



A new screw fixation technique for minimally invasive percutaneous plate osteosynthesis

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Minimally invasive percutaneous plate osteosynthesis (MIPPO) has well-documented biological advantages and appears to be a reasonable treatment option for complex femoral and tibial fractures. However additional radiation exposure during reduction of the fracture, application of the plate to the bone and screw fixation is one of the disadvantages of this technique. We describe a technical trick for screw fixation in MIPPO with locking compression plates which decreases the duration of fluoroscopy use during the operation.

Keywords : MIPPO ; minimally invasive ; osteosynthesis ; technical trick.

INTRODUCTION

Minimally invasive percutaneous plate osteosynthesis (MIPPO) has been developed as a method of fracture fixation with which the soft tissue envelope around the fracture is preserved and the fracture biology is less affected (1). The plate is placed through small incisions with as limited dissection and stripping of the soft tissue envelope as possible. This technique has many biological advantages compared to the traditional open reduction and internal fixation. MIPPO involves minimal soft tissue dissection with preservation of the vascular integrity of the fracture as well as preserving the osteogenic fracture haematoma (2). Several previous studies have reported high success rates with this technique in the distal tibia, the femur, the

proximal tibia and the tibial shaft (3,6-9,14). However the use of indirect reduction techniques and small incisions to insert hardware is technically more demanding and requires fluoroscopic control throughout the procedure. Intraoperative fluoroscopy is essential to judge fracture reduction and hardware placement.

The technique described in this study may help decrease the duration of intraoperative fluoroscopy during screw fixation in MIPPO.

Surgical technique

The patient is positioned supine on a radiolucent table. Antibiotic prophylaxis is administered and routine preparation of the injured limb is performed. A tourniquet is not used. Elevating the

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injured limb on the radiolucent table enables a clear lateral view with fluoroscopy and avoids interference from the other leg. Standard intraoperative fluoroscopy is used throughout the procedure. Both indirect and direct reduction techniques (manual traction, femoral distractor, external fixation devices or direct reduction with fracture reduction forceps) can be used, depending upon the nature and pattern of the fracture. Separate stab incisions may be required and reduction of large fragments can be maintained by individual lag screws. In our series we achieved satisfactory reduction in all patients with manual traction and manipulation.

In the distal tibia, the plate is applied on the anteromedial aspect. A 3- to 4-cm skin incision is made distal to the fracture over the medial aspect of the tibia. Articular fragments require direct visualization and rigid fixation before plate placement. The fibula is fixed in cases where this is deemed necessary to restore the stability and normal anatomy of the ankle joint or where it is considered helpful to have a template for length. In the distal femur, the plate is applied on the lateral cortex through a 5- to 7-cm lateral incision. A parapatellar incision is required to reduce and fix the articular fragments of the intraarticular extension of distal femoral fractures.

An extraperiosteal, subcutaneous tunnel is created with long scissors or a periosteal elevator using blunt dissection (fig 1a). A 4.5 mm precontoured locking compression plate for the femur or a 3.5 mm precontoured locking compression plate for the tibia is then passed along the tunnel (fig 1b). Mechanically, a locked construct does not require a friction fit of the plate against the bone and a gap beneath the plate has advantages in preserving periosteal circulation. The position of the plate is controlled with fluoroscopy on anteroposterior and lateral views. Once the accurate plate positioning is achieved, the plate is secured by passing 3-mm Kirschner wires through the most proximal and distal holes (fig 2a). A second plate of similar size and length is placed through the same holes on the Kirschner wires. It acts as an external guide to localize the screw holes and skin incisions without any need for fluoroscopic control (fig 2b & 3a). The stab incisions are made close to the Kirschner wires

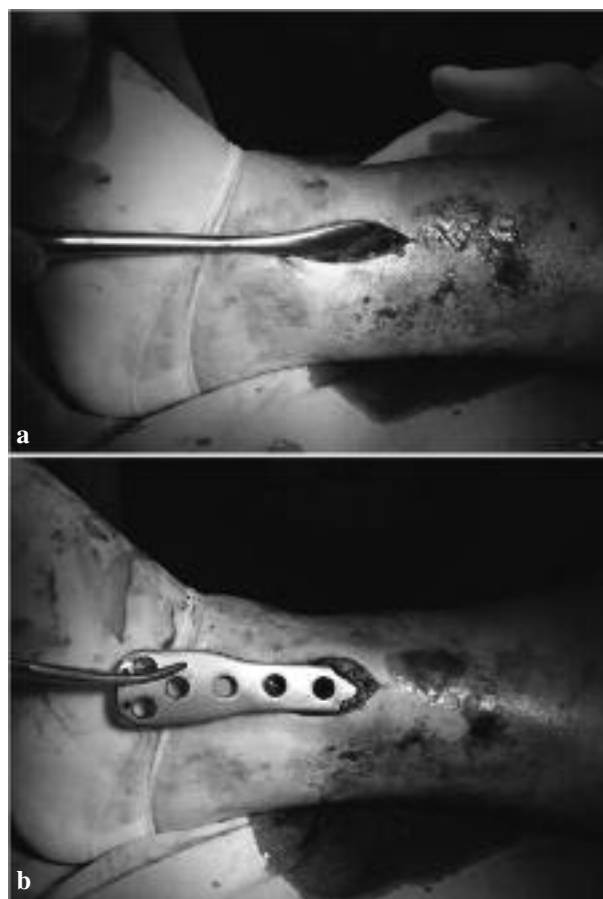


Fig. 1. — (a) A subcutaneous tunnel is created with a periosteal elevator. (b) The plate is inserted subcutaneously.

and the second plate is then removed to allow insertion of the locking drill guide (fig 3b). One proximal and one distal screw are inserted. Additional screws are then applied using the same technique. Once definitive fixation is achieved, the incisions are irrigated and sutured in standard fashion (fig 4).

Postoperatively, patients are not routinely splinted. Early active and passive hip, knee and ankle motion is encouraged, but weight bearing is delayed for a minimum period of 6 weeks.

RESULTS

Thirteen patients were operated between January 2005 and August 2007 with the principles of minimally invasive percutaneous plate osteosynthesis

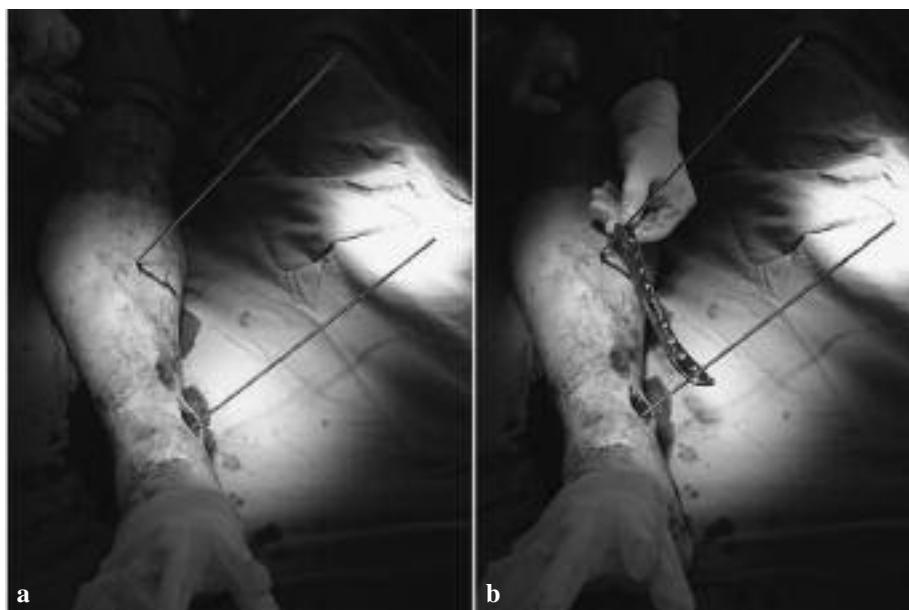


Fig. 2. — (a) The Kirschner wires are inserted into the bone through the most proximal and distal holes of the plate. (b) A second plate of similar size and length is placed through the same holes on the Kirschner wires to determine the screw holes.



Fig. 3. — (a) The second plate is used as an external guide to localize the skin incision. (b) The locking drill guide is inserted into the subcutaneous plate holes.

(MIPPO). There were ten males and three females with a mean age of 37.6 years (range ; 15-66 years). Six patients had femoral fractures and seven had tibial fractures. All fractures were classified according to the AO comprehensive classification sys-

tem (12) (table I). There was no open fracture in this series. The average duration of follow-up was 15.3 months (range, 6-36 months). MIPPO technique was performed with locking compression plates (LCP) in 11 patients as described in the



Fig. 4. — The skin incision for the plate placement and the stab incisions for the screws.

surgical technique (fig 5). The average operating time was 76 minutes (range, 65-90 minutes) and the average image intensifier time was 188.8 seconds (range, 150-240 seconds) for these patients. The remaining two were operated with less invasive surgical stabilisation (LISS) plates (Synthes, West Chester, PA) and the average operating and image intensifier time were 70 minutes and 175.5 seconds respectively. There were no cases of failure of fixation during the follow-up. The total number of screws in patients with LCP plates was 84. All of them were targeted to the screw holes satisfactorily.

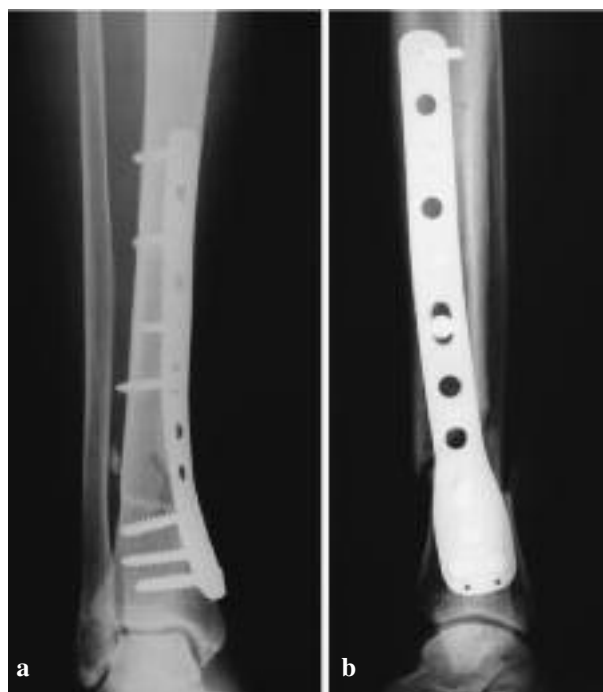


Fig. 5. — Early postoperative (a) anteroposterior and (b) lateral radiographs for the 6th patient in table I.

Table I. — Detailed patient and operative data

Patient	Age/ (years) Gender	Fracture	AO classification type	Locking plate implant used	Number of screws proximal and distal	Operative time (minutes)	Fluoroscopy time (seconds)
1	28 / female	Tibia	43 – A1	7-holes 3.5 mm LCP medial distal tibia	3 – 4	65	150
2	21 / male	Tibia	42 – B1	13-holes 3.5 mm LCP medial distal tibia	4 – 4	80	195
3	34 / male	Tibia	43 – A1	13-holes 3.5 mm LCP medial distal tibia	4 – 5	85	190
4	36 / male	Tibia	42 – A2	9-holes 3.5 mm LCP medial distal tibia	4 – 3	70	175
5	48 / male	Tibia	42 – A2	9-holes 3.5 mm LCP medial distal tibia	4 – 3	90	240
6	42 / male	Tibia	42 – B2	11-holes 3.5 mm LCP medial distal tibia	4 – 4	70	168
7	18 / male	Tibia	42 – A1	9-holes 3.5 mm LCP medial distal tibia	4 – 3	65	172
8	32 / male	Femur	32 – B2	13-holes 4.5 mm LCP lateral distal femur	5 – 4	85	210
9	60 / male	Femur	32 – A1	11-holes 4.5 mm LCP lateral distal femur	3 – 4	80	200
10	15 / male	Femur	32 – A3	7-holes 4.5 mm LCP lateral distal femur	3 – 3	70	186
11	54 / female	Femur	33 – C1	11-holes 4.5 mm LCP lateral distal femur	5 – 4	75	191
12	36 / male	Femur	33 – A3	13-holes LISS	5 – 6	70	178
13	66 / male	Femur	33 – A3	13-holes LISS	5 – 5	70	173

DISCUSSION

Minimally invasive percutaneous plate osteosynthesis (MIPPO) offers several theoretical advantages compared to conventional open plating technique. A mechanically stable fracture-bridging osteosynthesis can be obtained without significant dissection and surgical trauma to the bone and surrounding soft tissues. As a consequence, the vascular integrity of the fracture and the osteogenic fracture haematoma are preserved (1,2). However MIPPO does not allow direct visualisation of the fracture and the surgeon is dependent on intraoperative fluoroscopy to confirm that an adequate reduction has been achieved (4,5,13). Additional radiation exposure during application of the plate to the bone and screw fixation and therefore extended operating time are challenging problems of this technique (11).

Locking compression plates (LCP) and less invasive surgical stabilisation (LISS) plates are locked plates that can be used for biological fixation in a minimally invasive manner especially for periarticular fractures of the femur and tibia. LISS plates are attached to a radiolucent outrigger device that aligns a drill sleeve with each hole in the plate and allows screw fixation without using image intensification. But the application of LISS plates is limited to the distal femur and the proximal tibia. LCP plates have been designed for the treatment of most periarticular fractures. They are precontoured to fit the underlying bone and can be used anywhere a traditional plate is applied. However screw fixation should be controlled with fluoroscopy throughout the procedure.

In general, one or two screws can be placed through the incision used for plate insertion under direct visualization. The other screw holes are localized on the lateral image projection and small stab incisions are made in the skin at these levels. The incision can be enlarged slightly from the intended screw hole, allowing up to 3 holes in the plate to be accessed through one incision (10). The second plate used in this technique serves as an external guide and eliminates the need for larger

incisions for screw fixation and additional fluoroscopy during the procedure. This technical trick aids in insertion of locked screws during application of a minimally invasive percutaneous plate.

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