

Osteosynthetic Materials Used in Open Reduction and Internal Fixation of Facial Fractures in University Hospital Setting- A Retrospective Study

M.Ashwin Shravan Kumar¹, Madhulaxmi Marimuthu², Revathi Duraisamy³

¹Research Associate, Dental Research Cell, ²Professor, Department of Oral and Maxillofacial Surgery, ³Senior lecturer, Department of Prosthodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai

Abstract

Facial fractures and management form a significant quantum of work for maxillofacial surgeons. Understanding the appropriate surgical techniques and materials can avoid complications like infections, implant loosening, improper healing and resurgeries. The aim of the study is to compare the two most commonly used osteosynthetic materials for open reduction and internal fixation - stainless steel and titanium. A retrospective data collection was done from March 2019 to June 2020 for a period of 10 months. Case records of patients who reported with facial trauma and underwent open reduction internal fixation (ORIF) were reviewed. There were 105 patients who reported with facial trauma, among which 47 patients needed ORIF. Parameters analysed were age, gender, site of fracture and choice of plate material. Among these, 44 were males and 3 were females. 35 patients were below 35 years and 12 patients were above 35 years. 65% were treated using Titanium plate & 35 % with stainless steel plate. Chi square test was performed to study the statistical significance and p value was found to be (0.030) < 0.05, statistically significant proving titanium is more used in patients below 35 years of age. This study showed that titanium plates were most commonly preferred over stainless steel plates. This is in consensus with existing literature that titanium plates are widely used for ORIF in facial fractures. However, though 35% of our study group still preferred to be treated with stainless steel plates. Whether age or socioeconomic reasons played a role in the choice of treatment needs to be further evaluated with larger sample size and multicentre studies among our population.

Keywords: Open reduction internal fixation; Facial fracture; Stainless steel; Titanium; Trauma

Introduction

The surgical treatment of craniomaxillofacial region involves restoration of ideal form and function¹. Complete healing of facial fracture was highly reported after taking into principles of orthopaedics like closed reduction, open reduction and internal fixation. Especially when the fractures cannot heal on their own, have been treated by ORIF by maxillofacial surgeons globally². There are constant advancements in use of many materials from rigid metals to alloys to bioresorbable plates, In the middle of the 1980s Champy popularized the use of stainless steel for ORIF³. Stainless steel was thought to be toughest material to withstand stress and was comparatively cheaper, but it had the disadvantage of high surface damage. Also it was difficult for adaptation.

To overcome this there were researches done and many concluded titanium as a superior option. Titanium was reported for its unique property called osseointegration. It had shown better adaptation, low surface damage, higher stress. Hence they can be preferred for most maxillofacial procedures⁴, though cannot be generalized for all procedures like mandibulectomy^{5,6}.

Also the release torque of titanium is higher than its insertion torque which accounted for its overall less loosening during stress application. But the cost of hardware and hypersensitivity reactions were reported as disadvantages⁷. Researchers stated that there were more radiographic scatter in stainless steel than compared to others like vitallium and titanium. Francel et al stated

that there would be a need for removal of titanium plates as the biohazards were higher which would significantly increase procedure expenses of patients⁸.

Common sites of fracture in maxillofacial region are the nasal bones, mandible, zygomatico maxillary bone and orbit. Angle fractures are quite common considering that the angle of the mandible forms an area of lower resistance which contains a thicker upper border, a thin basilar bone, and the presence of an impacted mandibular third molar^{9,10}.

Plate removal can be a stressful procedure for the patients as it would require a second surgical procedure under general anesthesia¹¹. Though the procedure of plate removal may be minor, the anaesthetic procedures, anxiety, stress and minimal hospital stay can be burdening to the patients^{12,13-15}. Various schools of thought debating the need to remove plates electively vs not are found in literature^{16,17}. So the choice of an ideal material is a debate globally with varied conclusions based on studies and case reports.

The main aim of this study is to compare the osteosynthetic materials used or preferred based on their properties, location of usage, complications, post operative results.

Materials and Methods

Study Type & Setting:

This is a retrospective study and all data were collected by reviewing and analysing 105 trauma case sheets of Saveetha Dental college and Hospitals over a period of 10 months from June 2019-March 2020. Ethical clearance was obtained for the study from the Institutional Ethical Committee

Participants:

Among the 105 cases sheets reviewed, 58 patients were treated with closed reduction and were excluded from the study. Patients who were treated by Open Reduction and Internal Fixation alone were included and it accounted for around 47 patients where 44 were males and 3 were female patients. All data were tabulated and cross verified by 2 reviewers.

Data Analysis

Data retrieved were compiled in an excel sheet and imported to IBM SPSS Statistics Version 20. Statistical analysis was performed using chi square statistical test for significance. The independent variable is the plate material and dependent variables were age, gender and site of fracture.

Results and Discussions

All cases selected were operated in the same institution with the same team of surgeons. Surgical protocols were standardised and post operative medications both antibiotics and analgesics were common for both the plates^{18,19}.

It was seen that 55% of males (24/44) and 66% of females (2/1) preferred titanium over stainless steel (Fig-1). However the overall number of males who were treated were more than females treated²⁰. Among males an almost equal number of patients (20/44) preferred to be treated with stainless steel.

65% of patients treated with ORIF were of age less than 35 years and preferred titanium (22/35) over stainless steel. 70% of patients above 35 years of age preferred stainless steel (9/15) over titanium (Fig-2). Chee Wei Lee et al stated that most fractures were observed during the early 30s and hence we established a relation between age over the material preference²¹.

55% of mandibular fractures were treated with stainless steel whereas titanium was preferred over 50% of maxillary fractures and was the choice of preference overall for all fractures (26/47). Chi square test was performed. The p value was found to be 0.148, implying that there is no significance between location of fracture and the material used (Fig-3). All fractures involving orbit were only treated with titanium mesh or plates. This is possibly to avoid chances of infection and eventful needs of plate removal at later stages which can be very difficult.

Researchers stated that most reported cases of ORIF were in the mandible in Indian population in his earlier studies²². Dube et al also stated that the second most common region of facial fracture is seen in the middle third of face especially in the zygomatic region and in nasomaxillary region²³. Thus a study between location of

fracture and the preference of material was established.

Kaura et al stated that 61% of facial fractures were reported to hospitals due to road traffic accidents followed by trauma due to assaults (23%)^{24,25}. Such cases are prone to infections and necessitate the choice of the most inert biocompatible material. Based on this hypothesis, titanium is most preferred in the panfacial trauma or fractures involving the middle third of the facial skeleton. But there have been certain documentations stating the effects of titanium on bones causing hypersensitivity and preferred stainless steel.

Sensitivity to titanium is characterized by the local presence of abundant macrophages and T lymphocytes and the absence of B lymphocytes, indicating Type 4 hypersensitivity. Researches are going on to develop a technique using flow cytometry, for the purpose of detecting the activation of lymphocytes stimulated by a metal, and measuring different mediators (cytokines, inflammatory mediators) released in response to the metal. Sahoo et al in his experiments found that there was osteoid tissue deposition around titanium which was a unique property lacking in stainless steel²⁶.

Veneable et al stated the presence of osteolysis around the fixation site when using stainless steel²⁷. Branemark et al in his studies proved that there was

microscopic evidence of osseointegration seen between bone and titanium²⁸. Titanium plates possess little biohazards and the second surgery to be performed for their removal has been minimal.

Hence, they remain the choice of preference for their strength and osseointegrative property²⁹. Also full or complete recovery from fractures can be obtained faster in using titanium over stainless steel due its various properties like osseointegration, high release torque, strength³⁰.

Thus incase of complicated fractures or multiple fractures or to enhance faster recovery titanium plates can be preferred. There has been global consensus with the result and this can be taken as evidence to practice.

Certain limitations in this study were less sample size and unequal gender distribution. The presence of other confounding factors like literacy and socio economic status were not well documented and hence could not be analysed.

Future prospects of this study can be established in larger sample size and also to find microscopic tissue level changes involved in both materials used for ORIF and so there can be a fair and conclusive evidence for their predominant preference and usage.

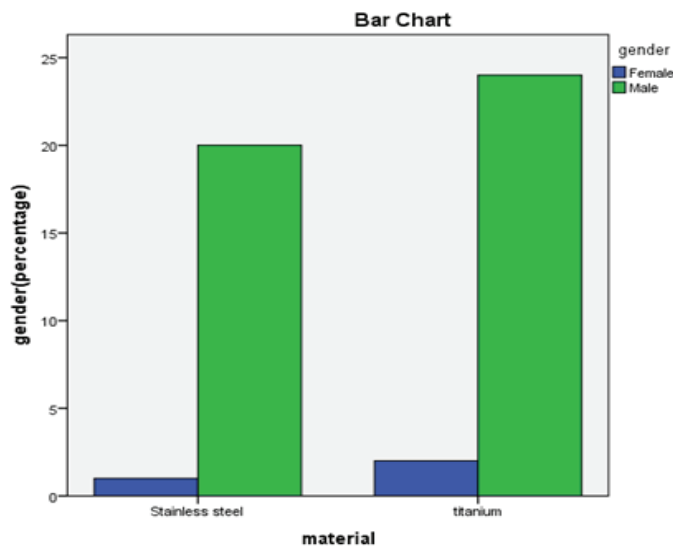


Fig-1: Bar graph representing the association between gender and the material used. X-Axis: Material Used (Titanium And Stainless Steel); Y Axis-Number Of Patients In Both Gender (Male-Green;Female-Blue). Chi square test was performed and the association was not significant. P value = 0.682 > 0.05, hence not significant proving osteosynthetic materials can be preferred irrespective of gender.

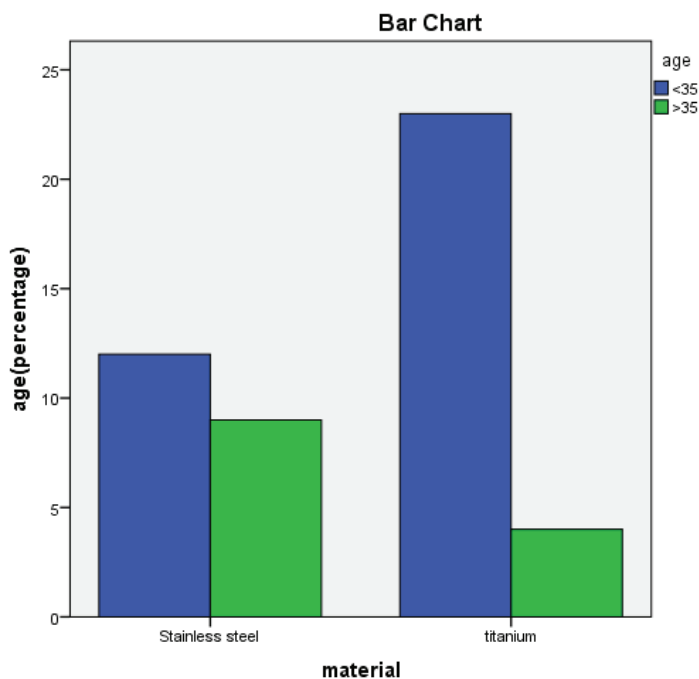


Fig-2: Bar graph representing the association between age and the material used.X-Axis: Material Used (Titanium And Stainless Steel); Y Axis-Number Of Patients In Both Age category(>35-Green;<35-Blue).Chi square test was performed and the association was significant. P value = 0.03 < 0.05, statistically significant proving titanium is the preferred material of choice by patients below 35 years of age .

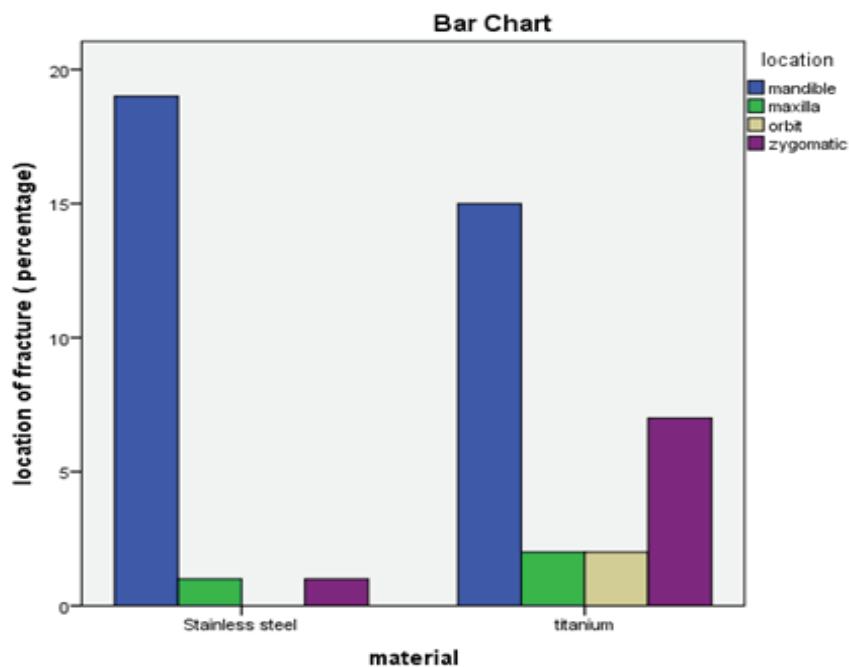


Fig-3: Bar graph representing the association between location of fracture and the material used.X-Axis: Material Used (Titanium And Stainless Steel); Y Axis-Location of fractures (maxilla-Green;mandible-Blue;orbit-Grey; zygomatic-Purple).Chi square test was performed and the association was not significant. P value = 0.148 (> 0.05), hence not statistically significant proving titanium is more used irrespective of location of fracture.

Conclusion

Conventionally two biomaterials namely titanium and stainless steel are been used for Open reduction and Internal Fixation. There has always been a comparison between the preference of both the materials at different setup. Within the limitations of the study it can be concluded that titanium was considered over stainless steel for ORIF of facial fractures irrespective of age, gender and location because of their strength and properties like less surface damage, less scatter in radiographs and osseointegration.

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Conflict of Interest: The authors have no conflict of interest to declare

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Ethical Clearance: It is taken from “Saveetha Institute Human Ethical Committee” (Ethical Approval Number- SDC/SIHEC/2020/DIASDATA/0619-0320)

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