https://doi.org/10.5704/MOJ.2607.013

A Simple External Fixator Construct for Intra-operative Assessment of the Distal Femur Coronal Mechanical Alignment: A Case Report

Lai MC[1], MMed (Ortho Surg), **Tan GIL**[2], MRCS (Ireland), **Yeo KSA**[2], FRCSEd (Ortho)

[1]Department of Orthopaedic Surgery, Khoo Teck Puat Hospital, Singapore
[2]Department of Orthopaedic Surgery, Changi General Hospital, Singapore

This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited

Date of submission: 31st December 2024
Date of acceptance: 19th July 2025

ABSTRACT

Stable surgical fixation of the distal femur relies significantly on accurate restoration of the lower limb mechanical axis. Methods previously described such as the cable method, axis board method, and alignment rod method require assessment to be performed with the lower limb in extension. We describe a novel technique – which utilises simple and easily accessible components such as an Ilizarov half-ring, connecting rod, and two nuts – that permits intra-operative assessment of the lower limb mechanical axis with the knee in both flexion or extension. Allowing the knee to remain in flexion also facilitates fracture reduction, as the flexed position reduces the pull of the gastrocnemius muscle on the distal fragment. Intra-operatively, the Ilizarov half-ring is attached to the connecting rod in at the perpendicular and secured with two nuts. Fluoroscopy is used to confirm that the ring is placed parallel to the knee joint, and the tip of the rod centred on the femoral head; when both of these landmarks are aligned, it indicates the lower limb mechanical axis has been restored. This technique has proven accurate and reproducible in our institution but will require further evaluation with more detailed studies in a larger patient sample.

Keywords:
mechanical axis, lower limb alignment, laser method, cable method

INTRODUCTION

Distal femur fractures commonly occur due to high-energy accidents in young patients or low-energy falls in the elderly. The goals of surgical fixation include anatomic reduction of the articular surface and achieving stability via the restoration of limb alignment, length, and rotation[1]. Restoration of the anatomic axis and normal valgus alignment of the distal femur has been linked with improved patient outcomes[2].

Accurate intra-operative assessment of the mechanical axis is critical towards achieving a stable, well- aligned fixation. Several methods have been previously described, such as: the cable technique: utilising a cable or metal wires to span the femoral head and centre of the ankle; alignment of the mechanical axis is confirmed with intensifier imaging at the knee joint[3]; the axis board method: which requires the use of a radiolucent board with pre-drawn metallic reference lines, with anterior-posterior (AP) radiographs taken pre- and intra-operatively to line up the mechanical axis to the reference lines[4]; and the alignment rod method: which uses a long rigid metal rod with one end placed at the femoral head and the other at the centre of the ankle. Fluoroscopic imaging allows evaluation of the hip- knee-ankle (HKA) mechanical axis[5]. Verma *et al* have described a variation of this method, using a simple external fixator construct employing two or three external fixator rods interconnected in a linear fashion using tube connector clamps[5].

During the surgical fixation of a distal femur fracture, the knee is usually placed in a flexed position in order to reduce the pull of the gastrocnemius muscle in order to aid fracture reduction. However, the above methods require the lower limb to be in extension, which may interfere with provisional fixation.

The novel technique we present utilises a ring fixator and its components to facilitate rapid but accurate intra-operative assessment of the mechanical axis regardless of whether the knee is flexed or extended.

Corresponding Author: Mun Chun Lai, Department of Orthopaedic Surgery, Khoo Teck Puat Hospital, 90 Yishun Central, Singapore 768828
Email: cmunchun2001@yahoo.com

Fig. 1: (a) Pre-operative radiographs of the right knee showing a right distal femur comminuted fracture. The right hip radiographs demonstrate a pre-existing cephalomedullary device inserted - used to fix a previous right hip intertrochanteric fracture. (b) These radiographs are of the patient one year post-operatively, showing the fracture has healed in neutral alignment and with the implant intact in-situ.

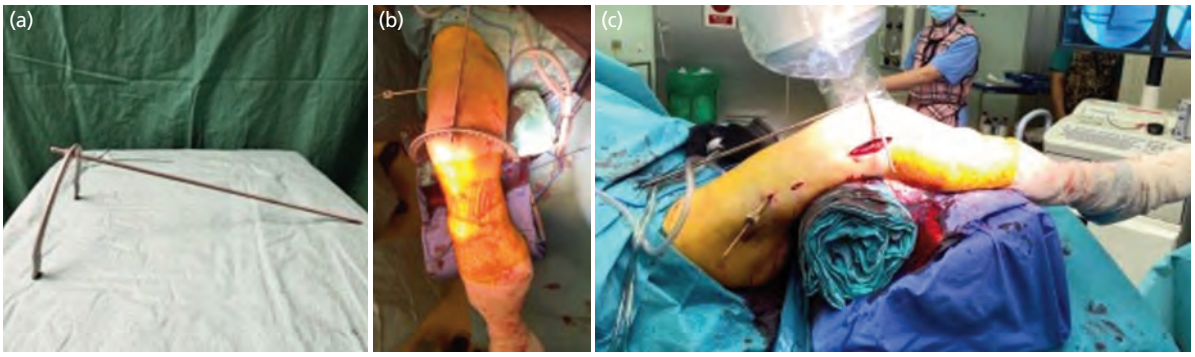

Fig. 2: (a) The assembled apparatus – a threaded connecting rod is inserted into an Ilizarov half ring on a perpendicular axis and secured with two nuts. (b) The photograph shows the ring portion placed parallel to the knee intra-operatively, and (c) demonstrates how the long rod portion extends up into the hip.

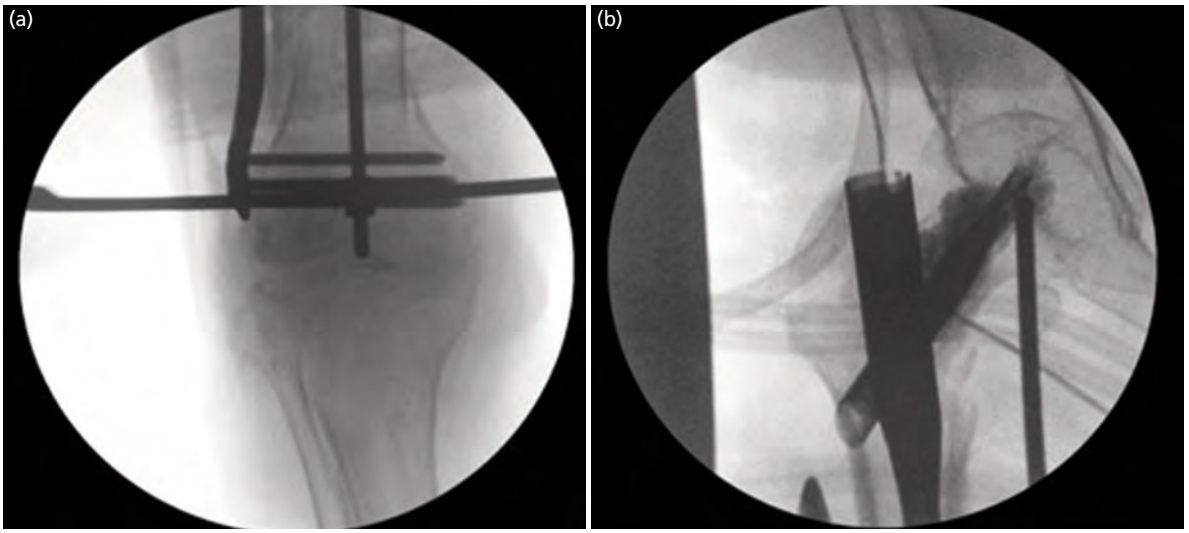

Fig. 3: (a) Intra-operative fluoroscopy confirms the ring has been placed parallel to the knee joint line, and (b) the tip of the rod centred in the femoral head.

CASE REPORT

A 72-year-old female sustained a comminuted right distal femur fracture (AO classification 33 A3) after a mechanical fall, demonstrated on plain radiographs (Fig. 1). Of note, the patient had previously undergone cephalomedurally nailing for an ipsilateral inter-trochanteric fracture three months prior.

Surgical fixation was performed with the patient positioned supine on a radiolucent table. After sterile draping, a sterile bolster was placed under the right knee to achieve 30° flexion – this facilitates correction of the hyperextension deformity and assists in fracture reduction.

Fracture reduction was achieved under fluoroscopic guidance. Prior to definite fixation and implant insertion, the proposed technique was used to guide the restoration of anatomical alignment. Our apparatus included an Ilizarov half-ring, a long threaded connecting rod and two nuts. The threaded rod is inserted to the middle of the half ring on a perpendicular axis and secured using the two nuts ensuring a 90° angle between the threaded rod and ring (Fig. 2). The ring portion of the device is placed on the knee, in line and with reference to the knee joint line and trans-epicondylar axis (Fig. 2). Under fluoroscopic guidance, the reduction is adjusted accordingly, ensuring the ring is parallel to the knee joint line and the tip of the rod is centred on the femoral head (Fig. 3). Once both images confirm alignment, it indicates the mechanical axis of the distal femur has been restored. Additionally, our assembled construct can serve as a verification guide during implant insertion.

This patient recovered well post-operatively; after a period of six weeks of non-weightbearing of the right lower limb. Radiographs performed one year post-operatively showed the femur has healed in neutral alignment with the implant intact and in-situ (Fig. 1). Our institution does not perform routine lower limb scanograms pre- or post-operatively. The technique has been utilised on other patients with distal femur fractures in our institution and has proven reproducible and accurate.

DISCUSSION

The various methods of intra-operative assessment of the lower limb mechanical axis as previously described have their individual merits. Advantages of the cable method include its simplicity and cost- effectiveness. However, it requires pre-operative set up and fluoroscopy and the flexibility of the cable may risk measurement errors if not tightly secured. The axis board is also easy to use both pre- and intra-operatively, but requires the purchase of the radiolucent board, and its accurate placement on the operating table. Methods utilising a rigid alignment rod have a reduced risk of mismeasurement, but require sequential imaging of the femoral head, centre of the ankle and the knee joint need to be in extension which could potentially affect intra-operative reduction. The methods discussed all have a prerequisite for the knee to be in extension to allow evaluation of the mechanical axis.

Comparatively, our novel technique offers several advantages. Firstly, it utilises simple and readily accessible tools such as a ring fixator that are easy to handle and rapidly assembled intra-operatively. Secondly and notably, our construct allows for assessment of the mechanical axis at the knee joint line – allowing for accurate assessment without including ankle joint as part of the axis. More importantly, this therefore permits accurate assessment of alignment whether the knee joint is in flexion or extension – this is pertinent given good reduction of a distal femur fracture relies on a flexed knee to reduce the pull of the

gastrocnemius muscle. Although technically feasible, the use of a Schanz pin with the half-ring construct offers potential for correcting hyperextension deformity. To maintain coronal alignment, particularly in orientating the half ring parallel to the joint line and the threaded rod towards the femoral head, it is recommended that a transverse wire be added to serve as a stabilising reference. Alternatively, the Schanz pin may be used as an independent reduction tool outside of the construct, allowing for more targeted sagittal plane correction without compromising coronal orientation. We acknowledge that in complex cases, a dedicated reduction instrument or external fixator-assisted technique may offer superior control. Finally, the assembled construct can be left in the surgical field to act as a verification guide during implant insertion.

Nevertheless, we acknowledge that this technique still requires the use of intra-operative fluoroscopy to verify the positioning of the device at the relevant bony landmarks. Another limitation of the technique is post-fixation the distal femoral alignment is restored to a normal or physiological limit of 90°, without considering the contralateral side's alignment or the overall coronal alignment of the hip, knee, and ankle[1].

In conclusion, the key advantages of our described technique lie in its ease of use, and in its ability to allow assessment the mechanical axis whilst permitting the knee to remain flexed – especially important maintaining the reduction of the distal femur fracture. However, more detailed studies and a larger sample size may be required to further evaluate its accuracy and outcome.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

REFERENCES

1. Scott BR, Wright RD, Moghadamian ES. Intraoperative Assessment of Coronal Alignment in Distal Femur Fracture Fixation: Technical Trick. *J Orthop Trauma.* 2019; 33(2): e69-e72. doi: 10.1097/BOT.0000000000001334
2. Krettek C, Miclau T, Grün O, Schandelmaier P, Tscherne H. Intraoperative control of axes, rotation and length in femoral and tibial fractures. Technical note. *Injury.* 1998; 29 Suppl 3: C29-39. doi: 10.1016/s0020-1383(98)95006-9
3. Chan CK, Shanmugam R. A Simple Cable Method for Intraoperative Limb Alignment Assessment. *Malays Orthop J.* 2016; 10(1): 69-70.
4. Liodakis E, Kenawey M, Liodaki E, Mommsen P, Krettek C, Hankemeier S. The axis-board: an alternative to the cable technique for intraoperative assessment of lower limb alignment. *Technol Health Care.* 2010; 18(3): 165-71. doi: 10.3233/THC-2010-0579
5. Verma T, Chavali VH. A Simple External Fixator Construct for Assessment of Intra-operative Hip-Knee-Ankle Axis Alignment in Lower Limb Deformity Correction Surgery. *Malays Orthop J.* 2020; 14(2): 149-50. doi: 10.5704/MOJ.2007.004

Cite this article:

Lai MC, Tan GIL, Yeo KSA. A Simple External Fixator Construct for Intra-operative Assessment of the Distal Femur Coronal Mechanical Alignment: A Case Report. *Malays Orthop J.* 2026; 20(2): 104-7. doi: 10.5704/MOJ.2607.013