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# The safety and feasibility of minimally invasive plate osteosynthesis (MIPO) on the medial side of the femur: A cadaveric injection study

C. Jiamton [a], T. Apivatthakakul [b,c,*]

[a] Institute of Orthopaedics, Lerdsin General Hospital, Bangkok, Thailand
[b] Department of Orthopaedics, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand
[c] Excellence Center in Osteology Research and Training Center (ORTC), Chiang Mai University, Thailand

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ABSTRACT

*Introduction:* Minimally invasive plate osteosynthesis (MIPO) on the medial side of the femur appears to be a dangerous procedure due to possible femoral artery injury.
*Objective:* This study aims to determine the feasibility of applying MIPO of the femur via the medial approach, and to determine the anatomical relationship and structures at risk between the artery and the implant using computed tomography angiography.
*Materials and methods:* A descriptive study of ten fresh cadavers was done. Two separate incisions were made, creating a submuscular tunnel close to the medial side of the femur. An 11- or 13-hole LCP lateral proximal tibial plate (5.0 mm) was inserted through the distal incision into the submuscular tunnel and fixed. A CT angiogram with 3D reconstruction was made to determine the distance from and location of the plate relative to the femoral artery and surgical dissection was done to identify the structures at risk.
*Results:* No disruptions of superficial or deep femoral arteries were found. The closest distances from the superficial femoral artery and deep femoral artery to the plate were 8.3–27.2 mm (average 16.3 mm) (99% CI: 12.7–19.9) at the level 3 and 4.5–20.0 mm (average 8.6 mm) (99% CI: 6.4–10.9) at the level 2 in the proximal part of femur, respectively. The location where the SFA crossed the anterior cortex of the femur in the sagittal plane was 9.7–36.0% of the femoral length (average 20.1%) (99% CI: 15.0–25.3%) and the posterior cortex of the femur was 24.7–55.3% of the femoral length (average 40.8%) (99% CI: 35.0–46.7%). The location where the DFA crossed the anterior cortex of the femur in the sagittal plane was 7.9–25.3% of the femoral length (average 13.4%) (99% CI: 10.6–16.3%) and where it crossed the posterior cortex of the femur was 21.7–39.4% of the femoral length (average 31.2%) (99% CI: 27.1–33.3%).
*Conclusion:* MIPO of the femur via medial approach is a feasible option for treatment of femoral fractures when the lateral approach is contraindicated. The distal 60% of the femoral length is safe for this approach.



## Introduction

Minimally invasive plate osteosynthesis (MIPO) maintains local fracture biology and promotes bone healing by preserving vascularity. It is an established alternative to standard fracture stabilisation methods and produces satisfactory outcomes [1–7]. With improvements in technique and implants, the use of MIPO has gained popularity for fractures of the femoral shaft, the distal femur and periprosthetic fractures [1,2,4–6,8]. The lateral MIPO approach, which is the standard approach, involves the lowest risk of injury to neurovascular structures. However, there are some situations in which a medial approach may be needed; for example, distal femoral fractures with medial column comminution [9–11], periprosthetic femoral fractures with previous lateral implants [12] and cases where lateral external fixator pins or poor soft tissue conditions prevent using the traditional lateral approach [13].

Percutaneous plate insertion on the medial side of the femur is thought to risk injury to the femoral artery. The common femoral artery (CFA) becomes the superficial femoral artery (SFA) after the deep femoral artery (DFA) branch. It runs along the medial side of the femur and enters the adductor canal distally [14,15]. A few studies have described a minimally invasive approach on the medial side of the femur [13,16–18] but the risk of injury to the

* Corresponding author at: Department of Orthopedics, Faculty of Medicine, Chiang Mai University, Chiang Mai 50200, Thailand. Tel.: +66 53 945544; fax: +66 53 217144.
*E-mail address:* tapivath@gmail.com (T. Apivatthakakul).

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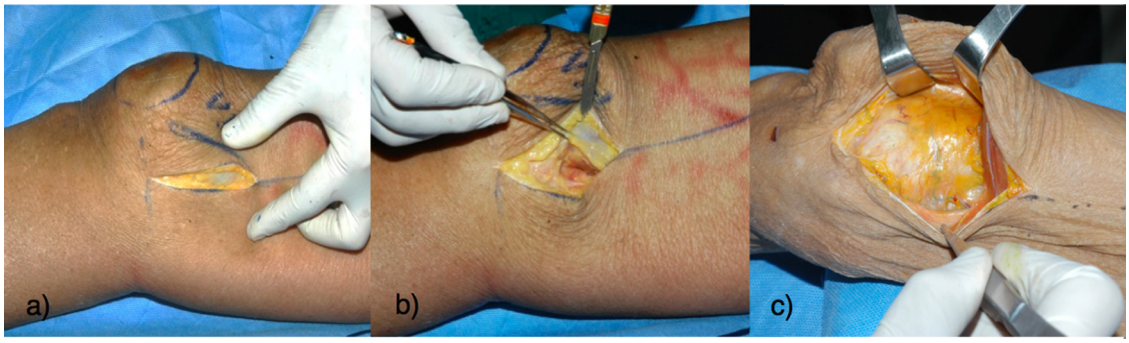


**Fig. 1.** Distal approach. (a) Make mid-sagittal incision over the medial epicondyle. (b) Elevate the vastus medialis anteriorly. (c) Expose the distal femur.

neurovascular structures have yet to be verified by anatomic cadaveric dissections.

This study aims to determine the safety of using the MIPO technique for stabilising femoral shaft fractures through a medial approach and to evaluate the accompanying risk of injury to the superficial and deep femoral arteries. The study describes the anatomical relationship between the arteries and a plate applied medially by the computed tomographic angiography (CTA) and assesses the risk of injury to the superficial and deep femoral arteries.

## Materials and methods

This study was conducted using ten randomly selected fresh human cadavers (20 femurs) obtained from the Department of Anatomy, Faculty of Medicine, Chiang Mai University. The donors were confirmed to be free of conditions affecting lower limb vascularity. Approval of the study protocol was obtained from the Institutional Ethical Committee Board.

Procedures were performed with the torso supine. The common femoral arteries (CFA) were exposed at the groin bilaterally using 8 cm longitudinal incisions. The CFA were then catheterized and secured with two non-occluding silk suture ties. The proximal parts of the CFA were ligated to prevent the liquid contrast gelatin tracking proximally. Clotted blood was flushed from the artery with 200 ml of warm normal saline until flow-through of the saline from the common femoral vein was seen.

The surgical approach described by Nayagam et al. [13] was used. Distally, a 5 cm mid-sagittal incision was made over the medial epicondyle. Here the medial border of the vastus medialis was dissected and retracted anteriorly from the medial intermuscular septum to expose the medial aspect of the distal femur (Fig. 1). The direction of the proximal skin incision was identified by drawing a line from the anterior superior iliac spine to the medial border of the patella. The level of the proximal incision was located using the length of a reversed 13-hole lateral proximal tibial locking plate (5.0 mm) (Synthes®) as a guide and measuring from the medial epicondyle. In shorter femurs, an 11-hole plate was selected. A 5 cm proximal incision was made just lateral to the palpable sartorius muscle, on the line connecting the anterior superior iliac spine to the medial border of the patella just anterior to the adductor tubercle. The plane between the rectus femoris and sartorius muscles was dissected and the sartorius was retracted medially to protect the neurovascular structures. Rectus femoris was retracted laterally. The vastii, first the merging heads vastus lateralis and vastus medialis and, in a deeper plane, the vastus intermedius were split longitudinally to expose the femur (Fig. 2).

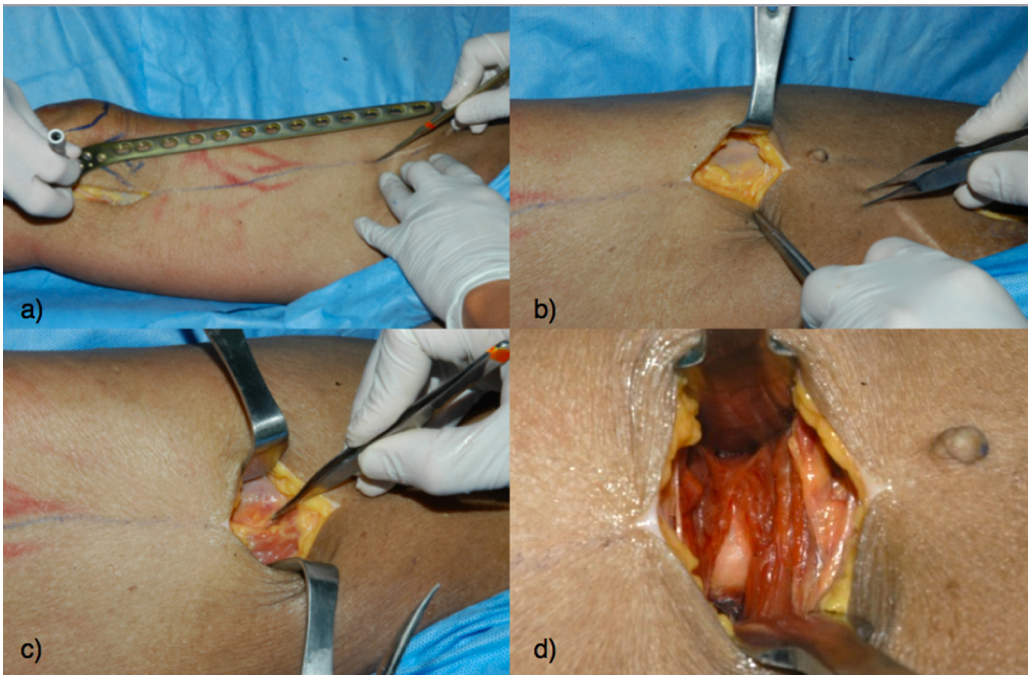


**Fig. 2.** Proximal incision. (a) Mark the proximal incision using the plate length. (b) Make incision at the lateral border of the sartorius. (c) Dissect the plane between the rectus femoris and the sartorius. (d) Longitudinally split vastus intermedius to expose femur.