Malrotation Due to a Design Element of a New Antegrade Femoral Nail

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Citation

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Abstract

Objectives : To determine if the longitudinal spiral grooves on the new Synthes Expert Antegrade Femoral Nail (A2FN) , a new design feature, are able to cause mal-rotation of the femur.Methods : Five synthetic femora clamped a bolt inserted distally in the axis of rotation, allowing free rotation. The femora were cut at an identical sub-trochanteric point. Long Kirschner wires (K-wires) were inserted into the distal segment and the proximal oblique hole in the nail, to reference rotation. Each femur was reamed to 10mm and a 10mm width A2FN nail was inserted. The angle degree of rotation was measured before and after inserting the nail to determine the degree of rotation caused by the spiral grooves gripping the distal segment.Results : The spiral grooves caused the femora to rotate on insertion. The average internal rotation was 61 degrees (51 – 71 degrees).Conclusions : We believe that in patients with femoral fractures proximal to the isthmus, the A2FN has the ability to grip the distal femur at the isthmus and cause a rotational deformity if the nail is not rotated during insertion, or if the canal is not sufficiently over reamed.

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INTRODUCTION

Intramedullary (IM) nailing has now become the preferred method of treatment for the majority of femoral diaphyseal fractures. Interlocking provides rotational stability and maintains length, thus allowing early movement, and avoiding mal-union of the fracture[1,2]. However, the closed approach makes anatomical reduction under direct vision impossible, resulting in less rotational accuracy when compared to the traditional method of plate fixation[1,2,3]. Mal-rotation is a well-established complication of IM nailing of the femur. Several studies have shown the incidence of rotational deformities after femoral nailing of 10 degrees or greater in up to 20% of cases[4,5,6]. In recent years there have been several developments in the design of antegrade femoral nails. We seek to identify a new design element, spiral grooves along the body of a new antegrade femoral nail (previous grooves were parallel with the nail), as a cause of mal-rotation.

This feature was brought to our attention after a case of malrotation following insertion of a Synthes Antegrade Femoral Nail (A2FN) in a 32 year old patient with a comminuted fracture of the proximal femoral shaft. After completing the procedure, we identified a significant rotational deformity of approximately 45 degrees. Under the same anesthetic, we removed the distal screws and manually corrected the deformity.

This case has led us to examine the design of the A2FN- in particular, the spiral grooves which line nearly the entire length of the nail. It is our hypothesis that the spiral grooves have the ability to grip the femur, particularly at the isthmus, and that, as the nail is inserted, it will grip and rotate the distal fragment. We feel that this is more likely to occur with high femoral shaft fractures (above the isthmus) particularly sub-trochanteric fractures, for which this nail is often used

MATERIALS AND METHODS

Five synthetic femora (SYNBONE Solid Foam models) were cut transversely at an identical sub-trochanteric point to simulate a sub-trochanteric fracture. A large bolt was then inserted distally into the medullary canal with a large washer, and the bolt was fixed with a clamp, so that the femur was oriented vertically. The femur was free to rotate on the washer and the bolt acted as the centre of rotation. A 3.0mm guide wire was drilled into the bone at an identical

distal point, such that the guide wire was pointing anteriorly. The femoral canal was then reamed to 10mm from a trochanteric entry point. Due to the artificial nature of the model, over-reaming did not allow any grip between the nail and the canal, which is usually encountered in vivo.

A 340mm by 10mm A2FN was prepared with another 3.0mm guide wire fixed into the proximal locking hole. The impaction device was then attached to the nail. An initial photograph was taken of the nail as it sat in the femoral canal prior to insertion (Figure 1). This photograph was oriented so that the angle between the two guide wires was 90 degrees. Once the nail had been inserted to the end of the spiral grooves, a final photograph was taken from a similar position (Figure 2) and the rotation between the two wires was measured. The nail was inserted without rotation during insertion.

RESULTS

Internal rotation occurred in each case, due to the gripping of the grooves of the nail in the isthmus of the bone. The degree of internal rotation was 51, 56, 62, 65 and 71 degrees in each case. The average internal rotation was 61 degrees (range: 51 to 71 degrees).

Figure 1

Figure 1 – Image of Synthetic Femur in clamp with Expert A2FN sitting in the medullary canal prior to insertion. Image is taken so that the angle between K-wires is 90 degrees.

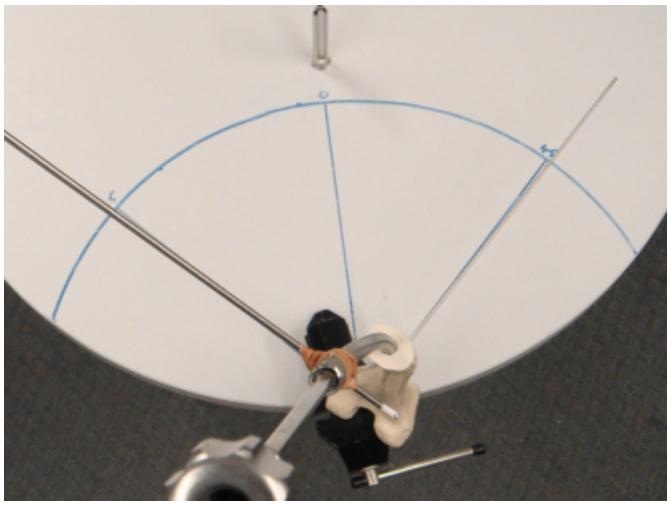
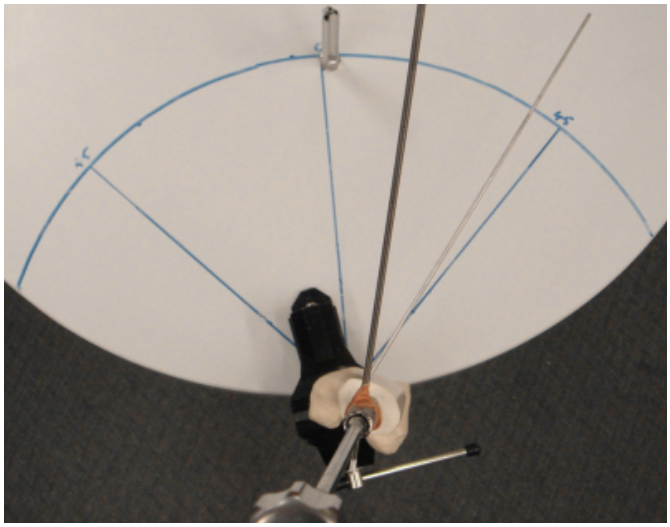


Figure 2

Figure 2 – Image of Synthetic Femur in clamp with Expert A2FN following insertion into the medullary canal. Angle between K-wires is now 25 degrees.



DISCUSSION

Our initial concern was that the new spiral grooves would cause rotation of the distal fragment during insertion, if the nail was inserted without sufficient rotation. Our experiment confirms that if the A2FN is able to grip the femur it can cause a rotational deformity. We believe that this is less likely if the grooves along the nail are straight, or if the grooves did not exist at all (as with other nails). The rotation can be minimised by rotating the nail during insertion, corresponding to the rotation in the spiral grooves. However, ‘straight’ insertion of this nail has the potential to cause mal-rotation. Depending on the grip of the nail in the bone, correction of the rotation around the nail is possible, once any mal-rotation has been identified.

The degree of potential rotation is likely to be higher than our estimate, as we did not completely insert the nail during our experiment. Surgeons should be aware of the large degree of potential rotation associated with straight insertion of this particular nail and, as with any femoral nailing, care should be taken to assess rotation at the end of the procedure.

References

1. Wiss DA, Fleming CH, Matta JM, Clark D. Comminuted and rotationally unstable fractures of the femur treated with an interlocking nail. Clin Orthop 1986;212:35-47.
2. Deshmukh RG, Lou KK, Neo CB, et al. A technique to obtain correct rotational alignment during closed locked intramedullary nailing of the femur. Injury 1998;29:207-10.
3. Svenigson S, Nesse O, Finsen V. Intramedullary nailing vs AO-Plate fixation in femoral shaft fractures. Acta Ortho

Scand. 1986;57:609
4. Jaarsma RL, Van Kampen A. Rotational malalignment after fractures of the femur. J Bone Joint Surg [Br] 2004;86-B:1100-4.
5. Dunn DM. Anteversion of the neck of the femur: a method of measurement. J Bone and Joint Surg [Br]1952:181-6
6. Terjeson T, Anda S, Svenningson S. Femoral anteversion in adolescents and adults measured by ultrasound. Clin Orthop 1990; 256:274-

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