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Review Article

FEMORAL INTERTROCHANTERIC NAILS: THE POST-OPERATIVE COMPLICATIONS VIA RADIOGRAPHIC STUDY

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ABSTRACT

The short cephalomedullary nails have been mostly used in practice to treat the femoral intertrochanteric and pertrochanteric fractures. Although different versions of the nails have been introduced according to the femoral anatomy and compatibilities, there have always been some mismatches and post-operative complications related to the intertrochanteric nails, mostly with the Asian femoral anatomies. The mismatches are mostly reported on the anterior femoral curvature of the femur and the straight plane of the nails; the impingement of the distal nail tip to the femoral cortex leading to the post-operative fracture of the femoral shaft; and also the mismatch of the proximal nail tail protrusion over the greater trochanter leading to the chronic hip pain syndrome. This article focuses on the immediate and the late post-operative complications reported in various literatures on distal nail tip impingement and proximal nail tail protrusion with the use of the short cephalomedullary nails among the Asian population.

Keywords: Femoral inter-trochanteric fracture, Short cephalomedullary nail, Compatibility, Anterior bowing of femoral shaft, Femoral greater trochanter, Nail tip impingement, Asian population

INTRODUCTION

The hip fractures are one of the major fractures reported among the geriatric population. These fracture have always noted to be a hot topic among many orthopedic surgeons in the world[1-3].The cases of hip fractures are assumed to be increased as the number of older population increases in the world. The rate of hip fractures in old aged population is expected to be higher in Asia than other countries[4] because the Asians are being reported to have longer expectancy of life, mostly in China in comparison to the other Asian countries. Hip fractures if left untreated or mal-treated can leading to several dangerous health related consequences. It may also lead to cost effective treatments affecting individuals to the family and also to the society[5]. These fractures still have high incidence rate till the present date although many orthopedic trauma medics have been putting this fracture as the topic of discussion from the very beginnig.

The hip fractures generally mean the fracture of the hip bones or the proximal femoral fracures. Therafter, the proximal femoral fractures mean (a)Femoral neck fractures and (b)Trochanteric fractures with the sub-types, the intertrochanteric and pertrochanteric fractures. This article has put more concern towards the intertrochanteric fractures and its treatment to the patients. The main aim is to provide good quality of life, proper medical support and advices to the patients and to treat the fracture surgically and immediately, with proper recovery, earliest off bed mobilization, and to bring the life of the individual back to normal. Different literatures have been introduced to operate the intertrochanteric and pertrochanteric fractures within 24 to 48 hours of the injury. And also to provide the enhanced recovery after surgery (ERAS) to the patients[6]. Nowadays many trauma practitioners prefer intramedullary nails over the traditional extramedullary implants to fix the unstable per/intertrochanteric fractures because of comparatively better intra and post operative results[7-8].

Background, Types and Current state:

The sliding compression hip screw (SHS) and side plates were introduced during the 1950s [9-10]. The blunt ends of the screws avoided the femoral head cut-outs and also avoided the screw threads for more head purchases. It was then preferred as the choice of operation impant to treat the intertrochanteric fractures. The SHS helped the patients with earliest off bed mobilization after the operation and allowed to start early physical activities. But the fractures of the lateral wall were noted significantly after the implant fixation. Also the increased blood loss during the operation, soft tissue damage because of open reduction and fixation and worsening of existing co-morbidities were also noted with the use of the SHS devices.

Haider et al.[11] introduced the antegrade intramedullary nailing of the intertrochanteric fractures for the first time during the 1980s. A short nail was called the Gamma nail was introduced. It was inserted to through greater trochanter into the femoral cavity. The interlocking screw was inserted through the lateral surface of this implant into the head of the femur. This operation benefited with the minimal invasive technique with minimal blood loss. It also showed advantages in the reduction of unstable hip fractures types effectively and with good stability[12]. The lockingscrew at the distal part of the implant prevented the post-operative

rotation of the implant. However still, some intra-operative and post-operative problems were still noted even with the use of the Gamma nails[13-14].

The PFNA was the introduced in the practice with more improvements following the gamma nails. It was designed by the Arbeitsgemeinschaft fur Osteosynthesfragen/Association for the Study of Internal Fixation (AO/ASIF) group in 2004. The PFNA- II, the second generation was introduced in 2008 because the PFNA first generation was not built as the Asian version. So the PFNA-II second generation was specially introduced for the Asian femurs with narrow and short anatomies. The PFNA-II had more stable and strong helical blade which showed to have more strong and stabile resistance against the femoral head cut-outs. The intra and post-operative complications were also noted less with the use of PFNA-II nails[15-16]. But still with many improvements noted in the PFNA-II nails, the femoral head cut-outs were seen in several cases especially in severe osteoporotic patients. Also, the proximal screw or helical blade loosening and lateral migration resulted to the fixation failure in many cases[17].

Therefore, the InterTan (IT) nail was introduced and became the highly preferred IM nails among many trauma surgeons. It was considered the modified version to the highly preferred intramedullary nails the PFNA-II nails. The intertan nail had a peculiar design of two unified lag screws as one unit. It provided the fracture pieces with more strong stabile formation and avoided thefragments to have the post operative rotational complications. Therefore, the intertan nail was biomechanically more effective than other nails. Wu et al.[18] reported the InterTan nail as better option than the gamma nails as the intertan nails reported to have decreased cases of the femoral head cut-outs and also decreased cases of the post-operative fracture of the femoral shaft. It provided the good functional outcomes in the case presented and complicated with unstable fractures patterns. Kochai et al.[19 reported the varus collapse which was one of the major failed parameters was reported to be of high incidence with the use of the PFNA nails. Whereas th evarus collapse was found to be less with the use of the INTERTAN nails. The interlocking mechanism provided by the two proximal screws with different structures but together as a one structure in a whole provided better stability and resistibility to the shaft and head-neck portions of the femur. It was observed to be stable even in the long term.

Although there were many advantages and benefits with the use of the Intertan nails, several complications were still noted in the cases. The trapezoidal anatomy of the proximal part of the nail could not be properly inserted into the confined marrow femoral cavity, which was noted mostly among the Asian patients. The operation time was noted to be prolonged due to the repeated expansion of the femoral cavity and the repetitive reduction and fixation process of the nail into the femoral cavity. The increased intra-operative blood loss was also noted I several cases, mostly in severely unstable fracture types. The multiple exposure of the fluoroscopic radiation was also noted as disadvantage and inconvenient to the patient and the medical team[18]. In the study conducted by Yu et al.[17], it was reported that the mean operation time, the mean blood loss and the fluoroscopy time of the InterTan nail was longer than the PFNA-II nails. They also described the lateral femoral cortical fractures observed due to the screws used in InterTan nailings.

Problems with current cephalomedullary nails:

Although with the use anf improvement of the nails from SHS to Gamma nailing, to PFNA-II and to InterTan nailing along with different surgical techniques to effectively treat the pertrochanteric and intertrochanteric fractures with the aim to provide proper reduction with either open or closed as minimally invasive approach, with decreased consequences and with increased early off bed mobilization of the patients[8], still the complications like the anterior plane of the implant which was straight resulted as mismatch with the anterior and lateral surfaces of the femur which may lead to impingement of the distal nail tip to the femoral canal from inside, resulting to the femoral shaft fractures as secondary complications[20-21] (Fig 1 and Fig 2), and also the protrusion of the proximal nail tail outside the greater trochanter which also proves to be the mismatch between the nail and the proximal femoral part[22] (Fig 3) were noted in several cases.

Figure 1

Figure 2

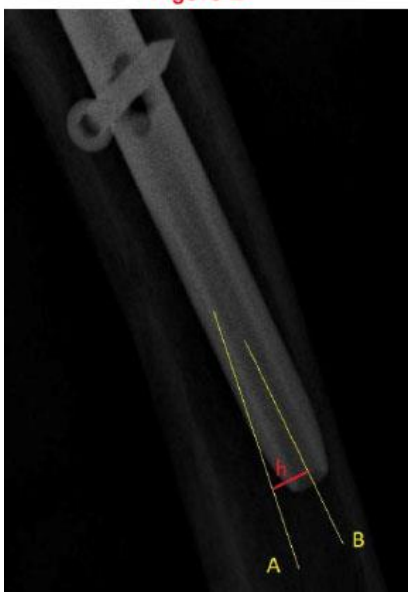

Figure 1: Showing the anterior bowing of the femur curvature on lateral view.

Figure 2: The impingement between the nail tip and the anterior femoral cortex on lateral view. The yellow line A denotes the mid-point/axis of the medullary canal. Line B denotes the central axis of the nail tip.

Figure 3: X-ray AP views showing protrusion of the proximal nail tail outside the greater trochanter.

As the Asian femurs are of shorter stature height with shorter femoral length, with increased anterior bowing of the femur and the marrow cavity being more narrower, even though we consider the traditional nail implants to be improved and modified, but the nail have always been showing some mismatches with the Asian femur structures[23]. The straight anterior planes of the PFNA-II nails although being an Asian version, still reported to show the mismatch with the Asian femur, which showed contact between the distal nail tip and the femoral cavity from the inside. This led to the femoral anterior cortex fracture during or even after the operation was successfully conducted. Avoiding this complication was difficult with the use of PFNA-II nail.

The impingement of the femoral cavity from inside with the distal nail tip was reported in 40% of cases among the Chinese patients with the application of PFNA-II in a study conducted by Chang et al. [20]. Similarly, also among the Hispanic Colombians, the impinegement was reported high in the study conducted by Peña et al.[21]. Hu et al.[22] in his study found that the reason behind the pain of the lateral hip was because of the protrusion of the proximal nail tail outside the greater trochanter with the use of PFNA-II nails. The author reported the proximal nail tail protrusion outside the greater trochanter to be more than 5 mm in 60.8% of cases with 31.7% of patients developing the pain over lateral hip after 15 months of follow-ups. The hip pain developed spontaneously after the irritation of the hip muscles due to the protrusion of the proximal nail tail over the greatertrochanter. Kim et al.[24] in 2020 also reported the protrusion of the proximal nail tail outside the greater trochanter in 30 out of 86 cases (34.9%) with the average protrusion height of 9.01 mm. The author also concluded the reason behind the lateral hip pain in patients to be the protrusion of the nail tail over the greater trochanter.

Thus, the studies concluded the PFNA-II as the Asian version also could not completely be compatible with the Asian femur structures. Further improvements with new modified designed nails are required to overcome the complications noted with the use of the traditional nails. And also to be compatible with the Asian femur anatomies.

DISCUSSION

Mismatch of nails in Asian population:

Treatment of the hip fractures has always been the topic of interest among the trauma surgeons. Especially among the Asian population for having geometric mismatch between the intra-medullary nails and the femoral anatomy. The IM nails were considered to be compatible with different kinds of the femur structures. However, some mismatches between the nail implants and the different ethnicity groups have always been noted in the practice. And many authors have described about the mismatches in several literatures.

Ostrum et al.[25] in 2005 reported the mismatch between the radius of the femoral nail and the femoral curvature. The nails were found to have larger radius (curvature) than that of the femur. This meant the nails were comparatively straighter than the anterior femoral cortex structure. In cases especially where the use of longer nails consisted of the insertion point to be more anterior, the impingement of the nail to the anterior cortex was noted while conducting the insertion of the nail.

Egol[26] in 2004 described the intertrochanteric fractures to be the most complicated fractures than any other femoral fracture types. The frontal plane of femoral shaft is always intact in intertrochanteric fracture types. So the nails while insertion cannot be accommodated with the fracture fragments of the anterior cortex.

In 2005, Tang et al.[27] reported the anterior bowing of the distal part of Chinese femur was relatively larger than the middle and upper segments along with having the antero-posterior curvature present.

Leung et al[28]in 1996 reported about the mismatch with the use of the Gamma nail. Also in 1989, he had noted on the incompatibility of the Gamma nail (first generation) among the Chinese patients. There was impingement of the distal nail tip with the antero-medial surfaces of the femur. The intra-operative fracture of the femur because of the forceful accommodation of the nail into the femoral canal was also noted in the study. With lesser diameter and decreased length of the second generation Gamma nails, the complications were reported less. But the intra-operative and post-operative fractures of the anterior cortex of the femur because of the straight nail on lateral view still reported of having the complications.

Complications associated with nail mismatch:

Complications related to the Gamma nail mismatch:

- Improper reduction and fixation of the fracture sites due to impingement of the nail tip to the antero-medial cortices.
- Intra-operative fracture due to the forceful insertion of the nail into the femoral canal.
- The straightness of the nail from sagittal plane leading to the impingement or penetration of the anterior part of femoral cortex leading to fracture of the cortex later.

Complications related to PFNA and PFNA-II nails mismatch:

- Impingement of the distal nail tip over the anterior aspect of femur leading to the fracture.
- Protuberance of the nail tail outside the femoral greater trochanter leading to soft tissue irritations and lateral thigh pain syndrome.

- Cut-out through the femoral head and/or loosening or lateral migration of the nail blade leading to fixation failure and non-union.

CONCLUSION

The cephalomedullary nails used to treat the pertrochanteric and intertrochanteric fractures have shown several mismatches with the Asian femur in accordance with the femoral anterior and lateral curvature, and the greater trochanter. This may lead to several immediate and long-term complications like fracture of shaft of the femur, long-term irritation of the hip muscles and chronic hip pain syndrome.

REFERENCES

1. Waddell JP. Fractures of the proximal femur: improving outcomes. Philadelphia: Elsevier Saunders; 2011
2. Egol KA, Leucht P. Proximal femur fractures: an evidence-based approach to evaluation and management. Switzerland: Springer; 2018
3. Chang SM. Geriatric intertrochanteric hip fractures. Beijing (China): Science Publisher; 2019 [In Chinese]
4. KanisJA, Oden A, McCloskey EV, et al. A systematic review of hip fracture incidence and probability of fracture worldwide. Osteoporos Int 2012; 23:2239-56
5. Orwig DL, Chan J, Magaziner J. Hip fracture and its consequences: differences between men and women. Orthop Clin North Am 2006; 37:611–22
6. Della Rocca GJ, Crist BD. Hip fracture protocols: what have we changed? Orthop Clin North Am 2013; 44:163–82
7. Mäkinen TJ, Gunton M, Fichman SG, et al. Arthroplasty for Pertrochanteric Hip Fractures. Orthop Clin North Am 2015; 46:433–44
8. Niu E, Yang A, Harris AH, et al. Which fixation device is preferred for surgical treatment of intertrochanteric hip fractures in the United States? A survey of orthopaedic surgeons. Clin OrthopRelat Res 2015; 473:3647–55
9. Clawson DK. Trochanteric fractures treated by the sliding screw plate fixation method. J Trauma 1964:27:737-52
10. Schumpelick W, Jantzen PM. A new principle in the operative treatment of trochanteric fractures of the femur. J Bone Joint Surg Am 1955:37:693-8
11. Haider SC. The Gamma nail for peritrochanteric fractures. J Bone Joint Surg Br, 1992; 74:34O4
12. Leung KS, So WS, Shen WY, et al. Gamma nails and dynamic hip screws for peritrochanteric fractures. A randomised prospective study in elderly patients. J Bone Joint Surg Br. 1992:74:345-51
13. Ekström W, Karlsson-Thur C, Larsson S, et al. Functional outcome in treatment of unstable trochanteric and subtrochanteric fractures with the proximal femoral nail and the Medoff sliding plate. J Orthop Trauma 2007; 21:18–25

14. Handoll HH, Parker MJ. Conservative versus operative treatment for hip fractures in adults. Cochrane Database Syst Rev 2008; 16:CD000337
15. Gadhe SS, Bhor P, Patel I, et al. Comparative study of PFNA vs PFNA 2 in unstable intertrochanteric fractures: A randomised control study of 50 cases. International Journal of Orthopaedics Sciences 2019; 5(3): 162-164. Doi:10.22271/ortho.2019.v5.i3c.1525
16. Loo WL, Loh SY, Lee HC. Review of Proximal Nail Antirotation (PFNA) and PFNA-2 –Our Local Experience. Malaysian Orthopaedic Journal 2011 Vol 5 No 2, Doi: 10.5704/MOJ.1107.001
17. Yu W, Zhang X, Zhu X, et al. A retrospective analysis of the InterTan nail and proximal femoral nail anti-rotation-Asia in the treatment of unstable intertrochanteric femur fractures in the elderly. Jr. ortho 2016, 11:10, DOI: 10.1186/s13018-016-0344-7
18. Wu D, Ren G, Peng C, et al. InterTan nail versus Gamma3 nail for intramedullary nailing of unstable trochanteric fractures. Diagnostic Pathology 2014, 9:191
19. Kochai A, Uysal M, Ozalay M, et al. Comparison of PFN and INTERTAN nail for unstable intertrochanteric femoral fracture in mobile patients. Int J Clin Exp Med 2019;12(5):5468-5474
20. Chang SM, Song DL, Ma Z, et al. Mismatch of short straight cephalomedullary nail (PFNA-II) with the anterior bow of the femur in Asian population. J Orthop Trauma 2014;28(1):17-22
21. Peña OR, Gómez GA, Espinosa KA, et al. Cephalomedullary nails: factors associated with impingement of the anterior cortex of the femur in a Hispanic population. Arch Orthop Trauma Surg 2015; 135(11): 1533–40, Doi:10.1007/s00402-015-2313-8
22. Hu SJ, Chang SM, Ma Z, et al. PFNA-II protrusion over the greater trochanter in the Asian population used in proximal femoral fractures. Indian J Orthop 2016; 50(6):641–6, Doi:10.4103/0019- 5413. 193475
23. Leung KS, Procter P, Robioneck B, et al. Geometric mismatch of the Gamma nail to the Chinese femur. Clin OrthopRelat Res 1996; 323: 42–8
24. Kim SS, Kim HJ, Lee CS. Clinical outcomes of PFNA-II in the Asian intertrochanteric fracture patients: Comparison of clinical results according to proximal nail protrusion. Injury 51 (2020) 361–366 Doi:10.1016/j.injury.2019.11.040
25. Ostrum RF, Levy MS. Penetration of the distal femoral anterior cortex during intramedullary nailing for subtrochanteric fractures: a report of three cases. J Orthop Trauma. 2005;19:656-660
26. Egol KA, Chang EY, Cvitkovic J, et al. Mismatch of current intramedullary nails with the anterior bow of the femur. J Orthop Trauma. 2004;18: 410–415
27. Tang WM, Chiu KY, Kwan MF, et al. Sagittal bowing of the distal femur in Chinese patients who require total knee arthroplasty. J Orthop Res. 2005; 23:41–45
28. Leung KS, Procter P, Robioneck B, et al. Geometric mismatch of the Gamma nail to the Chinese femur. Clin OrthopRelat Res. 1996; 42–48