

Comparative Functional Analysis between Titanium and Stainless Steel Proximal Femoral Nail in the Treatment of Intertrochanteric Fractures of Femur

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Abstract

Introduction: Intertrochanteric fractures constitute one of the most common fractures of the hip. The incidence of fractures in the trochanteric area has risen with the increasing numbers of elderly persons with osteoporosis.

Materials and Methods: The study is a prospective study done from January 2014 to July 2015 in MGMCRI, Pondicherry. The sample size was 60 with two groups of 30 each who underwent titanium and stainless steel proximal femoral nail. Patients were evaluated preoperatively and underwent closed reduction and proximal femoral nailing. Patients were mobilized immediately following surgery with full weight bearing with a walker support. Patients were assessed postoperatively with Harris hip score, radiological union, and complication related to implants and surgical site at 1, 2, 4, and 6 months.

Results: In this study, we found that majority of patients were male, with age group <60, involving mostly left side with the mode of injury being trivial fall. Type 2 Boyd and Griffin fractures were more in numbers. Harris hip score showed a significant improvement in regular follow-up in both the groups. Patients were started on early full weight bearing mobilization with walker support on the first post-operative day which helped in achieving a good outcome in Harris hip score in both the groups. Comparatively stainless steel group had three implant-related complications, and titanium groups had one implant-related complication at the end of this study. One patient in titanium group had non-union due to varus collapse. This was further treated with bipolar hemiarthroplasty. There was no surgical site infection in our study, inspite of giving only three doses of antibiotics.

Conclusion: In this study, the superiority of the properties of titanium nail did not make any significant difference with the stainless steel nail usage in relation to clinical and radiological outcome.

Key words: Intertrochanteric, Stainless steel, Titanium

INTRODUCTION

Intertrochanteric fractures constitute one of the most common fractures of the hip. The incidence of fractures in the trochanteric area has risen with the increasing numbers of elderly persons with osteoporosis.^{1,2} Although a large number of different implants are available for fixation, the ideal implant for the treatment of intertrochanteric fractures is still

a matter for discussion. The imperative goals of treatment are early mobilization by means of stable fixation using as minimally invasive procedure as possible. Nowadays, there is an increasing interest in intramedullary nailing, especially for unstable intertrochanteric fractures.³⁻⁵ This study on unstable trochanteric fractures focuses primarily on the reliability of fracture determination and classification, the (biomechanical) influence of the fracture on the fixation device, and the effect of a given fixation device on the fracture (healing and outcome). As surgeons often tend to forget their own contribution and influence on successful treatment outcome, we aimed to analyze the quality of fracture handling (classification and reduction) and stabilization by the surgeon, and the subsequent impact on the treatment outcome between the groups treated with titanium proximal femoral nail and stainless steel proximal femoral nail.

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Aims and Objectives

Aim

- To compare and assess the functional outcome between titanium proximal femoral nail and stainless steel proximal femoral nail in the treatment of intertrochanteric fractures of the femur.

Objective

- To compare the versatile nature of titanium proximal femoral nail and stainless steel proximal femoral nail in the treatment of intertrochanteric fracture of femur
- To analyze the rate of union and surgical site complications between the two implants.

MATERIALS AND METHODS

In our study, the patients who were admitted to the Mahatma Gandhi Medical College and Research Institute in the Department of Orthopedics with intertrochanteric fracture were included. The number of groups present in the study is two: Group A - those who are treated using titanium proximal femoral nail and Group B - those who are treated using stainless steel proximal femoral nail. The present study is longitudinal comparative study. The study period is from January 2014 to July 2015. Patients were treated with closed reduction and internal fixation with proximal femoral nailing by routine technique. Patients were followed up both clinically and radiologically at 1st, 2nd, 4th, and 6th month postoperatively.

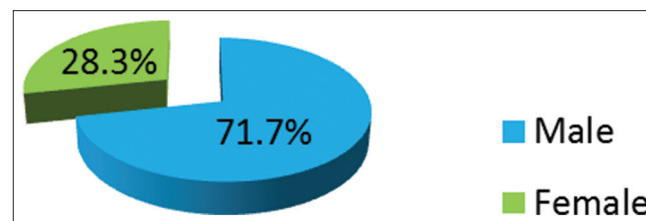
RESULTS

Out of 60 patients, the majority of them are male in the age group of <60 years. Their mode of injury is mostly fall alone than road traffic accident (RTA). Further injuries were observed, the majority of them had an injury at the left side and Type 2 fracture is higher than Types 3 and 4. All patients in this study received three doses of antibiotics, which was our institutional protocol. Harris hip score in the first 2 months was same showing similar results with most of the patients in both groups had fair score predominantly. During 1st month follow-up, there were less implant-related complications in titanium, but this was higher in stainless steel nail. Two patients had complications, one patient had back out of lag screw, and another patient had derotation screw tip breakage. In one patient in stainless steel nail group, we encountered stress fracture at distal locking site while fixing it intra operatively; hence, the patient was on high above knee slab postoperatively. During the 2nd month, one patient developed myositis ossificans due to massaging at native bone setting center. However, the implant-related complications were higher in stainless steel group. At the end of 4th month follow-up, Harris hip score rate was

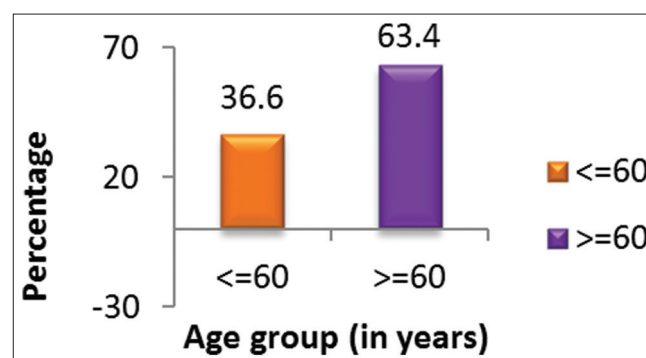
good in titanium, implant-related complications were less in titanium than stainless steel. In titanium group, one patient had non-union of intertrochanteric fracture which was then treated with bipolar hemiarthroplasty. In stainless steel group, one patient had derotation screw tip breakage. At the end of 6th month follow-up, we found that both the groups were showing improvement in Harris hip score, five patients from both the groups had excellent Harris hip, but the implant-related complications were more in stainless steel group. At the end of 6th month follow-up, when limb length discrepancy was measured, 5 patients had <10 mm shortening and 9 patients had more than 10 mm shortening of the operated limb (Graphs 1-5).

Functional Outcome at 1st Month Follow-up

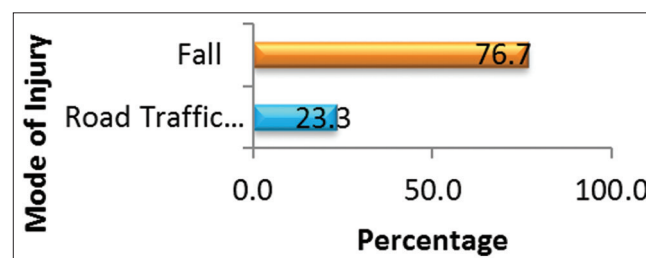
In titanium nail group, Harris hip score was poor in 6 (20.0) patients, fair in 19 (63.3%) patients and good in 5 (16.7) patients, whereas in stainless steel nail group it was fair in 17 (56.7%) patients and good in 13 (43.4) patients. There was no radiological union in both the groups. When implant-related complication is compared, titanium group did not have any complication, whereas stainless steel group had



Graph 1: Gender distribution



Graph 2: Age distribution



Graph 3: Mechanism of Injury

two complications, one patient had back out of lag screw, and another patient had a break of the derotation screw [Figures 1a and 2]. There was no surgical site infection in both the groups at the end of 1st month follow-up (Graph 6).

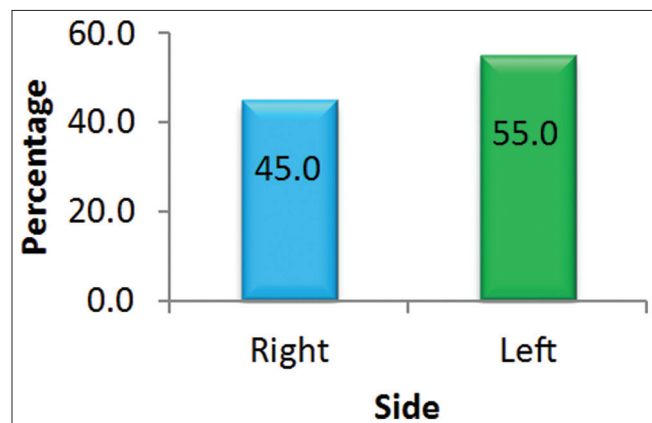
Functional Outcome at 2nd Month Follow-up

In titanium nail group, Harris hip score was poor in 6 (20.0) patients, fair in 19 (63.3%) patients, and good in 5 (16.7)

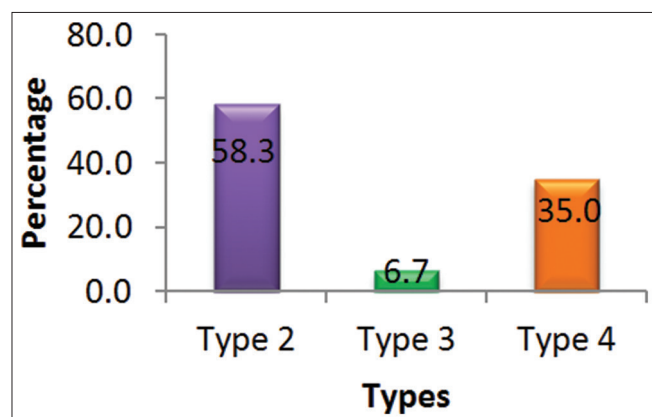
patients, whereas in stainless steel nail group it was fair in 17 (56.7%) patients and good in 13 (43.4) patients. When the radiological union was compared, 27 (90.0%) patients in titanium nail group and 28 (93.3%) patients in stainless steel group did not show radiological union. In one patient, we encountered myositis ossificans at the 2nd month follow-up. There was no fresh implant-related complication in both the groups during the 2nd month follow-up. There was no surgical site related complication in both the groups at the end of the 2nd month (Graphs 7-9).

Functional Outcome at 4th Month Follow-up

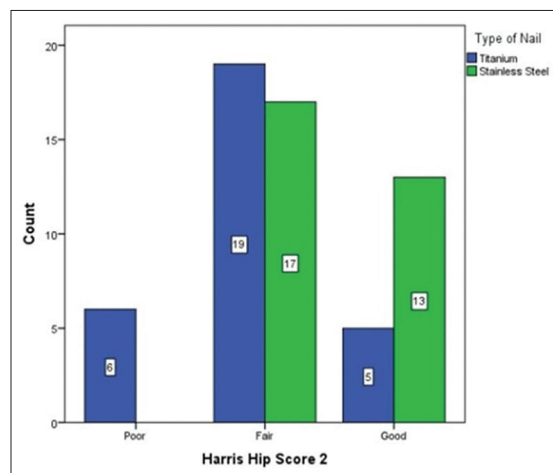
At the 4th month follow-up in titanium nail group, 2 (6.7) patients had poor, 12 (40.0) had fair, and 16 (53.3) had good Harris Hip score. In stainless steel nail group, 3 (10.0) patients had poor, 8 (26.7) patients had fair, 16 (53.3) patients had good, and 3 (10.0) patients had excellent Harris Hip score. When the radiological union was compared between both the groups, 29 (96.7%) patients in titanium group showed radiological union, while 1 patient developed non-union due to varus collapse. In



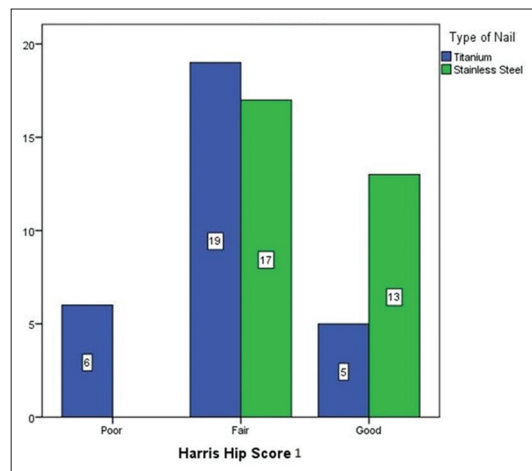
Graph 4: Distribution of side



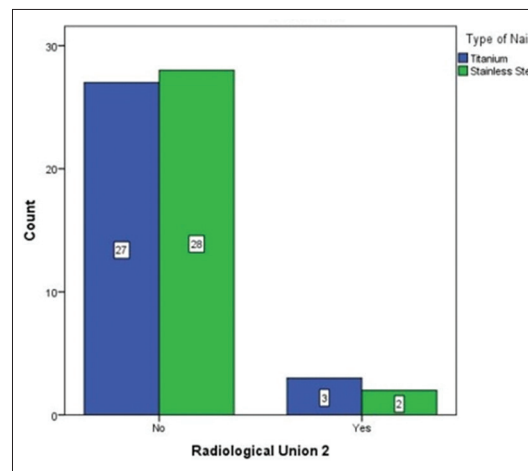
Graph 5: Distribution to Boyd and Griffin classification



Graph 7: 2nd month Harris hip score with type of nail



Graph 6: 1st month Harris hip score with type of nail



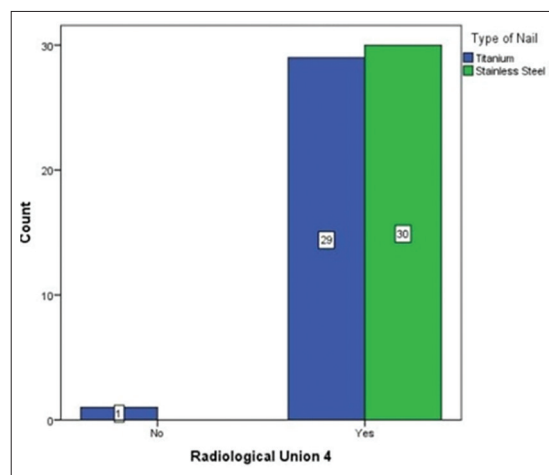
Graph 8: 2nd month radiological union with type of nail

stainless steel group, all the 30 (100.0%) patients showed radiological union at the end of 4th month follow-up. When implant-related complications were compared, 29 (96.7%) patients in titanium group did not have any implant-related complication, whereas 1 patient showed nonunion of intertrochanteric fracture which was then treated with bipolar hemiarthroplasty [Figure 3]. In stainless steel nail group, 27 (90.0%) patients did not have any implant-related complication, and 1 patient had derotation screw tip breakage [Figure 1b]. There was no surgical site related complication in both the groups at the end of the 4th month follow-up (Graphs 10-13).

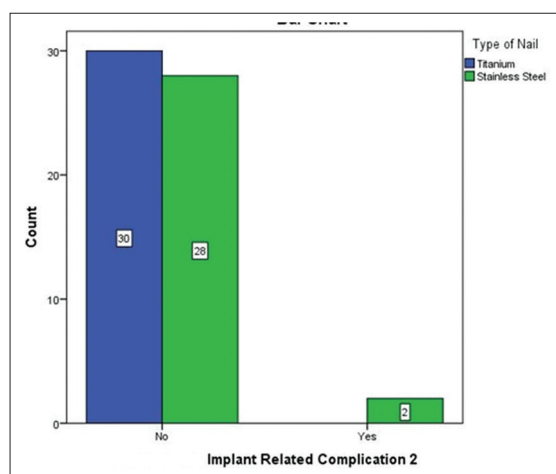
Functional Outcome at 6th Month Follow-up

Harris Hip score at the end of the 6th month follow-up showed poor in 5 patients, fair in 2 patients, good in 18 patients, and excellent in 5 patients. In stainless steel nail group, Harris hip score showed poor in 3 patients, fair in 5 patients, good in 17 patients, and excellent in 5 patients. When the radiological union was assessed between both

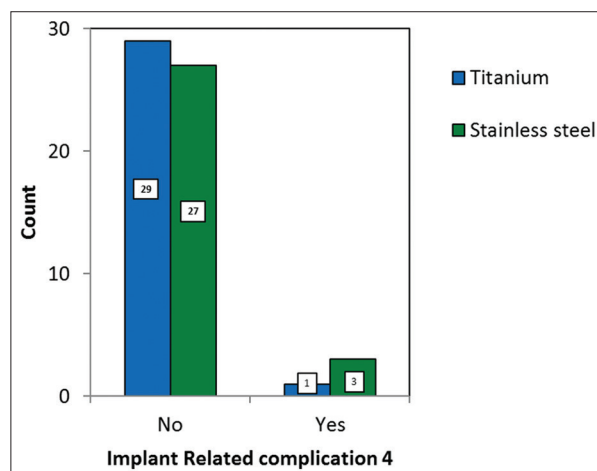
the groups, stainless steel group showed 100% union and titanium group showed union in 29 (96.7%) patients. There was no implant-related and surgical site related complication in both titanium and stainless steel group at the end of the 6th month follow-up (Graphs 13-16).



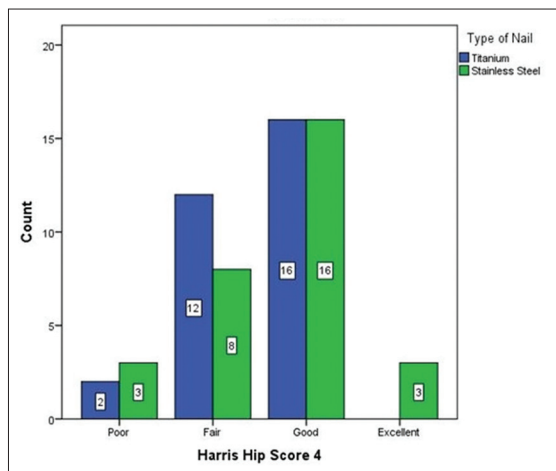
Graph 11: 4th month radiological union and type of nail



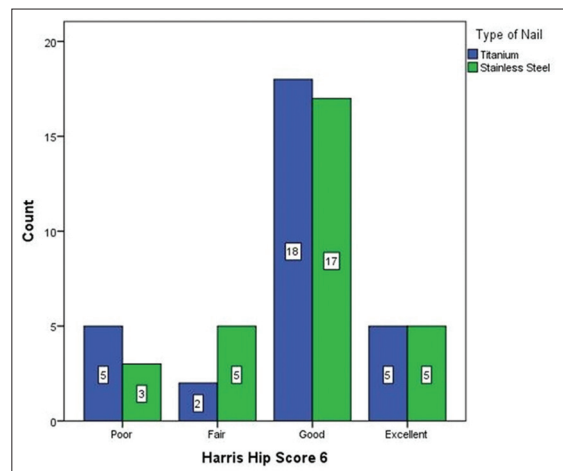
Graph 9: 2nd month implant-related complication with type of nail



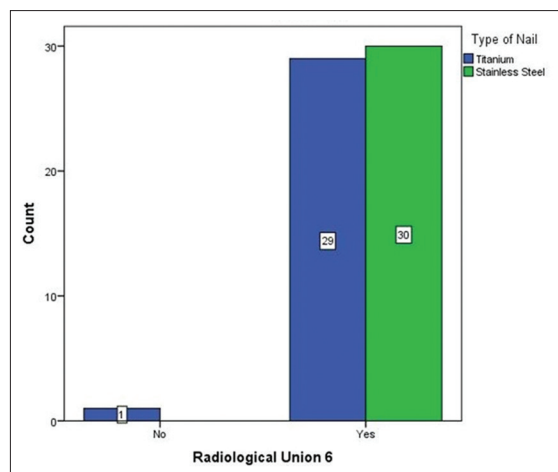
Graph 12: 4th month implant-related complication and type of nail



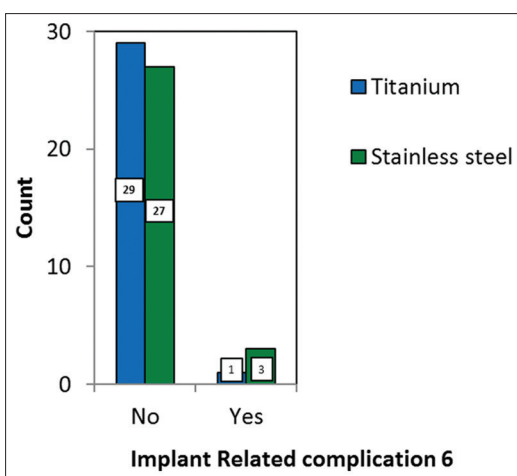
Graph 10: 4th month Harris hip score with type of nail



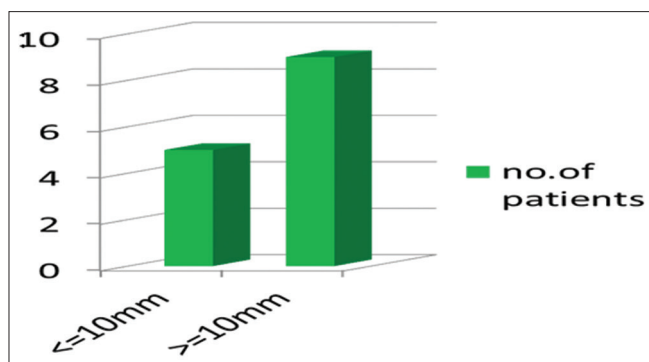
Graph 13: 6th month Harris hip score with type of nail



Graph 14: 6th month radiological union with type of nail



Graph 15: 6th implant-related complication with type of nail



Graph 16: Shortening at 6 months follow-up

DISCUSSION

The majority of them are male in the age group of <60 years were participated in this study. Age group in the study is well-supported by other studies in the field.^{1,2} Their study reported that the incidence of fractures in the trochanteric area has risen with the increasing numbers of elderly persons with osteoporosis. Further, the majority

of the participants in this study reported that injury occurs due to fall alone and only less number of them was involved in RTA. In line with this, the study of Huang *et al.*⁶ observed the majority of the injuries occurred due to fall and RTA. With regard to the side of the injury, most of the injury reported that they had left side. In line with our study result, the studies of Ali⁷ Eggensperger *et al.*⁸ and Yazici *et al.*⁹ showed similar results. Further, the study also observed Type 2 injury was reported higher in comparison with other types such as Types 3 and 4. Similar to this, the study of Benzel and Connolly¹⁰ observed Type 2 injury is more complicated than other types. To attain the below objective, the present study carried out complication tests in different months are as discussed below:

In this study, 50% of the patients had titanium and remaining 50% had stainless steel nail. Most of the fractures were an unstable intertrochanteric fracture of Type 2 and Type 4. The result of the present study is supported by Baumgaertner *et al.*,³ Adams *et al.*,⁴ and Klinger *et al.*⁵ where they have proved that unstable intertrochanteric fractures can be treated with intramedullary nailing. In this study, all patients were mobilized on first post-operative day which was very much supported by a study done by Mohammed *et al.*, which proves early mobilization with weight bearing improves the morbidity status of the patient and also gives a good outcome at regular follow-ups when assessed with Harris hip score.¹¹

The study identifies the complications of 1st, 2nd, 4th, and 6th month, and we have found that implant-related complications were higher in terms of using stainless steel nail. In line with this, Uhthoff *et al.*¹² and Sagan *et al.*¹³ showed the similar result like titanium is effective and less complications than stainless steel. In line to our study finding, the study of Wall *et al.*¹⁴ Rios *et al.*¹⁵ have proved that stainless steel provides a good functional outcome in pediatric femoral shaft fractures. During the 1st month and 4th month follow-ups, two cases from stainless steel group had derotation screw tip breakage; this may be related to the less strength and rigid properties of stainless steel implants.¹⁶ When shortening was evaluated at the 6th month follow-up, we found that patients who had varus collapse showed more shortening in both the groups which has been proved by a study conducted by Pauveloudosa *et al.*¹⁷ From the overall study findings, it was observed titanium and stainless steel nail shows no difference in relation to functional outcome, union, surgical site infection, and implant-related complications. However, there was the incidence of more implant-related complications in stainless steel nail group when compared to titanium nail group.¹⁸

LIMITATIONS AND RECOMMENDATIONS FOR THE FUTURE

Normally post implant removal all the nails should have been subjected in the metallurgical analysis to see any damage or loss of substance from the implant surface. By this method, we could have reached a conclusion regarding actual properties of both metal implants with respect to corrosion and biocompatibility, not done because we had no failures. Short duration and less number of subjects are also a limitation in our study.

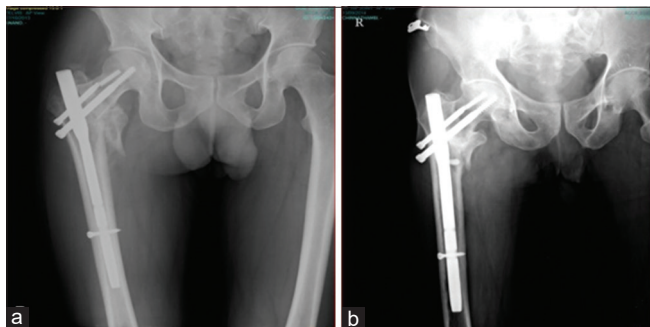


Figure 1: Derotation screw tip breakage in two patients stainless steel group



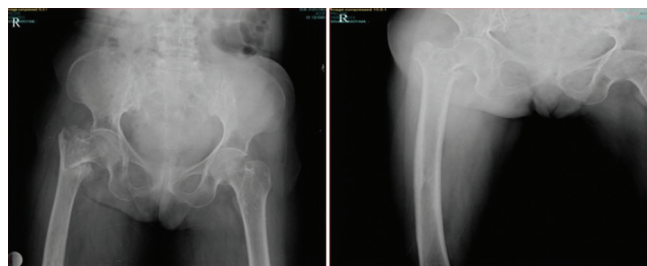
Figure 2: X-ray showing back out both screws in stainless steel group

CONCLUSION

Functionally 76% of our patients had good and excellent Harris hip score. Both implants acted similarly with respect to union and achieved union in all the cases except one in titanium group. In our study, we did not encounter a single case of surgical site infection. Early full weight bearing mobilization with walker support helped in achieving a good outcome in both nail groups. In this study, the superiority of the properties of titanium nail does not make any significant difference with the stainless steel nail usage in relation to clinical and radiological outcome.

CASE ILLUSTRATIONS

Titanium nail (excellent outcome)



Pre-operative X-ray

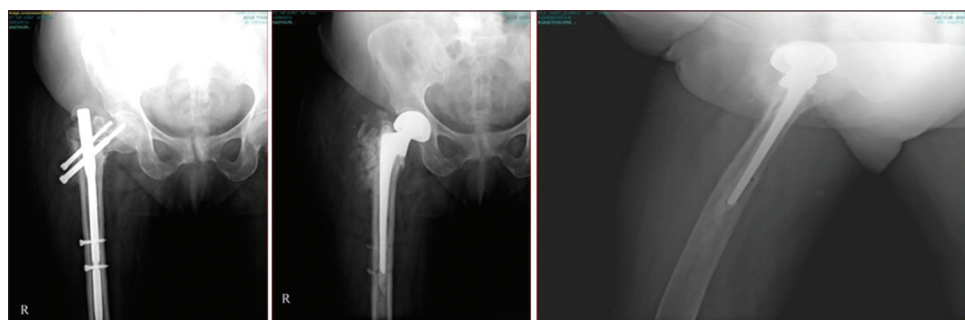
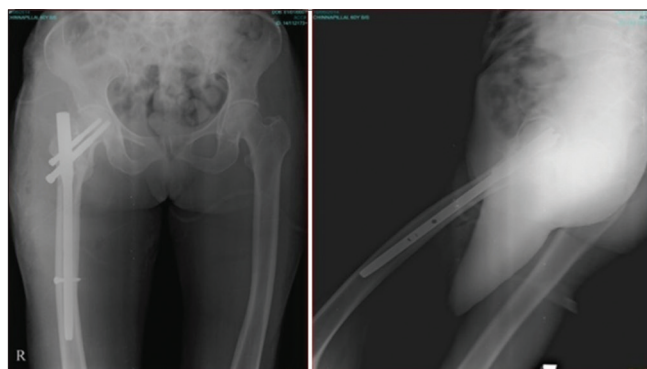


Figure 3: Titanium group complication showing varus collapse

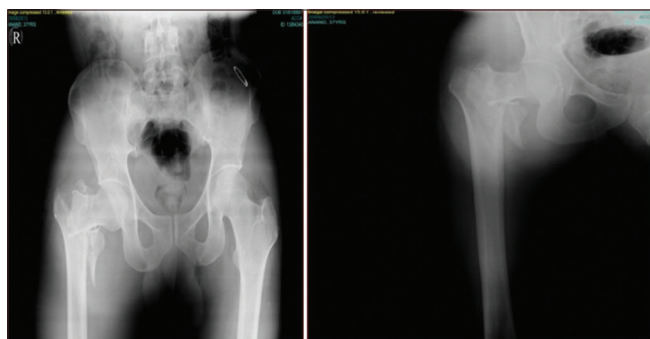
6 months post-operative X-ray

Titanium nail (excellent outcome)

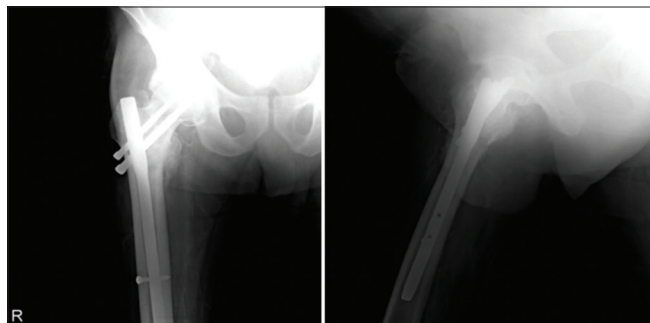


Patient's clinical photographs

stainless steel (excellent outcome)



Pre-operative X-rays



6 months post-operative X-rays

Stainless steel nail (excellent outcome)



Bipolar hemiarthroplasty done after removal of proximal femoral nail and fracture mobility was checked under fluoroscopic which showed non-union

REFERENCES

- Gullberg B, Duppe H, Nilsson B, Redlund-Johnell I, Sernbo I, Obrant K, *et al*. Incidence of hip fractures in Malmö, Sweden (1950-1991). *Bone* 1993;14 Suppl 1:S23-9.
- Kannus P, Parkkari J, Sievänen H, Heinonen A, Vuori I, Järvinen M. Epidemiology of hip fractures. *Bone* 1996;18 1 Suppl:57S-63.
- Baumgaertner MR, Curtin SL, Lindskog DM. Intramedullary versus extramedullary fixation for the treatment of intertrochanteric hip fractures. *Clin Orthop Relat Res* 1998;87-94.
- Adams CI, Robinson CM, Court-Brown CM, McQueen MM. Prospective randomized controlled trial of an intramedullary nail versus dynamic screw and plate for intertrochanteric fractures of the femur. *J Orthop Trauma* 2001;15:394-400.
- Klinger HM, Baums MH, Eckert M, Neugebauer R. A comparative study of unstable per- and intertrochanteric femoral fractures treated with dynamic hip screw (DHS) and trochanteric butt-press plate vs. proximal femoral nail (PFN). *Zentralbl Chir* 2005;130:301-6.
- Sagan ML, Datta JC, Olney BW, Lansford TJ, McIlff TE. Residual deformity after treatment of pediatric femur fractures with flexible titanium nails. *J Pediatr Orthop* 2010;30:638-43.
- Ali MM. Influence of early post operative weight bearing on hip function after femoral trochanteric fractures. *Bull Fac Ph Th Cairo Univ* 2010;15:69.
- Eggensperger N, Smolka K, Scheidegger B, Zimmermann H, Iizuka T. A 3-year survey of assault-related maxillofacial fractures in central Switzerland. *J Craniomaxillofac Surg* 2007;35:161-7.
- Yazici U, Yazıcıoğlu A, Aydın E, Aydoğdu K, Kaya S, Karaoğluoğlu N. Penetrating chest injuries: Analysis of 99 cases. *Turk J Med Sci* 2012;42:1082-5. Available from: <http://www.journals.tubitak.gov.tr/medical/issues/sag-12-42-6/sag-42-6-21-1203-56.pdf>. [Last accessed on 2014 Dec].
- Benzel EC, Connolly PJ. *The Cervical Spine*. Lippincott Williams & Wilkins; 2012. p. 1666. Available from: https://www.books.google.co.in/books?id=uIYL14Qs8qoC&dq=Type-2+injury+was+reported+higher+in+comparison+with+other+types+like+Type+3+and+4&source=gb_s_navlinks_s. [Last accessed on 2014 Dec]
- Uthoff HK, Bardos DI, Liskova-Kiar M. The advantages of titanium alloy over stainless steel plates for the internal fixation of fractures. An experimental study in dogs. *J Bone Joint Surg Br* 1981;63-B:427-84.
- Sagan ML, Datta JC, Olney BW, Lansford TJ, McIlff TE. Residual deformity after treatment of pediatric femur fractures with flexible titanium nails. *J Pediatr Orthop*. 2010;30(7):638-43.
- Wall EJ, Jain V, Vora V, Mehlman CT, Crawford AH. Complications of titanium and stainless steel elastic nail fixation of pediatric femoral fractures. *J Bone Joint Surg Am* 2008;90:1305-13.
- Ríos AU, Arango DF, Molina CO, de Jesús Toro Posada A. Femoral shaft fractures treated with stainless steel flexible nails in children aged between

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- 5 and 12 years at the HUSVP: A two-year follow-up. *J Child Orthop* 2009;3:129-35.
15. Salonen A, Lahdes-Vasama T, Mattila VM, Välipakka J, Pajulo O. Pitfalls of femoral titanium elastic nailing. *Scand J Surg* 2015;104:121-6.
 16. Dousa P. Presentation of the existing experience in the use of Proximal Femoral Nail Synthes (PFN) in trochanteric fractures. *Orthop Traumatol Surg Res* 2009;95:139-44.
 17. Oldani C, Dominguez A. Department of Materials and Technology, National University of Cordoba, Argentina. Available from: [Http://www.intechopen.com](http://www.intechopen.com). [Last accessed on 2015 Sep 24].
 18. Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: Treatment by mold arthroplasty. An end-result study using a new method of result evaluation. *J Bone Joint Surg Am* 1969;51:737-55.

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