

Mismatch of long Gamma intramedullary nail with bow of the femur: Does radius of curvature of the nail increase risk of distal femoral complications?



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ABSTRACT

Introduction: Anterior cortical penetration of the distal nail tip is a recognized complication of intra-medullary nailing of the femur particularly in the geriatric population. This has been attributed to a mismatch between the femoral bow and the radius of curvature (ROC) of the femoral nail. We wanted to see if there was a reduction of this risk comparing cephalomedullary nails with ROC of 200 cm and 150 cm.

Methods: 52 patients were split into 2 groups similar with respect to age, sex and comorbidities. Group A with 25 patients used a nail with a ROC of 200 cm and Group B with 27 patients used a 150 cm ROC nail. Lateral radiographs of the distal femur were evaluated to note the position of the nail tip in relation to the femoral canal. The diameter of the femur at the tip of the nail was divided into 3 equal zones. The anterior one-third was designated as Zone 1, the middle one-third as Zone 2 and the posterior one-third as Zone 3. **Results:** 80% of the cases with a 200 cm ROC nail had the tip of the nail in the anterior one-third of the canal (zone 1). Fracture of the anterior femoral cortex distally by the nail tip was seen in 2 patients. Only 18.5% of cases with a 150 cm ROC nail had the tip of the nail in anterior one-third of the canal (zone 1). There were no incidences of complications such as fractures and anterior cortical perforation.

Conclusions: A cephalomedullary nail with a ROC of 150 cm had its distal tip more towards the center of the femoral canal when compared to a nail with ROC of 200 cm. No case of anterior femoral penetration was seen when using a nail with an ROC of 150 cm.

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1. Introduction

Proximal femoral fractures are becoming increasingly common in orthopaedic practice particularly in geriatric population. A large number are being treated with cephalomedullary nailing with reports of distal femoral complications in the literature. This has been attributed to a mismatch between the femoral bow and the radius of curvature of the nail used.

It was noted in our departmental audit that there were two cases of anterior cortical penetration whilst using a 200 cm ROC cephalomedullary nail (Gamma3- STRYKER Trauma GmbH, Schonkirchen, Germany). We hypothesized that using a 150 cm ROC nail would reduce the incidence of this complication. Hence we requested our implant supplier to change our stock of nails from a radius of curvature of 200 cm to 150 cm to see if this would be the case.

2. Materials and methods

52 patients underwent a long intra-medullary nailing for a proximal femoral fracture at Tameside General Hospital. All patients underwent fixation on a fracture table, following the manufacturer's suggested technique, by experienced surgeons.

We retrospectively looked at 25 consecutive elderly patients treated with long Gamma nails with 200 cms ROC (Group A) for proximal femoral fractures performed in 2014. This was done as a departmental audit. We noted that the distal nail tip tended to be closely related to the anterior cortex of the femur. Based on our findings, we requested our implant supplier to change our inventory to the 150 cm radius of curvature nails. Once this was done, we prospectively included the first 27 patients who had undergone the procedure in 2016 (Group B). Proximal femoral fractures included intertrochanteric and sub trochanteric fractures.

Two blinded investigators evaluated the lateral radiographs of the distal end of femur in these patients. They looked at the position of the tip of the nail in relation to the canal at this point. The diameter of the femur at this point was divided into 3 equal

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zones. The anterior one-third was designated as Zone 1, the middle one-third as Zone 2 and the posterior one-third as Zone 3 (Fig. 1).

We then compared the 2 groups in relation to the position of the distal end of the nail and the complications were noted.

Patients who had a short cephalomedullary nail or had preexisting femoral deformities due to any cause, i.e.; Paget's, post-traumatic etc. were excluded.

3. Results

A total of 52 patients were enrolled in the study. There were 23 males and 29 females. Both groups were similar with regards to age, sex and side of surgery.

In Group A, 20 patients (80%) had tip of the nail in zone 1 where in the distal end of the nail was abutting the anterior cortex in 4 patients. There were 5 patients (20%) with distal end of the nail in Zone 2 and none with the nail tip in Zone 3. Two patients have had the nail penetrate through the anterior cortex of the distal femur thus breaching the patello-femoral compartment (Figs. 2 and 3).

In Group B, 5 patients (18.5%) had the tip of the nail in Zone 1, 20 patients (75%) had the nail tip in Zone 2 and 2 patients (7.4%) had the tip of the nail in Zone 3. There were no incidences of complications such as fractures and anterior cortical perforation (Fig. 4).

4. Discussion

The radius of curvature of the native femur has been shown to be 110–120 cm^{1,3}

Femoral bow increases with age⁵ and undergoes morphological change with thinner cortices, because of increasing bow, the anterior tensile cortex becomes thinner and posterior compressive cortex becomes relatively thicker.^{2,5} Hence it is easy to perforate the anterior cortex either while reaming or during nail insertion with a straight nail put in a curved femur.

Kuntscher first introduced nails for femoral fractures where it was slotted, straighter and less rigid compared to the current non-slotted nails based on the principle of 3-point fixation.

Since then, femoral nails have undergone several changes particularly to include a bow in order to match the femoral bowing. Anterior cortical penetration is a known complication particularly in the elderly. Several studies have been performed which has led to change in surgical technique and nail morphology. Manufacturers have changed the radius of curvature from 300 cm to 200 cm and with some companies to 150 cm to mimic the native femoral radius of curvature more closely.

Our study found that we initially had 2 cases (8%) where there was breach of the anterior femoral cortex distally when using the



Fig. 2. Lateral radiograph of distal end of femur showing nail encroaching the anterior cortex with a 200 cms ROC nail.



Fig. 3. a) & b) 2 cases of Lateral radiographs of distal end of femur showing peri-implant fracture due to eccentric placement of the distal end of the nail when using a 200 cms ROC nail.

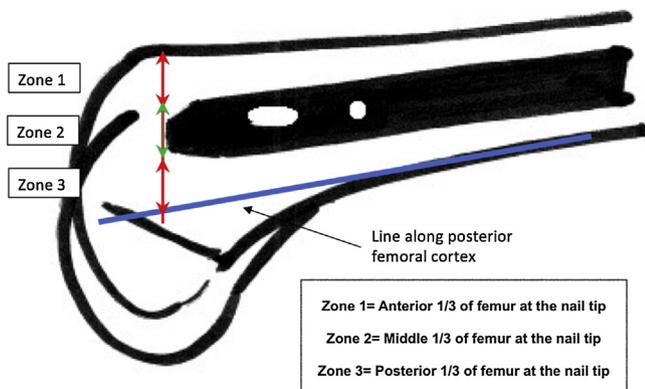


Fig. 1. Schematic diagram showing the distal end of the femur divided into 3 equal zones at the tip of the nail.

200 ROC nail. 80% of the patients had the distal end of the nail positioned in the anterior third of the canal. This improved to 18.5% when we changed to a 150 cm ROC nail. We also did not have any cases of anterior cortical penetration with this nail in our study period.

Bazylewicz et al. have suggested that the incidence of distal femur anterior cortical perforation during intramedullary nailing of the proximal femur is 0.47%.¹ They also observed that the nail

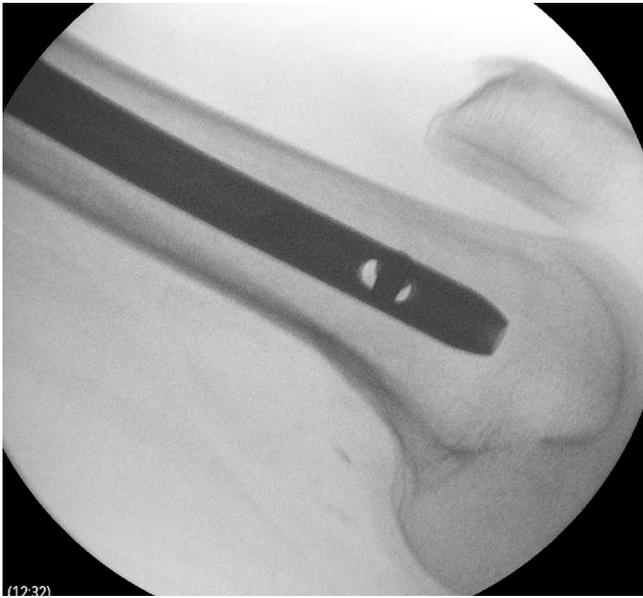


Fig. 4. Lateral Radiograph of distal end of femur showing ideal position of tip of the nail. 150 cms ROC.

ended up in the anterior third of the distal femur in 47.5% of their cases.

We presume that in mid shaft femoral fractures, eccentricity at the distal end is less of an issue because of some accommodative translation and/or angulation that occurs at the fracture site with insertion of a long nail with increased ROC. The distal end hence, more often lines up with the axis of the femur.

In proximal femoral fractures with an intact isthmus, the nail entry point and the radius of curvature of the nail play a very important role in the final position of the distal nail tip particularly in elderly patients where there is increased femoral bowing.⁴

A slightly posterior entry point may prevent anterior placement/perforation at the distal end of the femur.⁴ However a few millimetres of shifting the entry point posteriorly probably has a limited role in maneuvering a long nail to ensure the distal end is not close to the anterior cortex distally. A posterior entry point can also compromise proximal screw positioning in the femoral head due to the anteversion.

Although our study suggests that a nail with a ROC of 150 cm is ideal, this may not necessarily be the case. There are some limitations to our study with it being partly a retrospective one with limited numbers in both groups. Since a functional assessment was not varied out, we are not sure if there is a clinical relevance to having the distal end of the nail positioned anteriorly. Our study does suggest that the incidence of anterior cortical penetration distally has reduced after using the 150 cm ROC nail.

We recommend future studies to be conducted in larger numbers to confirm the reduction of complications, which would be easier done with multicenter collaboration.

Conflict of interest

None.

Funding

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Ethical approval

This article does not contain any studies with animals performed by any of the authors. The study itself was approved by the Orthopaedic departmental audit committee.

Informed consent

Informed consent was obtained from all individual participants included in the study.

References

1. Bazylewicz DB, Egol KA, Koval KJ. Cortical encroachment after cephalomedullary nailing of the proximal femur: evaluation of a more anatomic radius of curvature. *J Orthop Trauma*. 2013;27(6):303–307.
2. Fantry AJ, Elia G, Vopat BG, Daniels AH. Distal femoral complications following antegrade intramedullary nail placement. *Orthop Rev*. 2015;7(1):533–545.
3. Harper MC, Carson WL. Curvature of the femur and the proximal entry point for an intramedullary rod. *Clin Orthop Relat Res*. 1987;220:155–161.
4. 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(9):656–660.
5. Tucker D, Surup T, Petersik A, Kelly M. Full circle: 3D femoral mapping demonstrates age-related changes that influence femoral implant positioning. *Injury*. 2017;47(2):471–477.