Review Article

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Factors contributing to superior gluteal nerve injury during cephalomedullary nailing of femoral fractures

Ahmed A. Khalifa, Ahmed M. Ahmed, Mohammed Khaled, Elsayed A. Said

Abstract:

Operative treatment of femoral fractures using intramedullary nailing is considered as the gold standard technique; despite safety and minimal invasiveness, it is prone to some complications, of these is the persistent abductor lurch even after complete fracture healing. In this review, we are discussing the possible factors which may endanger the superior gluteal nerve during cephalomedullary nailing of the femur.

Keywords:

Cephalomedullary, femoral, nailing, superior gluteal nerve

Introduction

Cephalomedullary nails have become a gold standard for treating femoral fractures since the 1980s,[1-3] because nailing is a minimally invasive and relatively easy procedure with mechanical advantages.[4,5] However, residual complications may develop such as hip pain, stiffness, limping, decreased walking distance, and difficulty with stairs.[6-11] These symptoms are primarily attributed to postoperative hip abductor weakness described by the patients as a lurch in their gait. Surgeons often neglect this complaint, or the lurch is so mild that it may go unnoticed.[12] It is postulated that the decreased abductor strength is partially related to superior gluteal nerve (SGN) injury during nail insertion.

Anatomical Overview

The anatomy of the SGN and its surgical implications have been discussed in different anatomic studies [Figure 1].[9,13-18] The lumbosacral plexus gives off the SGN which then runs through the greater sciatic foramen above the piriformis muscle. The SGN usually follows a "spray pattern" where it spreads out along the intermuscular plane between the gluteus medius and gluteus minimus muscles. The most inferior branch of the nerve provides innervation to the gluteus minimus muscle and continues anteriorly to pierce the fused anterior edges of the gluteal muscles to supply the tensor fasciae latae muscle. Another distribution is called "transverse neural trunk pattern" where short branches arise to supply the gluteal muscles from a long trunk terminating in the tensor fasciae latae muscle.[19-21] The inferior main branch, the principal neuronal supply of the gluteus medius, is thought to be the most susceptible part of the SGN to injury during reaming.[17,20]

Patient's Position

Nailing can be performed with the patient lying in either the supine or the lateral decubitus position. Although the supine position is more common, it permits only a limited amount of adduction and flexion of the limb, and therefore, it may

Department of Orthopaedic and Traumatology, Qena Faculty of Medicine and Its University Hospital, South Valley University, Qena, Egypt

Address for correspondence:
Dr. Ahmed A. Khalifa, Department of Orthopaedic and Traumatology, Qena Faculty of Medicine and Its University Hospital, South Valley University, Kilo 6 Qena-Safaga Highway, Qena 83523, Egypt.
E-mail: ahmed_adel0391@med.svu.edu.eg

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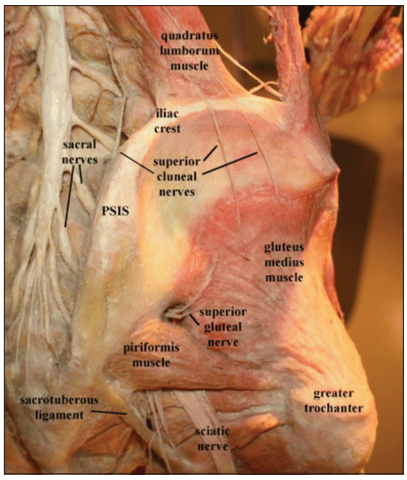

Figure 1: Course and anatomical relations of the superior gluteal nerve (Image courtesy of Andrea Trescot, MD)

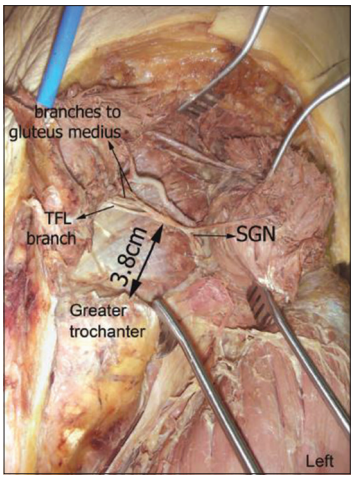

Figure 2: Relation of the tip of the greater trochanter (Image courtesy of Dr. Nihal Apaydin)

be challenging to create an entry point.[22] In a study by Ansari Moein *et al*.,[14] an antegrade femoral nail was introduced in ten cadavers lying in the supine position. In two of them, the inferior branch of the SGN was found to be at high risk of injury, being <5 mm from the surgical incision in the gluteus medius.

In contrast, a higher degree of both flexion and adduction (up to 30°) can be achieved with the lateral decubitus position on the fracture table which provides more accurate access to the correct point of entry.[22] Another reported method is manual traction with the patient in the so-called sloppy lateral position, in which the affected limb was elevated with a bolster placed beneath the buttock allowing an even higher amount of hip adduction (up to 45°).[23] The safety of these positions was tested by Ozsoy *et al*.[20] who noticed that higher degrees of flexion and adduction, as is possible with the patient in the lateral position on a fracture table or in the sloppy lateral position on a radiolucent table, the SGN is displaced superiorly and anteriorly and thus at less risk of being injured.

Surgical Incision

An optimal skin incision (location and length) should provide both safety (for soft tissues including the SGN) and accessibility for the nail instruments. Jacobs and Buxton[21] were the first to describe a "safe area" as much as 5 cm proximal to the tip of the greater trochanter [Figure 2]. Despite the technical difficulty to obtain an instrumentation trajectory that is "in line" with the femoral canal, particularly in muscular and obese patients,[24] it was determined that a more distal skin incision, 2–5 cm proximal to the tip of the greater trochanter, should be used. However, the exact location of this safe area remained controversial, because the distance between the branches of the SGN and the greater trochanter may alter in relation to many variables including body height and pelvic anatomy.[25] This controversy (regarding incision location and length) was further proved by Ozsoy *et al*.[20] who found that the SGN is located in an average distance of only 7 mm (range, 0–17 mm) away from the instrumentation and the nail path when a piriformis entry intramedullary nail is inserted through the traditional distal incision.

On the other hand, a more proximal skin incision is considered advantageous as it makes it easier to obtain an "on-axis" trajectory to the femoral canal. The safety of this approach was questioned till evaluated by Lowe *et al*.[26] They positioned the leg in 15° of adduction and 10° of flexion to make an incision 1–2 cm distal to the most proximal subcutaneous border of the iliac crest aligned with the femoral shaft. No injuries to the main trunk or any of its branches were reported. As demonstrated by the authors, the gluteus medius muscle acted as a natural "barrier" or "buffer" to protect the SGN as well as its branches which lie on its "undersurface." In addition, the prominence of the iliac crest and gluteal tubercle prevents excessive medialization of the instrument and nail trajectory providing an extra protective effect. However, these protective effects can be achieved only when the procedure is performed by experienced hands.

Nailing Entry Point

There has been a conflict regarding the optimal portal of nail insertion to minimize soft-tissue injury [Figure 3]. The safety of piriformis and greater trochanter tip entry was examined by both cadaveric and clinical studies.

Studies by Ansari Moein *et al*.[14,19,27] concluded that there is no difference regarding the risk of SGN injury when it comes to the entry point. The nerve was either preserved in both groups or at similar risk of injury. On the other

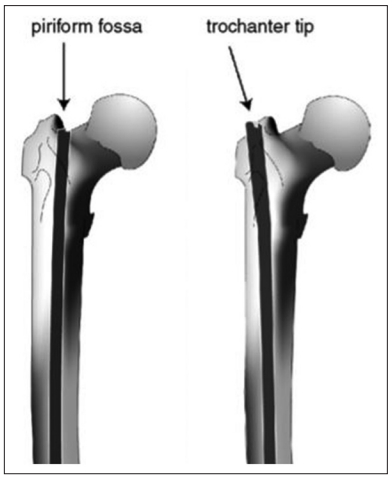

Figure 3: Entry points of a cephalomedullary femoral nail (Image courtesy of Dr. Ansari Moein)

hand, Khan and Knowles[28] found the average distance from the greater trochanter tip to the lowest branch of the SGN is ≥5 cm farther than the nerve's distance from the piriformis fossa entry portal. Therefore, using the greater trochanter tip as an entry point may reduce the risk of damage to these nerve branches. These results were supported by another clinical study where five of the patients in the piriformis fossa group had an abnormal electromyography with evidence of acute injury of the SGN directly after operation followed by reinnervation.[29]

Conclusion

After reviewing the possible factors, which can endanger the SGN during cephalomedullary femoral nailing, we believe that greater trochanter entry point represents a safer approach than the piriformis entry, and the lateral decubitus position, although less commonly utilized, seems to offer more protection for the SGN and its branches. The proximity of the skin incision does not affect the risk of SGN injury, but rather makes the procedure technically easier.

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Conflicts of interest
There are no conflicts of interest.

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