Injury, Int. J. Care Injured 43 (2012) 1779–1782

Contents lists available at SciVerse ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Case report

The use of an interference fit retrograde nail as an adjunct to plate fixation of a complex Vancouver B1 periprosthetic femoral fracture

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ARTICLE INFO

Article history:
Accepted 13 June 2012

As the number of hip arthroplasties performed continues to grow, increasingly complex periprosthetic fractures are encountered. In particular, fractures occurring near the tip of a well-fixed stem, classified as Vancouver B1, have been associated with high rates of failure.[1,2] Numerous treatment strategies have been recommended including traditional plating, locked plating, cortical allografts as well as retrograde nails overlapping the femoral stem tip.[2–6] The latter technique has been advocated as a less invasive method to stabilise periprosthetic fractures in elderly, low-demand patients unfit for extensive surgical procedures.[3] Here, we present the use of a retrograde nail overlapping a femoral stem in a young, active patient as supplemental fixation to a lateral plate for the difficult situation of a Vancouver B1 periprosthetic fracture proximal to an femoral shaft hypertrophic nonunion.

Case report

The patient is a 59-year-old, obese, non-smoking female with a history of hypothyroidism and osteoporosis, who was informed that her case would be submitted for publication and agreed to this. The patient's complex orthopaedic history began with a closed, segmental, femoral-shaft fracture treated with locked piriformis entry intramedullary-nail fixation 6 years prior. The proximal fracture united; however, the distal fracture resulted in hypertrophic nonunion. Nail dynamasation was unsuccessful in achieving union; however, her symptoms remained mild and further treatment by the referring surgeon was not pursued.

Five years later, the patient sustained a low-energy fall resulting in a displaced femoral-neck fracture in close proximity to the piriformis entry nail. The patient was treated with nail removal, insertion of an uncemented total hip arthroplasty, compression plating of the femoral-shaft nonunion and autogenous femoral-head graft to the nonunion site. The plate overlapped the femoral stem by ~10 cm.

Six months later, the patient sustained another low-energy fall resulting in a new Vancouver B1 fracture 2.5 cm distal to the femoral stem tip. The fracture occurred immediately proximal to the most proximal bicortical screw, with the plate pulling the two proximal unicortical locked screws from the bone. The femoral stem and distal-plate fixation remained stable. As this new fracture occurred due to the stress-riser between the proximal most bicortical screw and the femoral-stem tip, the decision was made to treat this fracture with the same plate employing more robust proximal fixation. The new fracture as well as the nonunion site was augmented with the off-label use of Bone morphogenetic protein 2 (BMP-2) (Infuse, Medtronic, Minneapolis, MN, USA).

Eight weeks later, the patient noted increased thigh pain and swelling without history of interim trauma or weight bearing. Plain radiographs revealed breakage of the plate at the level of the periprosthetic fracture (Fig. 1(a) and (b)).

Given the complexity of the patient's situation, the operative plan included the use of a retrograde nail overlapping the femoral stem to augment a locked plate, thus maximising the stability of the fractures. For this procedure, the patient was placed supine on a radiolucent operating table with a bump under the hip. A lateral approach to the femur was extended into a lateral parapatellar arthrotomy, and the hardware was removed. The femoral stem was noted to be well ingrown. The distal end of the proximal femoral fragment was manipulated to allow retrograde insertion of a 12.5-mm inner-diameter trephine reamer. This size trephine was selected based on the known outer diameter of the femoral stem. The trephine cleared bone circumferentially around the stem for a distance of 3 cm. Next, a 14-mm Synthes Universal Femoral Nail was cut and impacted to trial the fit over the stem tip. The nail size was selected to match the known size of the stem tip. In addition, the Universal Nail was employed as it is a slotted nail that allows expansion for an interference fit around the tapered stem. The nail was then removed, and attention was turned to the distal femur.

Using fluoroscopy, a standard approach for a retrograde nail was performed. With the fracture reduced, a distance of 240 mm was measured from the estimated proximal overlap of the femoral stem to the distal anticipated extent of the retrograde nail. The nail was then cut to 240 mm and carefully impacted in retrograde

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http://dx.doi.org/10.1016/j.injury.2012.06.010

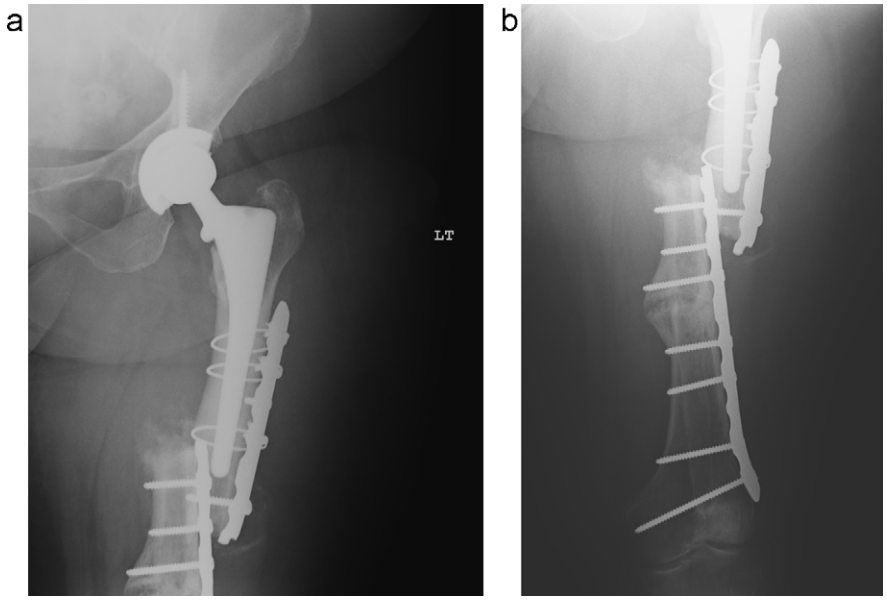

Fig. 1. (a) AP hip radiograph with periprosthetic nonunion and plate failure. (b) AP femur radiograph with periprosthetic nonunions and plate failure.

fashion across the reduced fractures, achieving 2.7 cm of stem overlap.

Next, attention was turned to placement of the 16-hole Synthes Locked Condylar Plate. As the laterally inserted distal interlocking bolts for the nail would interfere with the seating of the plate on the bone, their insertion was planned to be placed through the plate. To achieve this, the holes for the distal interlocking bolts were drilled with the perfect-circle technique prior to placing the plate. k-Wires were then inserted into the holes, and the plate was guided over these wires. The wires were removed, and plate was then secured with a combination of locking and non-locking screws and cerclage wires (Fig. 2(a) and (b)). Cancellous iliac crest bone was then harvested and placed at both fracture sites.

Radiographic and clinical union of both fractures occurred by 6 months, and the patient was progressed to full weight bearing. At 2 years of follow-up, the patient walks without assistive device and performs all of her own activities of daily living (Fig. 3(a) and (b)).

Discussion

The success of hip arthroplasty has resulted in increasing numbers being performed each year. Paralleling this increase, periprosthetic fractures are occurring with more frequency and complexity.[7]

Vancouver B1 fractures, or fractures around the femoral stem tip with a stable prosthesis, have been identified as a risk factor for failure after fracture treatment.[1,8] Numerous methods have been advocated in the treatment of these fractures; however, plate fixation employing screws and/or cerclage cables

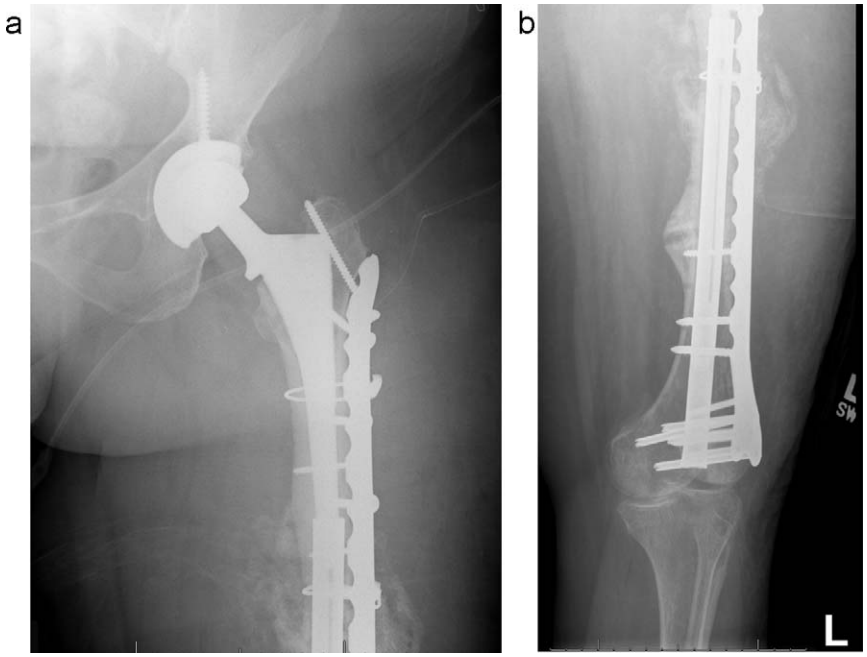

Fig. 2. (a) AP hip radiograph depicting the proximal plate fixation and the interference fit of the retrograde nail with the femoral stem. (b) Oblique radiograph of the knee depicting the distal plate fixation and interference fit of the retrograde nail with the femoral stem.

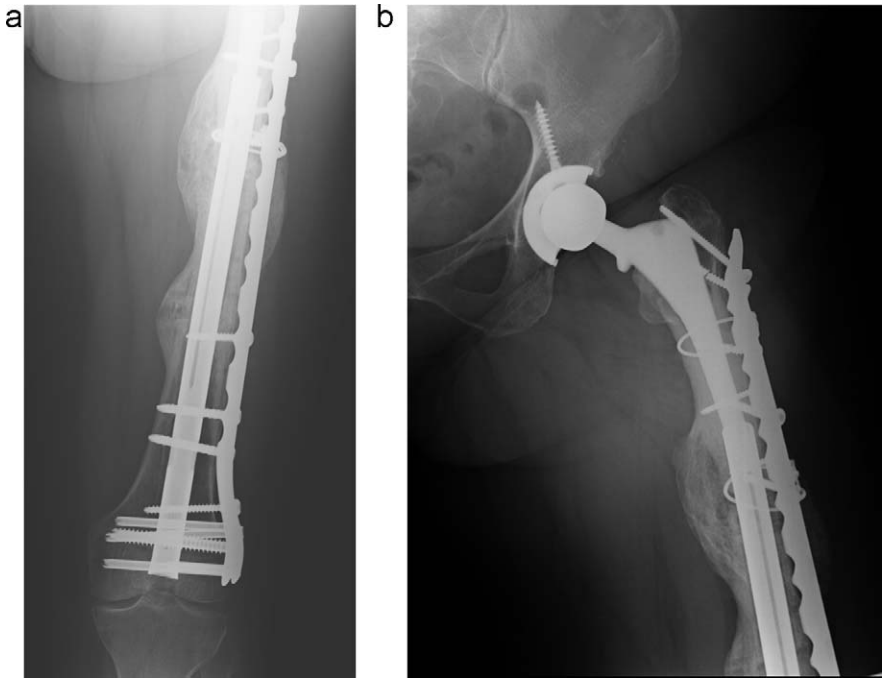

Fig. 3. (a) AP hip radiograph of healed fracture. (b) AP distal femur radiograph of both healed fractures.

through either an open or closed reduction has been used most often.

A retrograde femoral nail overlapping the femoral-stem tip has been used by some as an alternative to plate fixation for periprosthetic fractures with stable femoral stems and was first described in a case report by Verburg.[5] Several additional series have reported the success of this technique when used as the sole fixation construct in elderly, low-demand patients unfit for extensive surgery.[4–8] A follow-up biomechanical study by Zuurmond et al. found that this construct achieved a stable connection with the femoral stem and was able to resist high repetitive loads representative of full weight bearing.[9]

To our knowledge, this is the first report of a retrograde nail overlapping the femoral stem used in combination with plate fixation for the treatment of a complex Vancouver B1 periprosthetic fracture with ipsilateral femoral-shaft nonunion in a young, active patient. Given the patient's co-morbidities and numerous prior surgeries on the femur, maximal stability at the fracture sites was desired. The combination of both intramedullary and extramedullary fixation was felt to offer the best opportunity to heal the periprosthetic nonunion, protect the healing hypertrophic nonunion and minimise stress risers while maintaining the well-fixed femoral stem and thus preserving bone stock.

While the technique has been previously described, a few technical considerations should be emphasised. First, the size of the femoral-stem tip should be known preoperatively to allow for the availability of appropriately sized intramedullary nails and trephines. In addition, it must be remembered that a laterally based plate will not seat on the bone if the locking bolts are inserted through the nail prior to plate fixation. We used a technique of predrilling the path for the locking bolts, placing k-wires along the bolt paths and then guiding the plate over the k-wires so that the locking bolts can be placed through the plate and nail.

Another factor to consider is the amount of stem–nail overlap. Prior clinical series have reported successful results when greater than 3 cm of stem–nail overlap was used. Zuurmond et al. reported a stable stem–nail connection in a biomechanical model when 2.9–3.5 cm of overlap was achieved.[9] They also referenced in their discussion an unpublished pilot study from their laboratory that found 1.5 cm of overlap to be too small to generate a stable connection and recommended at least 2 cm of overlap.[9] The 2.7 mm of stem–nail overlap in our case represents the shortest overlap reported to date; however, the presence of the plate construct precludes a direct comparison to the prior cases. Factors such as the stem design, length, width, bone quality and nail design likely affect this variable and is area for further research. In addition, the consequence of the stress transfer from the nail to the stem tip on the long-term outcome of the arthroplasty is currently unknown.

With this report, we sought to highlight retrograde femoral nailing to obtain nail–stem overlap as a useful treatment adjunct to plating for complex periprosthetic fractures in younger, more active patients. We feel this technique offers increased stability while preserving bone stock, avoiding a long-stem revision and minimising stress risers. We maintain that the vast majority of Vancouver B1- and C-type fractures can be successfully treated with traditional plating techniques. However, surgeons should be aware of retrograde nailing as an option that can achieve success when applied in selected clinical situations.

Conflict of interest

None declared.

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