Titanium vs. Stainless Steel Intramedullary Interlocking Nails in the Fixation of Tibia Shaft Fractures

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Abstract: ***Introduction**: Surgical fixation of tibia shaft fractures involves use of intramedullary interlocking nails. Titanium and stainless steel are two common metals used to manufacture these nails. Both metals have unique biomechanical properties. It is therefore imperative to understand whether nail material affects fracture union. **Methodology**: Retrospective analysis of patient charts, preoperative, postoperative and follow up radiographs of patient's who underwent intramedullary nail fixation for tibia shaft fractures over the period of the last 3 years was done. Intra-articular, open fractures and patients lacking adequate follow up data were excluded. The sample size included a total of 51 patients. The subjects were divided into two groups, those that underwent fixation titanium intramedullary nails and those that underwent fixation using stainless steel intramedullary nails. The post-operative radiograph of these patients at the 6 month follow up visit was analyzed. Radiographic fracture union was evaluated using the modified RUST criteria. **Results**: There were a total of 51 patients who met the inclusion criteria. After analysis of the data, it was found that there was no statistically significant difference in the union rates of the two groups. **Conclusion**: The purpose of this study was to compare the union rates of titanium intramedullary interlocking nails with stainless steel intramedullary interlocking nails used to treat tibia shaft fractures. We discovered that the union rates of tibia shaft fractures treated with titanium and stainless steel intramedullary nails do not differ significantly. A bigger sample size and continued monitoring until implant removal could provide more information on the issue.***

Keywords: Titanium, Stainless steel, Tibia shaft fractures, IMIL, Intramedullary interlocking nail, RUST criteria

1. Introduction

Due to its high rigidity, strength, biological toleration, and all-around dependable function, metal has been used in fracture fixing with unparalleled success for many years. The majority of fracture care in the first half of the 20th century was immobilization in plaster or via traction, which limited function during the healing period. The ideology of fracture fixation changed with the advent of better implants and open reduction and internal fixation with implants. [1] Stainless steel and titanium alloys are the two most common materials used. Chromium (17%–20%), nickel (12%–14%), molybdenum (2%–4%), manganese (2%), and iron (the remaining 80%) are all found in steel. Stainless steel is affordable, has good ductility, is easily machined, and can be easily shaped. Although stainless steel has an excellent tensile strength, titanium outperforms it in terms of corrosion resistance, biocompatibility, and fatigue strength. The elastic modulus of stainless steel is eight times larger than that of bone. Hence the fixation provided by stainless steel is more rigid. [2] The other drawback is that 1%–2% of individuals experience an allergic reaction to steel's nickel content. Compared to titanium, stainless steel is known to cause higher inflammatory reactions.[3] When compared to titanium implants, stainless implants have a higher likelihood of infection. This was linked to titanium's greater biocompatibility, which may promote surface vascularization and tissue adherence to implants, as opposed to stainless steel implants, which produce fibrous capsules that enclose dead space with liquid film. The bacteria flourish here and are protected from defensive mechanisms. [4]

Long bone fractures constitute majority of the emergency room visits in most trauma centers. Tibia shaft fractures are the most common among these. Literature favors the use of intramedullary interlocking nails for definitive fixation of these fractures. [5] One key area of controversy is the material of the intramedullary nail to be used. The purpose of this study is to radiographically compare the healing of tibia shaft fractures treated with titanium intramedullary nails and those treated with stainless steel nails.

2. Materials and Methods

Retrospective assessment of patient charts, preoperative, postoperative and follow up radiographs of patient's who underwent intramedullary nail fixation for tibia shaft fractures over the period of the last 3 years was done. Intra-articular fractures, open fractures and patients lacking adequate follow up data were excluded. The sample size included a total of 51 patients. The subjects were divided into two groups, those that underwent fixation titanium intramedullary nails and those that underwent fixation using stainless steel intramedullary nails. The post-operative radiograph of these patients at the 6 month follow up visit was analyzed. Radiographic fracture union was evaluated using the modified RUST criteria. [6] At the 6 month interval, a score of 10 or more was accepted as adequate union.[7]

	Radiographic Criteria	
Score per Cortex	Callus	Fracture Line
1	Absent	Visible
2	Present	Visible
3	Bridging	Visible
4	Remodeled	Invisible

A score is given to each cortex (anterior, posterior, medial and lateral) and the RUST score is the sum of all cortex scores.

Image 1: Modified RUST Criteria

3. Results

The study involved 51 subjects that underwent intramedullary nail fixation for tibia shaft fracture, whose radiographs were analyzed at the 6 month follow-up visit. There were 22 female subjects and 29 male subjects. The mean age of the participants was 41.8 years.

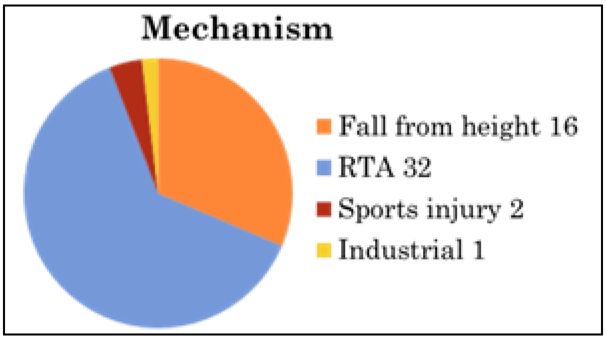

Image 2: Mechanism of injury

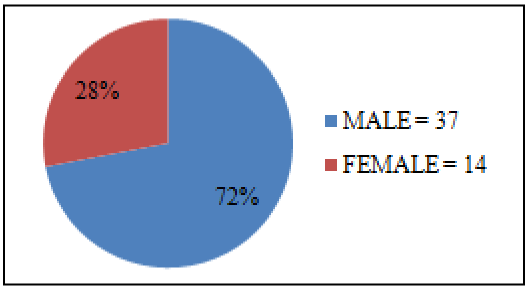

Image 3: Male to female ratio

37 patients underwent fixation with stainless steel nails and 14 patients underwent fixation using titanium nails. The union at the 6 month interval was as follows.

	SS	TT
UNION	21	11
NON UNION	16	3

Image 4: Table showing union rates in the two groups

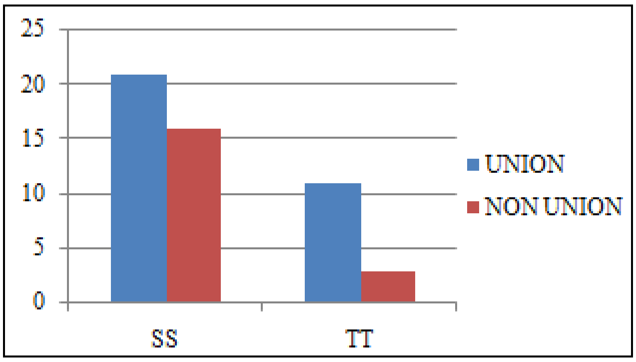

Image 5: Bar chart showing union rates in the two groups

The Fisher exact test statistic value is 0.2023. The result is not significant at $p < .05$. The chi-square statistic is 4.2208. The p-value is .039932. (Significant at $p < 0.05$) The chi-square statistic with Yates correction is 3.0849. The p-value is .079021. Not significant at $p < .05$.

4. Discussion

For its enhanced biocompatibility and biomechanical qualities, titanium nails have been recommended; nevertheless, questions have been raised as to whether they might result in increased complications. Despite being inexpensive, stainless steel has nearly eight times larger elastic modulus than bone. This makes fracture fixation rigid and inelastic. The best material for an implant is one that is biocompatible and has biomechanical characteristics similar to those of bone. These requirements are partially met by titanium. [8] Our study showed that there was no statistically significant difference in the union of tibia shaft fractures treated using titanium and stainless steel intramedullary nails. Since these patients were not followed up till complete union of fracture and until implant removal, soft tissue and local bone related complications were not fully known.

5. Conclusion

This study aimed to observe if there in any difference in union of tibia shaft fractures treated by using titanium intramedullary interlocking nails and stainless steel intramedullary interlocking nails. We found out that there is no statistically significant difference in the union rates of tibia shaft fractures treated using titanium and stainless steel intramedullary nails. A larger sample size and follow up until implant removal may throw more light on the subject.

References

[1] Hayes JS, Richards RG. The use of titanium and stainless steel in fracture fixation.Expert Rev Med Devices [Internet]. 2010; 7(6):843–53.
[2] Disegi JA, Eschbach L. Stainless steel in bone surgery. Injury 2000;31Suppl 4:2-6.
[3] Kraft CN, Burian B, Diedrich O, Wimmer MA. Implications of orthopedic fretting corrosion particles on skeletal muscle microcirculation. J Mater Sci Mater Med 2001;12:1057-62.
[4] Arens S, Schlegel U, Printzen G, Ziegler WJ, Perren SM, Hansis M, et al. Influence of materials for fixation implants on local infection. An experimental study of steel versus titanium DCP in rabbits. J Bone Joint Surg Br 1996;78:647-51.
[5] Study to Prospectively Evaluate Reamed Intramedullary Nails in Patients with Tibial Fractures Investigators, Bhandari M, Guyatt G, Tornetta P 3rd, Schemitsch EH, Swiontkowski M, et al. Randomized trial of reamed and unreamed intramedullary nailing of tibial shaft fractures: By the study to prospectively evaluate reamed intramedullary nails in patients with tibial fractures (SPRINT) investigators. J Bone Joint Surg Am [Internet]. 2008;90(12):2567–78.
[6] Litrenta J, Tornetta P 3rd, Mehta S, Jones C, O'Toole RV, Bhandari M, et al. Determination of radiographic healing: An assessment of consistency using RUST and modified RUST in metadiaphyseal fractures. J Orthop Trauma. 2015;29(11):516–20
[7] Perlepe V, Cerato A, Putineanu D, Bugli C, Heynen G, Omoumi P, et al. Value of a radiographic score for the assessment of healing of nailed femoral and tibial shaft fractures: A retrospective preliminary study. Eur J Radiol [Internet]. 2018;98:36–40.
[8] Naveen BM, Joshi GR. Comparative study of stainless steel and titanium limited contact-dynamic compression plate application in the fractures of radius and ulna. Med J Dr DY PatilVidyapeeth [Internet]. 2019;12(3):256.