removal in facial fractures.

MATERIALS AND METHODS

This was retrospective cum prospective study conducted in tertiary care hospital in North India for a period of 18 months. It included patients that were managed with open reduction and internal fixation (ORIF) for maxillofacial trauma and those who reported for plate removal. The type of plate and the status of screws whether it was loosened was also noted. The time between plate insertion and plate removal was designated as plate removal delay.

The epidemiological data and operative details including gender, age, fracture type, surgical approach, type of plate, status of screws whether snug fitting or loose fitting, socio economic status of patient, education level, alcohol or drug abuse, level of oral hygiene and plate location were recorded (as per proforma attached).

Age groups

The patients were classified as being children (12 years or less), teenagers (13 -19 years) or adults (20 years or more). Adult patients were further classified into age groups <50 years, >50 years.[3]

Fracture type –

Each patient was assigned a fracture type from following groups. (Figure 1)

1. Mandibular fracture alone (one or more sites)
2. Zygomatic fractures alone (tripod zygomatic fracture),
3. Orbital fracture alone (isolated orbital wall + rim fracture)
4. Midfacial fractures (Le Fort I - III, NOE or multiple midfacial fractures)
5. Combined fractures (mandibular + midfacial fracture or panfacial fracture)

Indication for Plate Removal

Plate Removal indication was selected from one of following groups:

1. Objective reasons such as wound infection, screw loosening, and broken hardware. This presented as a discharging sinus, exuberant granulation, exposed plate or swelling and cellulitis as shown in Figure 2.
2. Subjective reasons like cold sensitivity, palpability, deformity and other type of subjective discomfort.

Surgical technique

The procedure was performed under general or local anesthesia as per location of plate. The plate removal was done either through the skin or through the mucosal surface (transcutaneous, transbuccal or transconjunctival).

The mandibular plates were removed from intraoral or extraoral approach depending upon location of the plate. The parasymphyseal and body region was approached through the intraoral approach. The plates in the angle region were removed through the preexisting extraoral incision. The plates in the zygomatico-maxillary and nasomaxillary buttresses were removed through the intraoral upper buccal sulcus approach. The plates along the zygomatico-orbital rims were removed using the preexisting incision or coronal approach or rarely through the blepharoplasty incision. The hardware along the

infraorbital rim was removed through transconjunctival route or through a preexisting subciliary incision. The plates in the fronto-orbital region were removed through coronal incision. All patients were followed up at 3, 6, 9 months and were evaluated for symptoms and signs. Data were presented as mean ± SD or median and interquartile range. Mann-Whitney *U*-test was used for statistical analysis of continuous variables. For normally distributed data t-test was applied. Pearson χ^2 test or Fisher's exact test was used for analysis of categorical. *P* value of <0.05 was considered statistically significant. All calculations were performed using SPSS® version 15 (Statistical Packages for the Social Sciences, Chicago, IL).

RESULTS

A total of 466 patients of facio-maxillary injury presented in emergency surgical OPD of our hospital. The majority of patients (88.41%) were male. The commonest age groups were 20-49 years (72.74%) and 50 years & above (12.46%). 14.80% of patients were teenagers, and there were no children in this series.(Table 1) The commonest cause of the injury was Road side accident (RSA). The commonest associated injury in these patients was Head injury (Figure 3). The most common fracture type was isolated mandibular fracture (30.47%). The next common locations were mid facial fractures (27.46%) and panfacial fractures (23.39%). Fracture distribution of patients is listed in Figure 4.

Majority of patients (67.24%) had two to four osteosynthesis plates inserted. Distribution of patients according to number of plates inserted is shown in Table 2. The cost factor and affordability of patient were major factors in this regard. Education and income level of patients in this study is presented in Figure 5.

Fracture fixation was performed either by intraoral approaches in 51.37%, extraoral approaches in 10.68% of patients, or combined intra- and extraoral approaches in 37.93% as shown in Figure 6.

60.76% of all the plates had been inserted with an intraoral approach. Most common plate location was mandible intraoral (38.8%) followed by maxilla.

Distribution of plates according to their approach and locations of 1157 plates in 290 pts is shown in Table 3.

39 plates (3.37%) were removed from 18 patients (6.20%). Plates were removed due to either objective or subjective reasons as shown in Table 4.

Two of 18 patients who underwent plate removal had received fracture fixation with 2 plates, and both underwent removal of both plates. Nine patients had been treated with 4 plates. Five underwent removal of 2 symptomatic plates, in three patients only 1 plate and in one patient all 4 plates were removed.

One patient each had received fracture fixation with five and seven plates, 2 patients received six and 3 received fracture fixation with eight plates. One symptomatic plate was removed from patient with five plates. In two patients with six plates, one underwent removal of 1 and other underwent removal of 2 plates. In patient with seven plates, 3 plates were removed and in three patients with 8 inserted plates, 7 plates from one and 2 each from two patients were removed.

Table 5 shows the indications for plate removal with respect to gender distribution, fracture type. The plates were removed for objective reasons in 77.77% and for subjective reasons in 22.23%. The objective reasons were the main cause of plate removal; this observation was statistically significant. p=0.01. The commonest objective reason was infection, whereas most common subjective reason was pain. There was no statistical difference in education and income status and distance of their residence from this centre (p>0.05). Similarly no difference was observed when time interval between injury and surgery was considered between plate removal group (6.16 months) range (14-16) and rest of patients (5.48 months) range 1-60 days. Oral hygiene was poor in almost all patients in first post operative visit, it improved gradually with each visit so this factor could not be compared statistically.

Table 6 shows relation of plate removal to gender and fracture type. Though there were differences between these three factors but they were not found to be statistically significant p>0.05. Women had plate removal for subjective reasons more often than men (33.33% vs. 20.0%) (p 0.31). Plate removal was performed for objective reasons more often in patients who had sustained exclusively panfacial fractures (85.71%) (p=0.59) than in patients who had sustained mandibular fractures (62.5%) (p=0.48) but both were found to be statistically insignificant.

Average plate removal delay was 11.32 months (range 2 mths - 3.6 years). Retention time was less than six months in 9 of 18 patients (50%), between six months and one year in 4 patients (22.22%), between one and two years in 2 patients (11.11%), more than two years in two patients (11.11%) and more than three years in one patient.

Average plate removal delay was shorter for patients who had plate removal because of subjective reasons (7.07 months) than objective reasons (12.53 months) but difference was not found to be statistically significant (p=0.593).Fracture group of patient of plate removal is shown in Table 7.

It shows relationship between plate removal and gender, age, fracture type, surgical approach, and plate location in 290 patients. The Chi-square tests revealed no significant differences in Plate Removal rates between males and females, between age groups. However, differences were observed when surgical approaches and plate locations were compared. Patients who underwent fixation with an extraoral approach had plate removal significantly more often (12.90%) than those who had fixation with a combined approach (10.90%) or intra oral approach (1.34%) (p = 0.02). Moreover, patients who had plates inserted in mandible by an extraoral approach had plate removal statistically significantly more often than patients who had plates inserted in mandible from an intraoral approach or in any other location (0-15.8%) (p = 0.001) as shown in Table 7. Zygomatico orbital fractures were found to be contributing significantly to plate removal than other fracture types (0.04).

25 out of total 39 plates removed were of stainless steel as shown in Table 8. Rest 14 plates were of titanium. 18 patients out of 290 operated ultimately presented for plate removal. This resulted in plate removal rate patient wise as 6.20%. Plate removal rate plate wise in this study came out to be 3.37%. Plate removal rate of titanium plates patient wise (2.79%) and plate wise (1.70%) were lesser than that of stainless steel plates (17.91%) and (8.56%). Both these results were statistically significant (p=0/01).

Plates that had been inserted with an extraoral approach were significantly more frequently removed (5.94%) than those inserted with an intraoral approach (1.70%) (p\0.01). Plates that had been inserted in the mandible with an extra oral approach were removed more frequently (11.25%) than plates inserted in the mandible with an intra oral approach (2.00%), in maxilla and in other locations through extraoral incisions (1.30-4.54%) (p\0.001).

Majority of plates were removed from mandible (69.23%). Second most common region was lateral orbital rim as shown in Figure 6.

In adjusted logistic regression analyses, females had a 1.5-fold greater risk of Plate Removal compared with men. Moreover, exclusively mandibular fractures had a 2.2-fold and zygomatico-orbital fractures a 1.5- fold greater risk of Plate removal compared with other fracture types. However, these results were not statistically significant. An extraoral surgical approach had a significantly higher risk of Plate Removal compared with operations in which combined extra- and intraoral approaches were used. Plates situated in lateral orbital rim had significantly higher risk of plate removal than plates situated in maxilla or frontal bone.

DISCUSSION

1157 plates were placed in 290 Facio maxillary cases operated in this study. 39 plates (3.37%) were removed subsequently from 18 patients (6.20%) secondary to objective and subjective reasons, and majority of plates removed were from the mandible (69.23%).

Table 9 shows comparison of our study with other groups. The plate removal rate per patient in our series was 6.20%. It is of same magnitude as that has been observed in previous studies Hanson et al (5.0%) [1], Murthy AS et al (6.57%) [2]. However some studies have reported higher rates (12-33.3%) (Islamoglu; Nagase; Bakathir,) [3, 4, 5]. Our plate removal rate per plate i.e. 3.37% is lowest among the studies

available in literature. The infection rate was 3.44% per patient in our series and between 3% when compared to a rate of 9.2% in literature,[4] the infection rate per plate in our study is 1.55% as compared to 1.2-8.3% in other series[4]. Nagase et al[4] found infection rate per patient as 3.0% and per plate as 1.2%. In their study, discomfort by the patient was the main reason for plate removal and the overall plate removal rate 33.3% was much higher than our study. Infection rate was found to be highest in a study by Bhatt 9.2%.[10]

Mobility at fracture site is a known risk factor for infection.[4] Nagase et al preference for use of stronger and thicker plates might have played a role in lower infection rates, but this benefit came at expense of higher discomfort rates. It is quite possible that the colder climate could have played a role in plate discomfort. However, Szabo et al believe that climate has a very minor role in genesis of plate-related discomfort.[4] It is possible that indoor/outdoor temperature differences alone are sufficient to cause discomfort in certain patients, irrespective of regional climate.[4] In our study no patient of plate removal had cold or thermal sensitivity as the reason.

Plate exposure rate noted by Nagase[4], Francel [9] was quite similar to our study, but discomfort removal rate noted by Nagase[4] and Chaushu[11] was much higher than our study (Table 9). Plate exposure per patient rate of 1.37 % was lowest in our study as compared to rate of 1.5% in Nagase[4] and 1.8% in Francel[9] series. . Even when per plate exposure rate was considered then also our rate 0.51% was low and comparable to Nagase 0.4%[4]. Szabo reported highest exposure rate in literature 3.37%.[4]

In our series, more plates were removed from mandible than from middle third of face. This is similar to the conclusions by with Islamoglu[3], Bhatt and Langford[10] but in disagreement with Francel[9]. A study by Brown[12] has reported no relationship to site of plates. In our current study , the angle of mandible and lateral orbital rim were 'high risk' sites necessitating plate removal and were found to be statistically significant ($p<0.01$). In our study majority of plates removed were from mandible angle 18 (46.15%) and parasymphysis 5 (12.82%) body mandible 4 (10.25%). The other common sites from where the plates were removed included fronto zygomatic buttress 3 (7.69%), infra orbital rim 3 (7.69%), zygomaticomaxillary buttress 2 (5.12%), nasomaxillary buttress 2 (5.12%), anterior maxillary wall 1(2.56%), and frontal bone 1 (2.56%).

Nagase[4]et al found a decreasing incidence of discomfort from upper to lower regions of facial skeleton in their population. They concluded that the nature of soft tissue coverage and proximity to the frontalis muscle could have led to this discomfort.

However we did not notice this difference in discomfort rates rostral to caudal in our study; all the 4 patients who underwent plate removal because of discomfort had mandibular fractures.

Murthy[2] revealed that there were 6 plates removed in 5 out of 76 patients and all plates were removed from mandibular region, 3 each from angle and symphyseal region. Similarly in our study, mandible was most common location of plate removal accounting for 69.23% cases of plate removal. Lateral orbital rim was second most common location of plate removal 12.82%.

This study also provided opportunity to compare incidence of complications among type of plates used. 6 patients (2.79%) out of 215 patients with titanium plates and 12 (17.91%) patients out of 67 patients with stainless steel plates came for the hardware removal. This makes steel plates 6.41 times more prone to removal as compared to titanium plates. If we consider per plate rate of removal then also stainless steel plates are 5.06 times more likely to be removed (Table 8). Both plate removal rate per patient and per plate rate are found to be statistically significant ($p<.0001$).

Infection rate is 12.83 times more likely to occur with steel plates as compared to titanium plates. This infection rate per plate rises to 14.25 times more in stainless steel Than the titanium plates. Both these infection rates are found to be statistically significant ($p<.0001$).

Exposure rate per patient is 3.20 more common with steel plates. The exposure rate per plate is 24.58 times more common with steel plates .Exposure rate per patient is statistically insignificant however exposure rate per plate rate is found to be statistically significant. ($p<.0001$).

Discomfort rate is 3.20 and 8.21 times more common with steel plates if considering as per patient and plates respectively. Discomfort rate per patient is statistically insignificant however exposure rate per plate rate is found to be statistically significant ($p<.0001$).

CONCLUSIONS

There will always be a need for hardware removal in a portion of patients treated with metallic osteosynthesis devices. Approximately one in sixteen patients eventually undergo plate removal because of hardware-related objective signs or subjective symptoms. Weather does not seem to affect the rate of plate removal. Mandibular angle is the most common region of plate removal followed by lateral orbital rim. Patient compliance and regular follow up help in decreasing the plate removal rate. Chances of plate removal are much less with titanium plates as compared to stainless steel plates.

Our recommendation is that much vigilance is needed when encountered with mandible fractures of the angle and symphysis. All fractures in the mandible should be treated with ORIF early.[13] Different aspects of a mandibular fracture should be fully appreciated, i.e., torsional forces, thickness and contour of bone, presence of teeth, and fracture pattern. Good technique, including appropriate plate bending and bone cooling, should be used.

Conflict of Interest: Nil
Funding: Nil

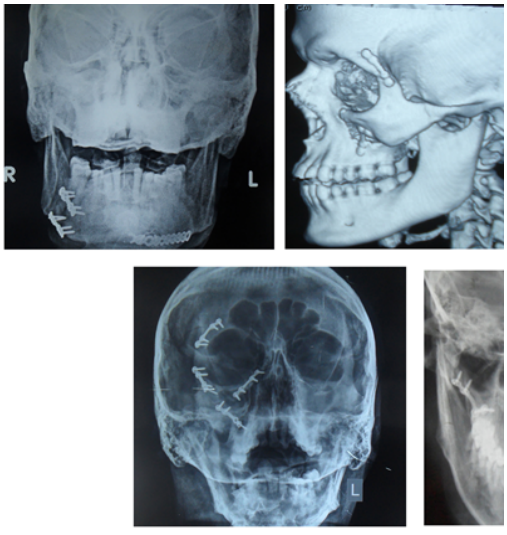
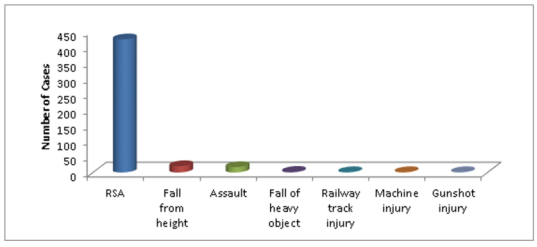
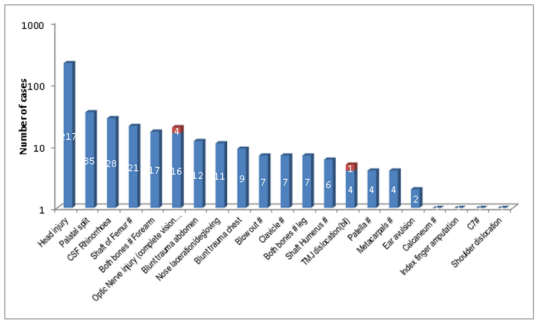


Figure 1-Showing location of plates .Upper Row: (left), mandible alone (center) zygoma alone and medial wall of orbit (right).Lower row: (left) zygoma and maxilla, (right) pan facial fractures.

Figure 2:-Clinical presentations Upper row: (left) swelling and inflammation; (middle) fluctuant swelling with pus discharge, (right) pouting granulation from the intraoral incision Lower row: (left) discharging sinus from submandibular area, (middle) exposed screw (right) granulations overlying the plate and exposed plate.



Aetiology of cases



Associated injuries

Figure 3 - Upper half: Etiology of fractures
Lower half: Associated injuries with the maxillofacial trauma.

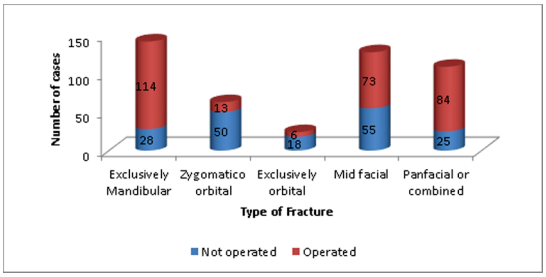
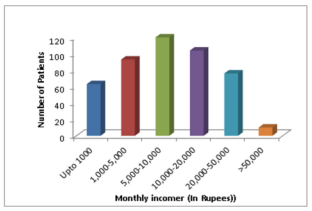
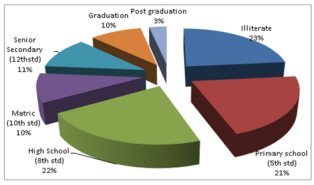


Figure 4 - Total number of cases that were seen. The ones that underwent ORIF have been shown in red. Majority of fractures involved mandible.



Income levels



Education levels

Figure 5 - Showing economic and educational status of the injured patients

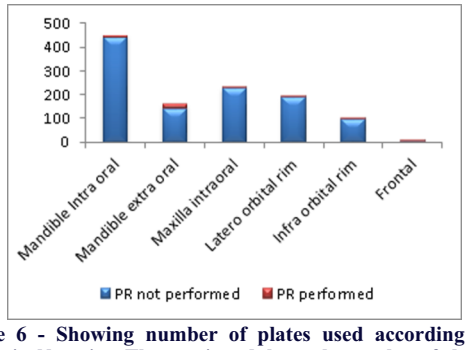


Figure 6 - Showing number of plates used according to the anatomical location. The area in red shows the number of plates that were removed.

Table 1: Age and sex distribution of the cases

	Male	Female	Age group	Number of cases
Total cases	412	54	12-19	69
			20-49	339
			50 and >	58
	466			

Table 2 Distribution according to type of plates.

Table 2											
Type of plates	**Number patient**	**Two plates**	**Three plates**	**Four plates**	**Five plates**	**Six plates**	**Seven plates**	**Eight plates**	**Nine plates**	**Ten plates**	**Total plates**
Titanium plates	223	67	28	62	24	23	13	4	2	-	865
Steel plates	67	15	3	20	12	11	3	2	-	1	292
Total	290	164	93	328	180		112	48	18	10	1157
The details of the number of plates used per case. The titanium and steel plates have been segregated											

Table 3	
Plate location	**Number of plates**
Mandible Intra oral	449 (38.8%)
Maxilla Intra oral	230 (19.87%)
Lateral orbital rim	194 (16.76%)
Mandible extra oral	160 (13.82%)
Infra orbital rim	102 (8.80%)
Frontal	22 (1.90%)
Number of plates used at various anatomical locations	

Table 4			
Objective Reasons		**No of patients**	
		14 (77.77%)	
	Infection		10 (55.55%)
	Exposure		4 (22.227%)
Subjective Reasons		4 (22.23%)	
	Pain		3 (18.75%)
	Palpability		1 (5.55%)
	p=0.018		
Reasons for removal of plates			

Table 5			
Gender		**Objective**	**Subjective**
	Males	12 (80%)	3 (20%)
	Females	2 (66.67%)	1 (33.33%)
	p value	.02	.31
Gender distribution of objective and subjective reasons of the plate removal			

Table 6				
		Plate Removal performed	**Plate Removal not performed**	**P value**
Gender				p=0.705
	Males	15 (5.85%)	241 (94.15%)	
	Females	3 (8.82%)	31 (91.17%)	
Age group	12-19	3 (4.34%)	66 (95.66%)	p=0.663
	20-49	14 (4.12%)	325 (95.87%)	
	>50	1 (1.72%)	57 (98.28%)	
Fracture Type	Exclusively mandibular	8 (7.01%)	106 (92.99%)	p=0.647

	Zygomatico orbital	3 (23.07%)	10 (76.93%)	p=0.04
	Orbital		6	
	Mid facial		73	
	Panfacial	7 (8.33%)	77 (91.67%)	p=0.337
	p=0.015			
Surgical approach	Intra oral	2 (1.34%)	147 (98.66%)	p=0.02
	Extra oral	4 (12.90%)	27 (87.10%)	
	Combined	12 (10.90%)	98 (89.10%)	

Statistical analysis of the plates as per sex, fracture type whether single or multiple, surgical approach and age.

Table 7

Plate location	Plates removed	No plates removed	P value
Mandible intraoral	9(2.04%)	440(97.96%)	
Mandible extraoral	18(10.11%)	142(89.89%)	.001
Maxilla intraoral	3(1.28%)	227(98.72%)	
Lat orbital rim	5(2.51%)	189(97.49%)	.04
Infra orbital rim	3(2.94%)	99(97.06%)	
Frontal	1(4.54%)	21(95.46%)	
p=0.0001			

Statistical analysis of the plate removal according to anatomical location and route of plate application

Table 8

	Titanium plates	Stainless Steel plates	Ratio of removal rate of steel and titanium plates	Statistical interpretation
Plate removal rate	2.79%	17.91%	6.41 times	Odds Ratio(OR) 7.6 (2.73-21.16)
Per patient Plate removal	6/215 patients (1.69%)	12/67 patients (8.56%)	5.06 times	p<.0001 OR 5.42
Per Plate Infection rate	14/824 patients (0.93%)	25/292 patients (11.94%)	12.83 times	p<.0001 OR 14.44(2.98-68.94)
Per patient Infection rate	2/215 patients (0.36%)	8/67 patients (5.13%)	14.25 times	P<.0002 OR 14.81(4.26-51.57)
Per Plate Exposure rate	3/824 patients (0.93%)	15/292 patients (2.98%)	3.20 times	p <.0001** OR 3.27 (.45-23.7)
Per patient Exposure rate	2/215 patients (0.24%)	2/67 patients (5.9%)	24.58 times	p=0.24 NS OR 26.09 (4.5-145.2)
Per Plate Discomfort rate	2/824 patients (0.93%)	4/67 patients (2.98%)	3.20 times	p=0.0004 OR 3.27 (.45-23.7)
Per patient Discomfort rate	2/215 patients (1.09%)	2/67 patients (8.95%)	8.21 times	p=0.24 NS OR 8.9071 (3.07-25.8)
Total plates removed	9/824	6/67		P<.0004

Comparison between titanium versus steel plates

Table 9

	Nagase	Francel	Bhatt	Szabo	Chaushu	Islamoglu	Hanson	Thoren	Our study
Plate removal	33.3%	12.0%	18.3%	12.0%		27.27%	24.0%	20.16%	6.20%
Per pt	45/135	61/507	28/153	54/452		18/66	246/5904	48/238	18/290
Plate removal	27.2%		16.6%	7.73%	21.6%	7.09%		17.43%	3.37%
Per Plate	135/497		51/308	108/1396	44/204	21/296		76/436	39/1157
Infection rate	3.0%	7.3%	9.2%					4.20%	3.44%
Per pt	4/135	37/507	14/153					10/238	10/290
Infection rate	1.2%		7.1%	1.8%	8.3%	2.0%			1.55%
Per Plate	6/497		22/308	25/1396	17/204	6/296			18/1157
Exposure rate	1.5%	1.8%							1.37%
Per pt	2/135	9/507							4/290
Exposure rate	0.4%		2.9%	3.37%		1.7%			0.51%
Per Plate	2/497		9/308	47/1396		5/296			6/1157
Discomfort rate	15.6%	3.0%						5.88%	1.37%
Per pt	21/135	15/507						14/238	4/290
Discomfort rate	13.7%		2.9%	2.4%	9.8%	1.0%			1.29%
Per Plate	68/497		9/308	23/1396	20/204	3/298			15/1157

Comparison between different studies

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