Titanium versus stainless steel implants in internal fixation in maxillofacial trauma

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ABSTRACT:
INTRODUCTION:
AIM: To compare effectiveness of titanium and stainless steel in internal fixation in maxillofacial trauma
OBJECTIVE: To compare rate of failure and complications associated with titanium and stainless steel fixation materials
MATERIALS AND METHOD :
Patients reported to Saveetha Dental College for surgical removal of fixation material from 2019 - April 2022 where included in this study .Reason for fixation material removal and material used for fixation where analysed.
RESULT: Total of 61patients reported for surgical removal of fixation material, were included in this study and the type fixation material were assessed . The patient presentation and the reason for the removal of the fixation material were tabulated and analysed. Out of 61 patients, 52 patients had stainless steel fixation material and 9 patients had titanium fixation material Tab1.
CONCLUSION: The use of titanium implants is supported by the study as it has a lesser infection rate when compared with stainless steel but prospective, comparative studies with larger sample size are needed to clarify and define potential performance and relevant clinical differences.

Keywords : Maxillofacial trauma, internal fixation, titanium, stainless steel

INTRODUCTION: The use of metal implants for internal fixation in fracture helps anatomic reduction, and facilitates earlier rehabilitation and enhancing functional outcome. Corrosion, insufficient material strength, and fracture of the implant are some of the early problems encountered with metal implants which led investigators to develop new implants with characteristics that could withstand the physical and physiological stresses of internal fixation of fractures.

An ideal implant must have ductility, strength, stiffness, and biocompatibility. Titanium and stainless steel are desirable for different functions or in different anatomic locations based on their properties . Ductile materials are capable of extreme plastic deformation and energy absorption before fracture. Implant materials are prone to material fatigue due to cyclic forces applied in the axial, flexural, or torsional direction which may lead to failure of the implant at loads considerably lower than the tensile or yield strengths of the material under static load(1).

Stainless steel alloys are proven to be durable enough to allow healing because they are significantly stiffer than bone . It also has the advantage of being ductile enough to allow contouring of the plate without fracture , biocompatible and inexpensive.

On the other hand Titanium more closely matches the modulus of elasticity of bone. Flexibility of titanium may be more beneficial for fracture healing in areas where more strain is required for a healing response to develop. Titanium alloy also has the advantage of being more resistant to cyclic load , notch sensitivity , good clinical track record when used in internal fixation devices for fractures.Titanium implants are nominally twice as flexible as similar-sized stainless steel implants. The higher flexibility directly translates into higher interfragmentary motion, which likely was responsible for the significantly increased callus formation seen with titanium implants but titanium implants are expensive when compared with electro polished stainless

It may be that neither metal is universally superior to the other, but that each has properties that may make it superior to the other in specific anatomic locations so, by comparing the advantages and disadvantages of each metal does not come to an obvious conclusion about which is better for fracture fixation. (1).

The aim of the current paper is to establish the efficacy of the titanium versus stain less stael implants by indirect method of assessing their failure rates when used for Maxillofacial trauma Fixation.

MATERIALS AND METHOD : Study includes all the patients who reported to us for removal of hardware between 2019 April to 2022 November. The following were the inclusion and exclusion criteria.

INCLUSION CRITERIA: patient reported for surgical removal of fixation material, who have been previously treated by ORIF for maxillofacial trauma .

EXCLUSION CRITERIA:

1. Patients reported for surgical removal fixation material who have been previously treated by other surgery like orthognathic surgery are excluded from the study.
2. Patient with existing comorbidities and under medication

The PICO approach has been used to define the objective of the study.

Participants:

Patient reported for surgical removal of fixation material, who have been previously treated by ORIF for maxillofacial trauma

Intervention:

Surgical fractures fixation with titanium plates and screw.

Comparator:

Surgical fractures fixation with stainless plates and screw.

Outcomes:

Complications including pain, pus discharge, swelling , plate exposure.

Data collection:

Statistical Analysis and result:

Patients reported to saveetha dental college for surgical removal of fixation material from 2019 to April 2022 were included in the study. Reason for removal and clinical signs of infection like pain, swelling ,pus discharge and their duration and site were assessed .

Results :

Total of 61patients reported for surgical removal of fixation material, were included in this study and the type fixation material were assessed . The patient presentation and the reason for the removal of the fixation material were tabulated and analysed.

Out of 61 patient, 52 patients had stainless steel fixation material and 9 patients had titanium fixation material Tab1.

Table 1:

	Number	Percentage
Stainless Steel	52	85.2
Titanium	9	14.8

Graph 1:

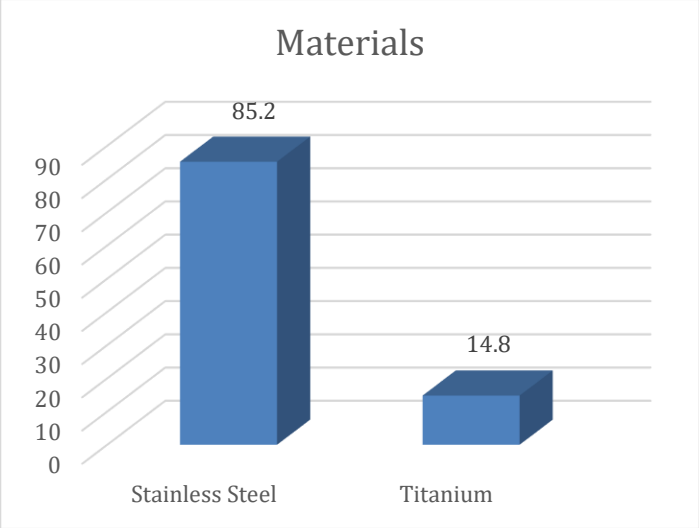


Table 2: Chief Complaint

	Number	Percentage
Pain	37	60.7
Abscess	1	1.6
Teeth Loosening	3	4.9
Swelling	3	4.9
Asymptomatic	11	18
Pain and Swelling	1	1.6
Screw Loosening	1	1.6
exposed plate	1	1.6
pain and Abscess	2	3.3
ulcer and Abscess	1	1.6

Graph 2: Chief Complaint

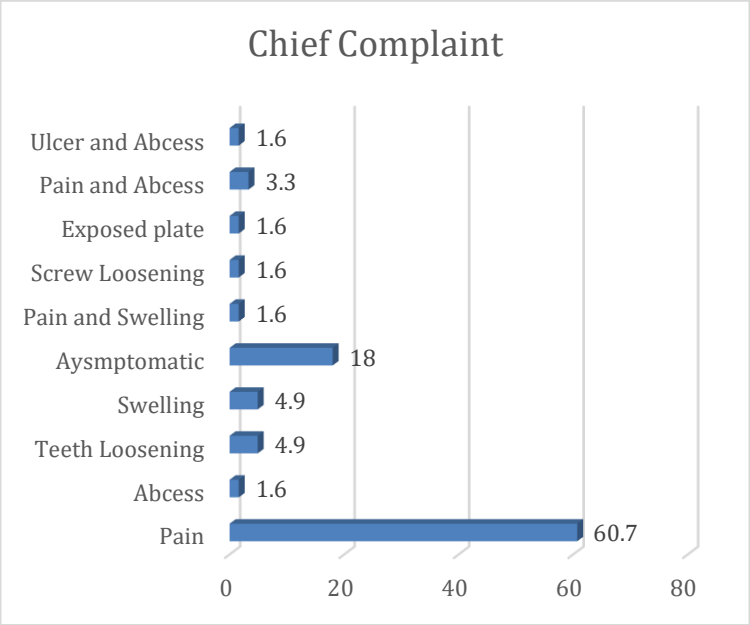


Table 3: Site

	Number	Percentage
Body	11	18
Para-symphysis	20	32.8
Infraorbital	3	4.9
Ramus	2	3.3
Symphysis	13	21.3
Zygomatic	5	8.2
Para and body	4	6.6
Symphysis and ramus	1	1.6
Not mentioned	2	3.3

Graph 3: Site

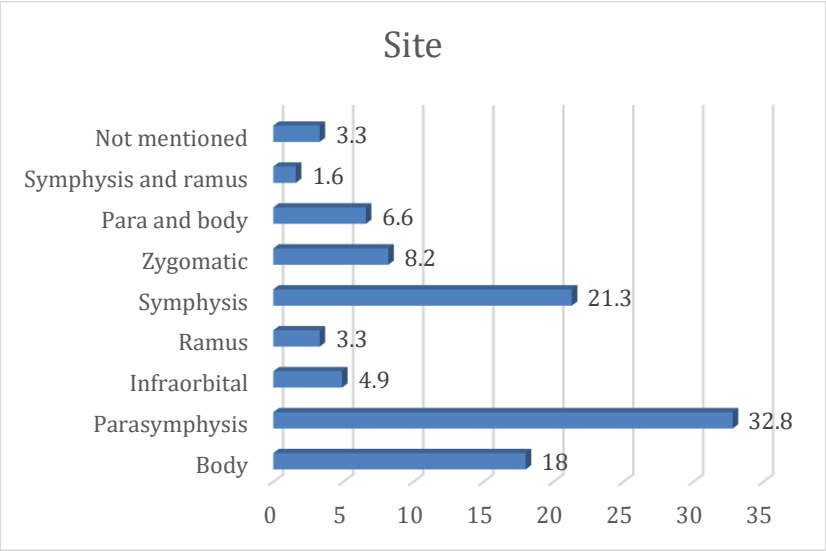
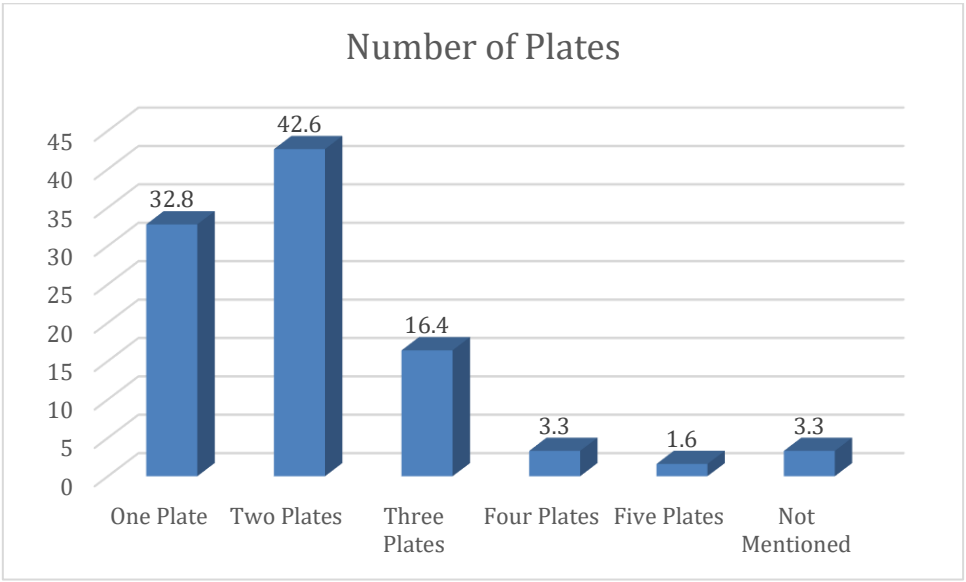


Table 4:

	Number	Percentage
One Plate	20	32.8
Two Plates	26	42.6
Three Plates	10	16.4
Four Plates	2	3.3
Five Plates	1	1.6
Not Mentioned	2	3.3

Graph 4:



Graph 5: Type of plates and chief complaints

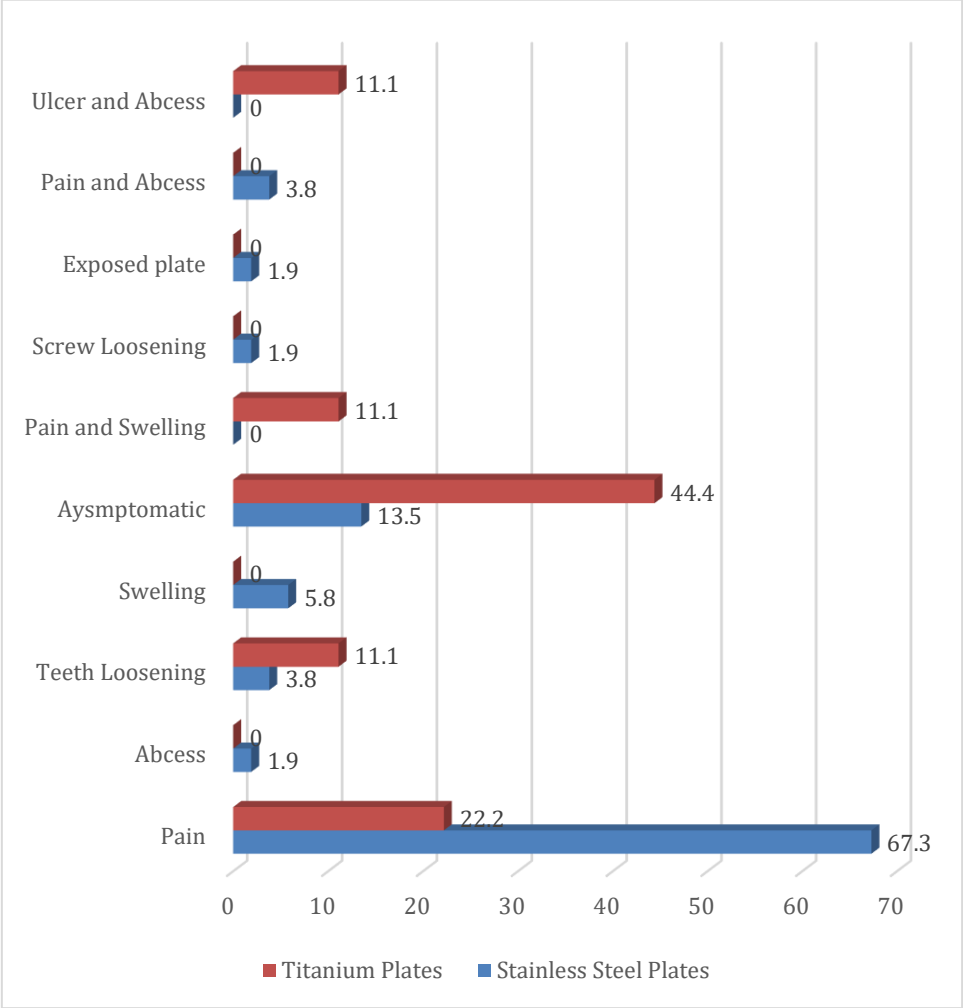


Table 5: Association between type of plates and chief complaints

	Stainless Steel Plates		Titanium Plates		Chi Square	P value
	Number	Percentage	Number	Percentage		
Pain	35	67.3	2	22.2	20.419	P = 0.015*
Abscess	1	1.9	0	0		
Teeth Loosening	2	3.8	1	11.1		
Swelling	3	5.8	0	0		
Asymptomatic	7	13.5	4	44.4		
Pain and Swelling	0	0	1	11.1		
Screw Loosening	1	1.9	0	0		
Exposed plate	1	1.9	0	0		
Pain and Abscess	2	3.8	0	0		
Ulcer and Abscess	0	0	1	11.1		
Total	52	100	9	100		

level of significance at P < 0.05

*Statistically significant at P < 0.05 using Chi Square test

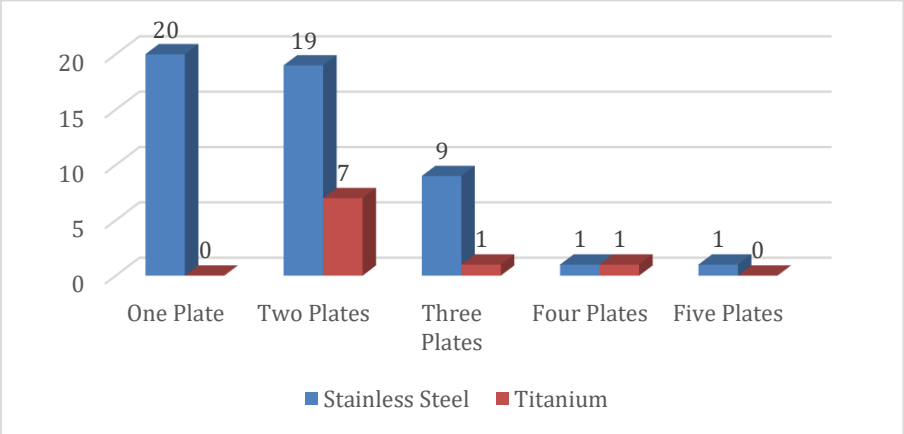
It was found that 67.3% of participants with stainless steel plates had pain and about 5.8% had swelling followed by loosening of teeth and pain & abscess in 3.8% of participants. In addition, about 22.2% of participants with titanium plates had pain and 11.1% of participants had loosening of teeth, pain & swelling and ulcer & abscess each. About 44.4% of participants with titanium plates were asymptomatic as against 13.5% of participants with stainless steel. This distribution was found to be statistically significant (P = 0.05).

Table 6: Association between number of plates and chief complaint irrespective of material

	One Plate	Two Plates	Three Plates	Four Plates	Five Plates	Total
	N (%)	N (%)	N (%)	N (%)	N (%)	N
Pain	13 (35.1)	14 (37.8)	9 (24.3)	1 (2.7)	0	37
Abscess	0	1 (100)	0	0	0	1
Teeth Loosening	1 (33.3)	2 (66.7)	0	0	0	3
Swelling	0	1 (50)	1 (50)	0	0	2
Asymptomatic	4 (36.4)	6 (54.5)	0	0	1 (9.1)	11
Pain and Swelling	0	0	0	1 (100)	0	1
Screw Loosening	0	1 (100)	0	0	0	1
Exposed plate	0	0	0	0	0	0
Pain and Abscess	2 (100)	0	0	0	0	2
Ulcer and Abscess	0	1 (100)	0	0	0	1
Total	20	26	10	2	1	59

It was found that pain was the most common complaint and 37.8% of participant with pain had two plates. Similarly, tooth loosening was seen in 66.7% of participants having two plates. About 54.5% of participants had two plates with plate exposure secondary to soft tissue dehiscence.

Graph 6: Number of plates and material



DISCUSSION:

These titanium alloys follow the principle of using non-toxic elements in the alloy formulation to optimize the property of biocompatibility . Ti-6Al-4V alloy is the sole exception since vanadium is considered a cytotoxic element. In vivo animal studies at the A0 Research Institute, Davos, Switzerland, indicated that although elemental vanadium created an undesirable biological response, the biocompatibility of Ti-6Al-4V alloy was similar to vanadium-free alloys that were evaluated.

Due to the absence of appreciable levels of nickel, chromium, and cobalt titanium alloys do not cause metal allergy reactions (4).

Biocompatibility of titanium is aided by the passive oxide film on the surface of titanium alloys , the mixed oxide films are comprised primarily of thermodynamically stable oxides such as TiO,, A&O,, Nb205, Zr205, and MOO* or MOO,. which is very corrosion resistant and is partially responsible for the outstanding biological properties , The stable oxides are very insoluble in biological fluids and this contributes to the excellent localized biocompatibility observed for these alloys (4).

Stainless steel is one of the most popular biomaterials for internal fixation which have favorable combination of mechanical properties, biocompatibility, corrosion resistance, and cost effectiveness . Stainless steel bone screws are easier to handle because the surgeon can feel the onset of plastic deformation and this prevents over torquing the screw(5).

An implant must be ductile (plastically deform without fracture), strong (withstand applied stresses without failure), stiff (resist deformation by an applied force), better performance under different mechanical demands and biocompatible (perform with an appropriate host response in a specific application).

From the current study, it is evident that Stainless plates had greater complications rates than titanium plates which may be attributed due to the surface characteristics and the plate profile of stainless steel plates compared to similar dimensional titanium plates. The titanium implants that were removed had good integration with the adjacent bone compared to the stainless steel counterparts supporting the concept of poor surface characteristics of stainless steal.

CONCLUSION: 85.2% of patient reported back for surgical removal are with stainless steel fixation. It is also found that 67.3% of participants with stainless steel plates had pain and about 5.8% had swelling followed by loosening of teeth and pain & abscess in 3.8% of participants.

The use of titanium implants is supported by the study as it has a lesser infection rate when compared with stainless steel but prospective, comparative studies with larger sample size are needed to clarify and define potential performance and relevant clinical differences.

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