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Technical Note

Percutaneous cerclage wiring for reduction of periprosthetic and difficult femoral fractures. A technical note

T. Apivatthakakul *, C. Phornphutkul

Department of Orthopedics, Faculty of Medicine, Chiang Mai University, Chiang Mai 50200, Thailand

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ABSTRACT

Background: Combining closed reduction techniques with minimally invasive plate osteosynthesis (MIPO) or intramedullary nailing is a technically challenging procedure, especially when dealing with complex femoral fractures such as periprosthetic fractures. Cerclage wiring is a well known adjunct for fracture reduction and fixation. However, it is usually performed by open reduction, requiring wide surgical exposures, that results in soft tissue stripping.

Objectives: To present how a novel cerclage wiring technique, employing a new percutaneous cerclage system, helped reduce a periprosthetic femoral fracture, fixed with MIPO, and a difficult proximal femoral fracture, stabilized with an intramedullary nail.

Conclusion: Percutaneous wiring is an alternative reduction technique to facilitate the reduction and maintenance of difficult femoral fractures, which reduces the radiation exposure to the surgeon.

Closed reduction of femoral fractures, especially proximal third fractures, is a technically challenging procedure. Reduction can be difficult due to deforming muscle forces and fracture comminution. Attempted closed reduction is preferred to open reduction, preserving fracture haematoma and periosteal blood supply. This consequently increases union rate and reduces infection risk. Various closed or percutaneous reduction techniques have been described for femoral shaft fractures.[1,2] Closed reduction of grossly displaced or reverse oblique intertrochanteric fractures is mandatory before closed intramedullary nailing or plating. Failure to reduce these fractures leads to varus displacement or angulation.

Cerclage wiring performed via an open technique is a well-known procedure used to reduce spiral or oblique fractures, especially periprosthetic femoral fracture.[3] The disadvantage of open wiring is its extensive surgical dissection which disrupts the blood supply at the fracture zone. Percutaneous cerclage wiring of the femur through a single incision has not been mentioned in the literature. This is likely because using a standard technique necessitates working through a small incision often obstructed by the femur's muscular cover over its metaphysis and diaphysis. A new percutaneous cerclage passer (Synthes®) was designed for achieving and maintaining reduction of femoral fractures. This system permits wire application through a small incision. It is a modular instrument, which consists of two dividable forceps with cannulated tubes that can be applied separately around the femur and connected together once around the bone (Fig. 1(a) and (b)). There are two sizes; the large size is used for the proximal or distal part of the femur and the small is used for the femoral shaft. The cerclage wire can be applied percutaneously as an adjunct to reduction or to provide additional fixation.

We describe how the use of this new percutaneous wiring technique helped facilitate the reduction of a periprosthetic femoral shaft fracture stabilized with minimally invasive plate osteosynthesis (MIPO) and a proximal femoral fracture treated with an intramedullary nail.

Case demonstration and surgical techniques

Case 1

An 84-year-old woman sustained a periprosthetic femoral shaft fracture after a simple fall. She had a total hip replacement 15 years ago with subsequent stem revision and strut grafting 8 years ago. This was followed by a total knee replacement 3 years later. She was able to walk with a walker before her injury. Radiographs demonstrated a spiral femoral shaft fracture distal to the femoral hip prosthesis that extended along the femoral shaft and exited just proximal to the knee prosthesis. There were no signs of loosening in either the hip or the knee prosthesis (Fig. 2(a)). The treatment plan consisted of closed reduction of the spiral fracture with two percutaneous cerclage wires and internal fixation with a locking compression plate (LCP) applied using MIPO techniques. It

* Corresponding author. Tel.: +66 53 945544; fax: +66 53 217144.
E-mail address: tapivath@gmail.com (T. Apivatthakakul).

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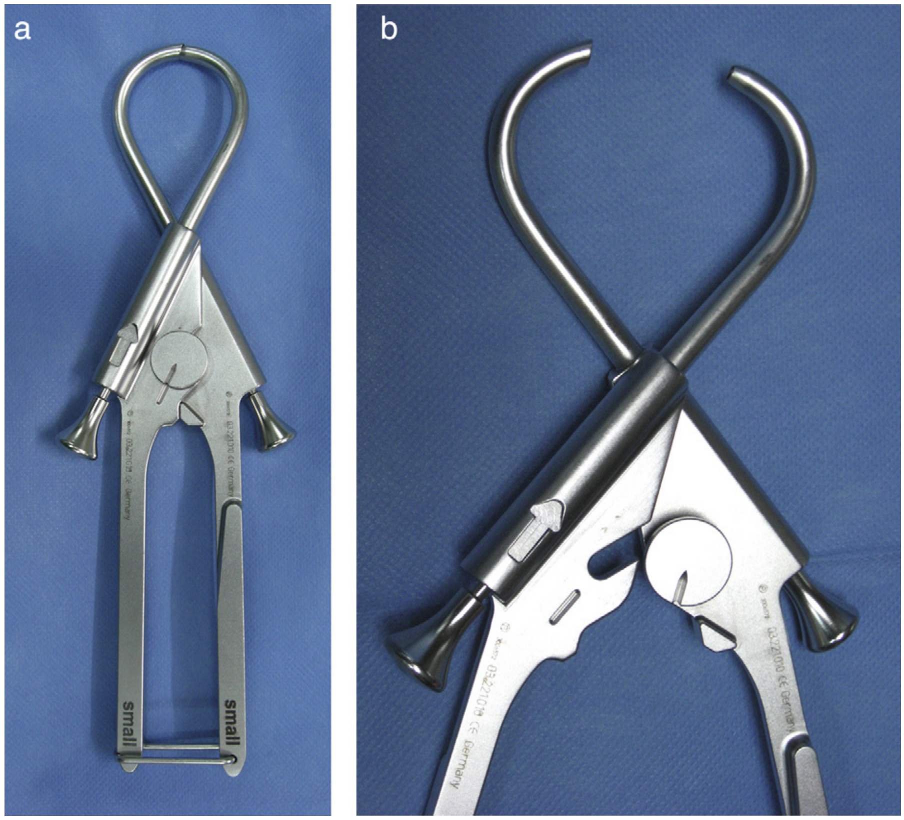

Fig. 1. (a) The percutaneous cerclage passer when closing the forceps, the tips will meet together. (b) The cerclage passer consists of a dividable forcep with the tube at the tip connecting in the middle flat part.

was planned to apply the first cerclage wire distally through an incision based over the lateral femoral condyle, later to be used during MIPO plating, and a second cerclage wire around the tip of the femoral hip prosthesis.

Positioning

The patient was supine on a radiolucent operating table. The contralateral lower limb was placed in the lithotomy position.

Preparing the cerclage tunnel

Preliminary reduction of the fracture by manual traction was needed. A 6-cm longitudinal incision was made over the lateral femoral condyle. A direct deep dissection to the lateral aspect of the femoral condyle was accomplished through a longitudinal split of the iliotibial tract and vastus lateralis. Preparation of the tunnel is necessary to facilitate the insertion of the cerclage passer. A tunnelling device was used to prepare the tunnels. It was carefully inserted both dorsally and ventrally around the femur (Fig. 2(b)). On the dorsal side, the tunnelling device has to penetrate the intermuscular septum as it inserts into the linea aspera. This is accomplished by slightly moving the tunnelling device proximally and distally to create a 2-cm hole. The tunnelling device can also be used as a reduction tool to manipulate the bone fragments.

Insertion of the cerclage passer

A trocar was placed in each tube of the cerclage passer to prevent soft tissue from entering the cannulated tubes. To ameliorate insertion through the incision, the forceps were initially connected together and manoeuvred down close to the femur. Thereafter, they were disengaged. One-half of the cerclage passer, marked with an arrow, was inserted dorsally through the prepared tunnel, the other half was inserted ventrally (Fig. 2(c)).

Connection and closure of the cerclage passer

The flat middle parts of the forceps were then connected. It is critical that the tips of the forceps are opened during connection (Fig. 2(d)). After being connected properly, the forceps were closed by bringing the ends of the handles together. Then they were subsequently secured by locking the bracket on the end of the forceps. The bracket must be closed without force. If the bracket cannot be closed easily, it means that the tips of the forceps are not meeting. Achieving the correct closed position can be aided with image intensification (Fig. 2(e)).

Insertion of cerclage wire

The trocars were removed from the forceps to allow a cerclage wire, of desired length, to pass. The correct one-way direction for insertion is marked with an arrow. The cerclage wire was then advanced through the cannulated tube with a plier in 1–2 cm increments to prevent kinking of the wire until the wire passed through the opposite side (Fig. 2(f)).

Removal of the forceps

The forceps were unlocked by opening the bracket and disconnecting both forceps. As one end of the wire was held with a plier, the opposing forcep was removed (Fig. 2(g)). Finally, before the tip of the wire comes out of the forcep it must be held with a plier to prevent it from recoiling. This helps reduce potential injury to the surgeon.

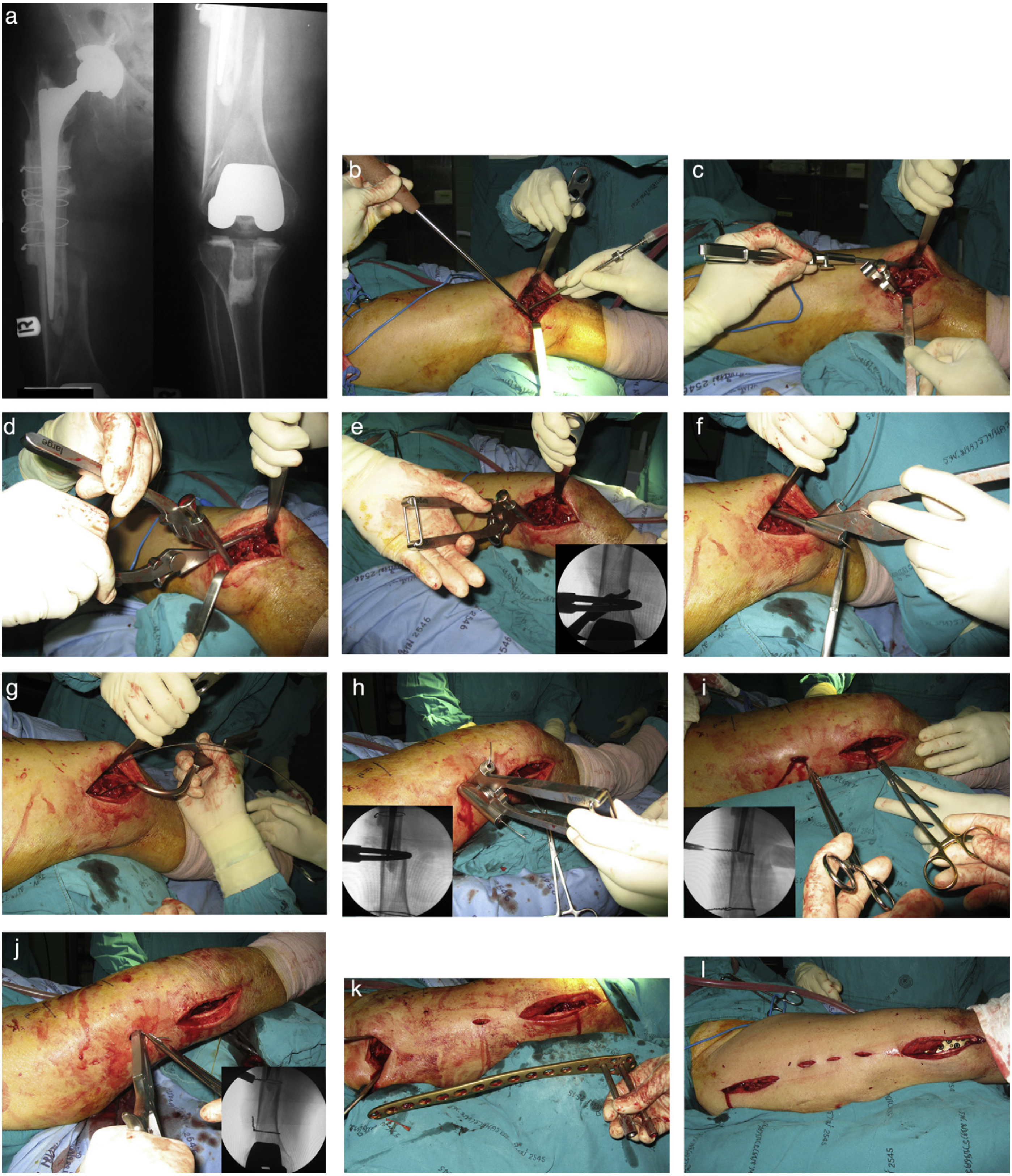

Fig. 2. (a) An 84-year-old woman sustained a periprosthetic femoral fracture below the hip prosthesis and above the knee prosthesis. (b) The tunnelling device passed dorsally through the intermuscular septum on the linea aspera. (c) The cerclage passer passed dorsally and ventrally at the distal part of the fracture. (d) The flat middle parts of the forceps were connected. (e) The tips of the forcep were closed and demonstrated by image intensifier. (f) Passing the wire through the tube until it come out the opposite side. (g) Remove the cerclage passer from both sides; the first wire loop was loosely tightened. (h) The cerclage passer being inserted through the second incision. (i) Tightening the wire loop to reduce the fracture. The X-rays showing the reduction of the fracture with the wire. (j) The wire was bent and cut with the percutaneous wire cutter. (k) The distal femoral LCP was inserted from the distal incision towards the proximal incision. (l) The incisions after complete fixation of the fracture. (m and n) The X-rays demonstrated the fracture healed after six months with a good clinical outcome.

Fig. 2. (*Continued*).

Reduction of the fracture

A second wire loop was passed through a 2-cm incision at the proximal part of the fracture using the same technique described above (Fig. 2(h)). Closed reduction of the fracture was done under an image intensifier by combining manual traction with different degrees of internal and external rotation of the leg until closure of the fracture gap was achieved. Meanwhile, the wire loops were sequentially tightened to provide a circumferential reduction force (Fig. 2(i)). Judged by the lack of cortical overlap or gap at the fracture site, proper length and rotation were achieved. Once reduced, wires maintained the fracture position.

Percutaneous cutting of the wire

A percutaneous wire cutter was designed for cutting the wire through a small incision. The cutter was slid into the incision over the wire until the tip touched the bone. The cutter was then pulled back 1.5 cm and used to bend the wire onto the cortex of the femur before being cut (Fig. 2(j)).

The spiral fracture was reduced and maintained with two wire loops. The fracture was then stabilized with a 13-hole distal femoral LCP (Synthes®) applied with the MIPO technique (Fig. 2(k) and (l)). After the pain subsided, early hip and knee range of motion was encouraged. Partial weight bearing with a 10–20 kg limit was allowed for 6 weeks and progressed to full weight bearing after 3 months. Fracture union was achieved by 6 months with a good clinical outcome (Fig. 2(m) and (n)).

Case 2

An 81-year-old woman sustained a comminuted unstable intertrochanteric fracture after a simple fall (Fig. 3(a)). The treatment plan was to achieve and maintain a closed reduction with a percutaneous cerclage wire and subsequently stabilize the fracture with a proximal femoral nail.

The patient was placed supine on the traction table with the body bent towards the opposite side. Intra-operative radiographs demonstrated the displaced proximal femoral fracture (Fig. 3(b)). A percutaneous cerclage wire was inserted through a 3-cm incision using the same technique described above (Fig. 3(c) and (d)). A wire loop was applied loosely for preliminary reduction. The reduction forcep and the periosteal elevator were used to manipulate and complete the fracture reduction (Fig. 3(e)). Thereafter, the wire was tightened to maintain the completed reduction (Fig. 3(f)). The time to achieve fracture reduction was 16 min. The fracture was then stabilized with a proximal femoral nail in the standard fashion (Fig. 3(g) and (h)).

Discussion

Various reduction techniques have been described to aid in reduction of difficult femoral fractures. Pape et al.[2] described intra-operative reduction techniques for such fractures. These included those employing external forces such as strategically placed bumps, the F tool and a crutch or percutaneous techniques with a ball spike pusher, bone hook, Schanz pins, joysticks, intramedullary pin or blocking screws. Oh et al.[1] used a nail to assist with reduction before percutaneously plating paediatric femoral fractures.

Cerclage wiring is a well-known procedure that aids reduction and fixation of fractures. It is an elegant technique that helps reduce and maintain the alignment of long oblique, spiral or spiral wedge fractures without obstructing definite fracture fixation with either a plate[3,4] or an intramedullary nail. However, cerclage wiring is normally performed through an open technique, which requires extensive soft-tissue dissection and periosteal stripping. As a result, the risk of complications including delayed union, nonunion, infection and implant failure is higher than when performed through closed means. Kim et al.[5] described a percutaneous wiring technique employed to maintain fracture reduction during the course of MIPO plating of distal femoral fractures. Their technique was performed through medial and lateral thigh incisions and employed an arthroscopic knot pusher with a bent end loaded with a 25-guage wire. They showed a marked reduction in radiation exposure. However, it requires two incisions and the medial incision has a risk of injury to superficial femoral vessels.

Percutaneous cerclage wiring for femoral shaft fractures accomplished through a single incision has not been described in the literature. The newly developed cerclage passer instruments, described in this article, offer not only the potential for percutaneous wire passage but also the ability to cut the wire through the same minimal incision. The radiation exposure is also markedly reduced.[5] Spiral, oblique and some wedge fractures can be reduced and maintained in a reduced position using this technique. Holding

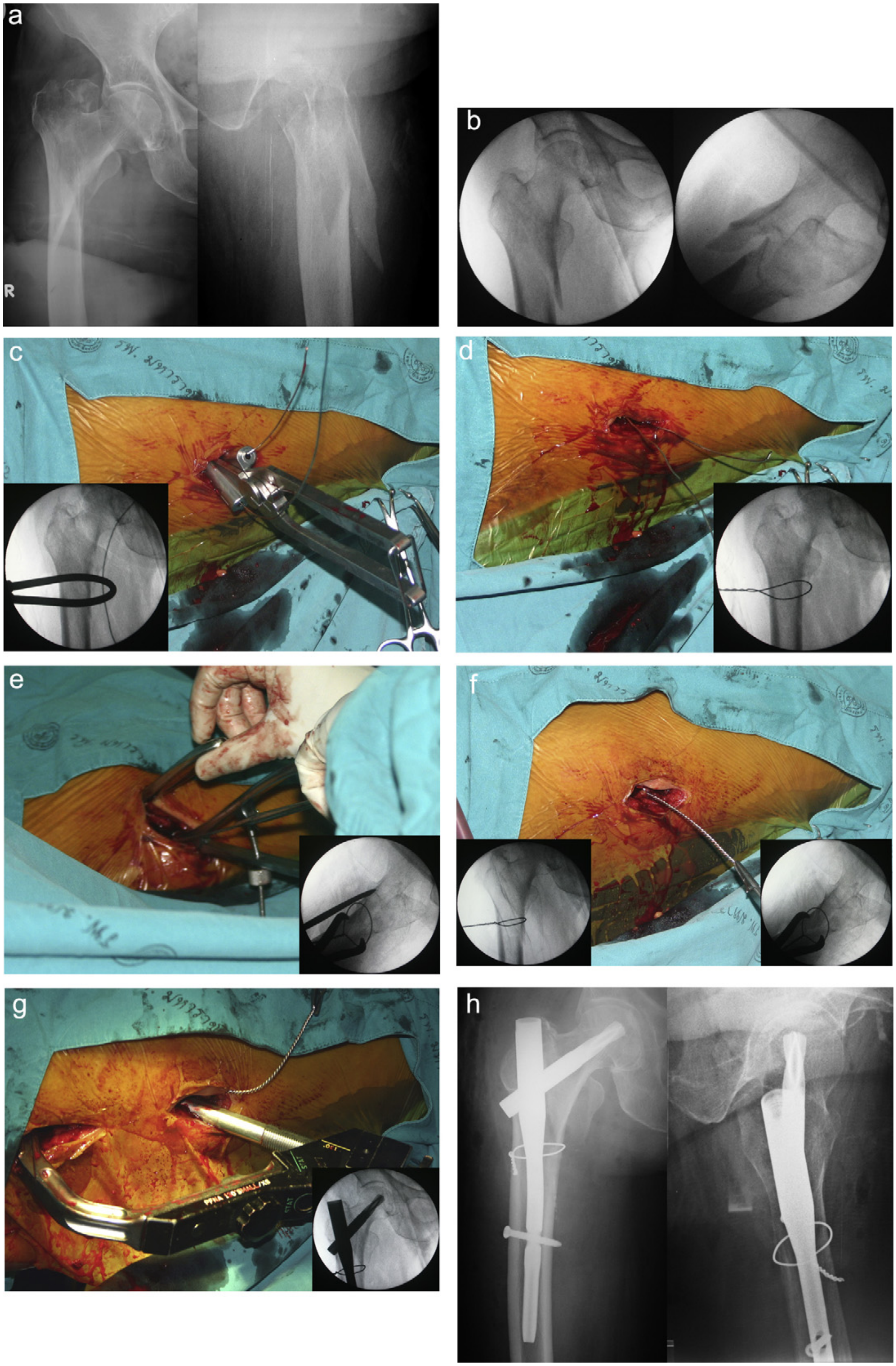

Fig. 3. (a) The X-rays of an 81-year-old woman with unstable intertrochanteric fracture. (b) Intraoperative X-rays demonstrated the displacement of the fracture. (c) The cerclage passer was inserted through a three cm incision at the central part of the fracture. (d) A wire loop passed around the fracture. (e) A periosteal elevator and reduction forceps were used to manipulate the fracture. (f) Complete reduction of the fracture by a single wire loop. (g) The fracture was stabilized with a proximal femoral nail using standard technique. (h) The postoperative X-rays showing the fracture fixation with good positioning of the implant.

femoral fractures in their anatomical alignment not only effectively prevents malreduction, but it also facilitates ease of definitive fixation. After cerclage wiring, using the MIPO technique on femur fractures[6,7] requires preparation of a submuscular tunnel, percutaneous plate insertion and plate fixation, all of which can easily be done through proximal and distal incisions. With intramedullary nailing, anatomical reduction of the fracture facilitates proper entry point selection. Proper nailing technique requires maintaining fragment reduction during guide wire insertion, reaming and nail insertion.[8] With the use of a small incision, our new technique can be employed to preserve perforator vessels and their anastomosis, which provide the blood supply to the periosteum around the femur. The disadvantage of this technique is its technically demanding nature. It must be done carefully to avoid serious injury to superficial femoral vessels.[9] Further study is required to elucidate the true biological effect of this technique on femoral blood supply.

Conclusions

Percutaneous cerclage wiring can be done by using the percutaneous cerclage passer instruments. It causes less soft-tissue injury and periosteal stripping than an open-wiring technique. It exists as an alternative adjunct, not only to helping achieve closed reduction, but also in maintaining reduction of difficult femoral fractures.

Conflict of interest

No conflict of interest is present.

References

1. Oh CW, Song HR, Jeon IH, Min WK, Park BC. Nail-assisted percutaneous plating of pediatric femoral fractures. *Clin Orthop Relat Res* 2007;**456**:176–81.
2. Pape HC, Tarkin IS. Intraoperative reduction techniques for difficult femoral fractures. *J Orthop Trauma* 2009;**23**:S6–11.
3. Berend KR, Lombardi Jr AV, Mallory TH, Chonko DJ, Dodds KL, Adams JB. Cerclage wires or cables for the management of intraoperative fracture associated with a cementless, tapered femoral prosthesis: results at 2–16 years. *J Arthroplasty* 2004;**19**:17–21.
4. Fishkin Z, Han SM, Ziv I. Cerclage wiring technique after proximal femoral fracture in total hip arthroplasty. *J Arthroplasty* 1999;**14**:98–101.
5. Kim YM, Yang JY, Kim KC, Lee HJ, Lee SR. Percutaneous temporal wiring method for minimally invasive plate osteosynthesis of distal femoral fractures. *J Trauma* 2009;**66**:938–41.
6. Krettek C, Schandelmaier P, Miclau T, Tscherne H. Minimally invasive percutaneous plate osteosynthesis (MIPPO) using the DCS in proximal and distal femoral fractures. *Injury* 1997;**28**(Suppl. 1):A20–30.
7. Apivatthakakul T, Chiewcharntanakit S. Minimally invasive plate osteosynthesis (MIPO) in the treatment of the femoral shaft fracture where intramedullary nailing is not indicated. *Int Orthop* 2009;**33**:1119–26.
8. Langford J, Burgess A. Nailing of proximal and distal fractures of the femur: limitations and techniques. *J Orthop Trauma* 2009;**23**:S22–5.
9. Aleto T, Ritter MA, Berend ME. Case report: superficial femoral artery injury resulting from cerclage wiring during revision THA. *Clin Orthop Relat Res* 2008;**466**:749–53.