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ORTHOPAEDIC SURGERY

Conservative treatment after failure of internal fixation for periprosthetic femoral fractures: a report of two cases

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Abstract Osteosynthesis using compression or locking plate following indirect fracture reduction and using a minimally invasive technique has been recommended for the surgical treatment of Vancouver B1 and C periprosthetic femoral fractures. Recent advancements in fracture healing emphasize the significance of the type of mechanical stability depending on fracture patterns and the importance of the preservation of the blood supply around the fracture sites. We report two cases of mechanical failure after internal fixation of periprosthetic femoral fractures despite adherence to the principles of fracture care. Both patients were treated conservatively with a thigh cuff cast due to other concurrent issues. Bone healing was successfully achieved in both cases as a result of the preservation of the tissues and the biology around the fractures during the initial operations. We present our experiences of conservative management together with the preservation of the biology around the fracture site, as viable alternative options for difficult and traumatic revision surgery in cases of failed periprosthetic fracture fixation procedures.

Keywords Periprosthetic fracture · Vancouver classification · Thigh cuff cast

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Introduction

The choice of surgical treatment for Vancouver B and C periprosthetic femoral fractures usually depends on the stability of the femoral stem [12]. Replacement of the femoral component with a long porous-coated cementless stem is recommended if the femoral stem is loose such as those in B2 or B3 type fractures. However, open reduction and internal fixation using cerclage cables and locking plates can be considered (such as those performed in B1 and C type fractures), since removal of the stable fixed femoral stem may require a long operation time, possible bone loss, significant blood loss, and a greater chance of complications [1, 3, 9, 11]. Nevertheless, open reduction and plate fixation for Vancouver B and C periprosthetic femoral fractures are also technically demanding procedures. In simple fracture patterns, compression of the fracture site and protection plating or compression plating can be considered following the anatomical reduction of the fracture. Skin incision for reduction and fixation of femoral fractures usually spans almost to the entire femoral length and requires many hours of hard work for the surgeon and results in significant surgical trauma for the patient. Devastating complications may follow this difficult procedure including implant failures after the initial operation. The Vancouver B1 periprosthetic fracture has a higher risk of failure compared to the other types of fractures with a failure rate of 33.9 % after plate fixation alone and 43.9 % after cerclage [7]. Reoperation including metal removal and refixation of the fracture is more traumatic than the initial fixation or even revision with a long femoral stem. We present two cases of implant failures occurring after the fixation of the Vancouver B1 and C periprosthetic fractures with expansion of the locking plate across the entire femoral length. Corrective procedures using another

plate and screws were recommended but both patients refused due to old age and personal reasons and opted instead, for conservative treatment. Successful union was achieved in both cases. We recommend conservative treatment as an alternative option in failed periprosthetic fracture fixation procedures.

Case 1

A 76-year-old man reported left thigh pain after a simple fall. Total cementless total hip arthroplasty with polyethylene cup had been performed on the left hip after a failed femur neck fixation 20 years previously. A transverse fracture was noted at the tip of the femoral stem with a small, comminuted fragment along with some osteolysis around the acetabulum and femur (Fig. 1a). Although there were no signs of cup or stem loosening or no previous hip or thigh pain, there was some osteolysis around the acetabulum and the femoral stem. We recommended replacement of the polyethylene liner along with revision with long femoral stem. However, the patient and caregivers both opted for fracture fixation only.

Under general anesthesia, the patient was placed in a lateral position on the radiolucent table. Skin incision and soft dissection were performed on the proximal femur, and a 17-hole locking compression plate (4.5-mm Broad LCP Plates; Synthes, Oberdorf, Switzerland) was inserted through the proximal window to the distal femur. Indirect

reduction was performed with gentle traction, a tap under the thigh to correct sagittal alignment, and the use of a prebended plate. Acceptable reduction was confirmed after temporary fixation of the fracture with the drill bit through the drill sleeve. Unicortical locking screws, additional cerclage cables, and a 3.5-mm locking attachment plate (Synthes, Oberdorf, Switzerland) were used for the fixation of the proximal fragment that was already occupied by the femoral stem. The distal segment was fixed with locking screws using the percutaneous technique (Fig. 1b) carefully avoiding exposure of the fracture site to preserve the soft tissue around the fracture site (Fig. 1c). Postoperative radiographs showed slight valgus alignment at the fracture site with a medial gap, but the reduction with a bridging plate was otherwise acceptable.

We allowed the patient to exercise immediate motion of the joint with the postoperative weight-bearing restriction. Low-intensity pulsed ultrasonography (LIPUS) was applied to enhance the bone healing because of the fracture comminution and the patient's age. However, after the third postoperative month, sudden onset of thigh pain was reported without any noticeable trauma. Although some callus was noted around the fracture site, the plate was broken with accompanying varus angulation (Fig. 2a). The patient refused the recommended surgical management for the implant failure. LIPUS was continued and the fracture was protected with a cast. The thigh cuff cast was applied from the inguinal area to the femoral condyles with emphasis on molding around the both medial and lateral
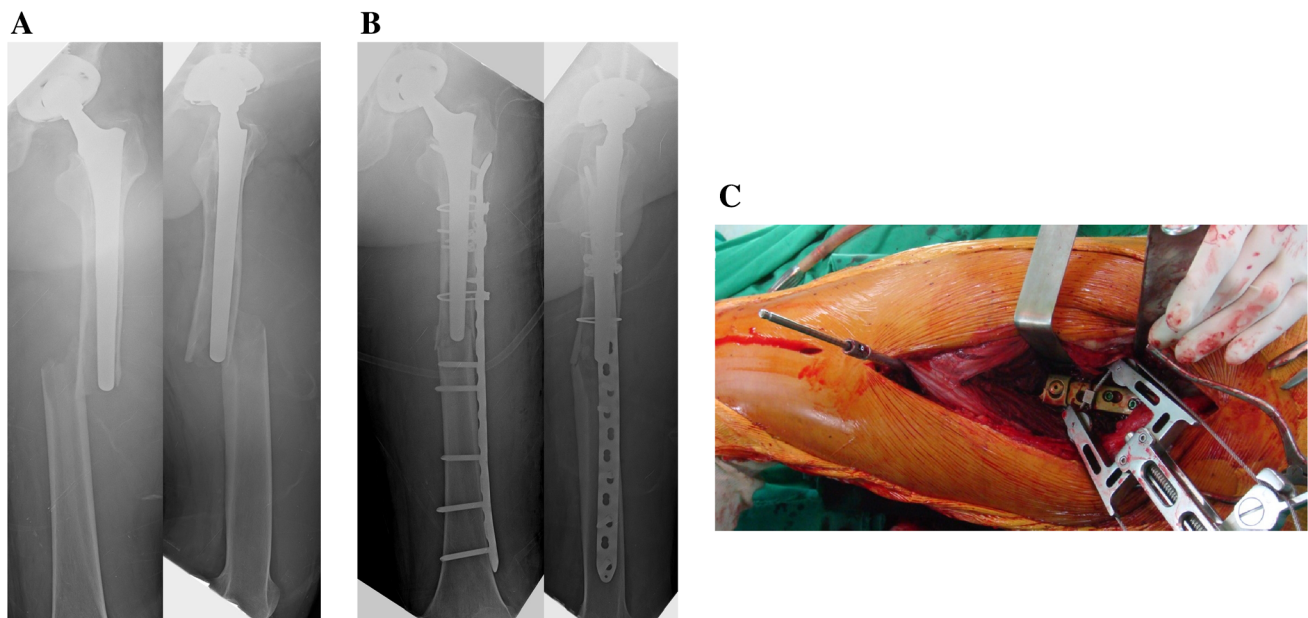

Fig. 1 Vancouver B1 periprosthetic fracture in a 78-year-old man. **a** Plain radiographs showed complete displaced femoral fracture at the tip of femoral stem without loosening. **b** Long locking plate was fixed using the 3.5 locking attachment plate and cerclage cable for the proximal segment. **c** Direct exposure and manipulation of the fracture was avoided to preserve blood supply around the fracture site
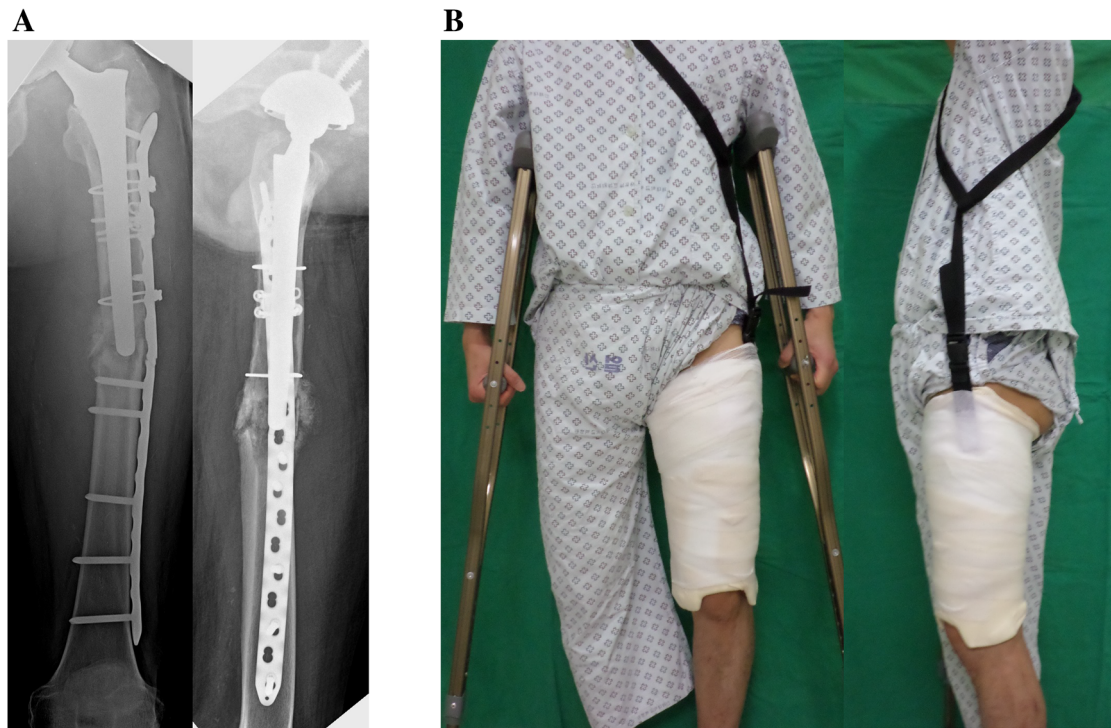
Fig. 2 **a** Plain radiographs at 3 months postoperative showed plate breakage at the fracture site, without significant fracture displacement in the presence of callus formation. **b** The thigh cuff cast was applied as a conservative treatment

condyle to prevent the cast from slipping down distally, as well as flattening of the proximal thigh and molding of the adductor muscle to prevent cast rotation. Hip and knee hinges were not applied, but a shoulder strap was applied to prevent the cast from slipping down (Fig. 2b). Two months

after implant failure, more callus was noted and the cast was changed to a thigh cuff brace (Fig. 3a). Four months after the implant failure, solid union with abundant callus was achieved despite the development of some anterior angulation (Fig. 3b).
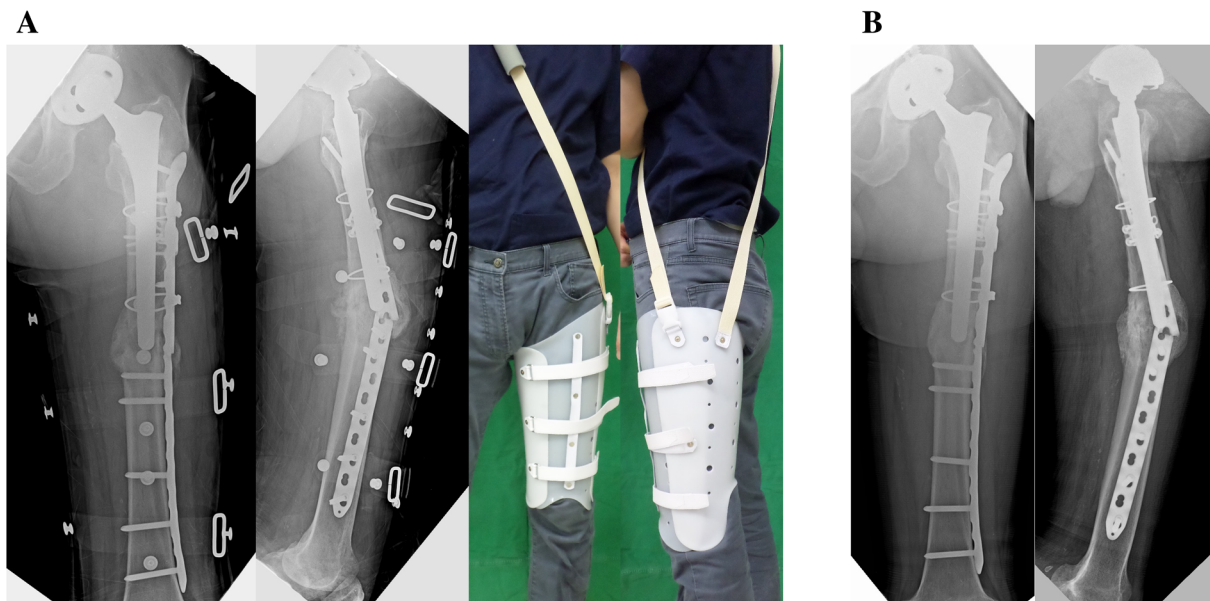

Fig. 3 **a** Two months after the implant failure, more callus could be seen and the cast was changed to a thigh cuff brace. At 7 months post injury, anterior angulation had progressed but solid union of the fracture was still obtained

Case 2

A 56-year-old man had cementless total hip replacement performed on the right femur due to avascular necrosis of the femoral head 10 years ago. Two months prior to admission, a periprosthetic femoral fracture occurred after a motorcycle traffic accident. The fracture was about 5 cm distal to the tip of the stem and almost transverse with a small butterfly fragment on the medial side. Open reduction and internal fixation of the femur with cables and short plate and screws was performed. Implant failure of the femur occurred at the fracture site, while the patient was using crutches and the patient was transferred to our hospital for further management (Fig. 4a). Refixation of the fracture was planned after removal of the broken plate along with autogenous bone graft from PSIS, but the patient refused the autogenous bone grafting. Sclerotic bones were revealed intra-operatively around the fracture site, so debridement was performed until we could find healthy cortical margins with bleeding. During the operation, we tried to preserve the soft tissue envelope around the fracture site that had already been damaged by injury and a previous operation. Instead of using a large reduction clamp for the fracture reduction, small footprints were left around the fracture site. A 3.5-mm locking plate (3.5-mm LCP Plates, Synthes, Oberdorf, Switzerland) was used as a temporary reduction tool on the posterolateral side using an indirect reduction technique. For the definite fixation, a 16-hole locking compression plate (4.5-mm Broad LCP Plates; Synthes, Oberdorf, Switzerland) was used as a long bridging plate. Proximal fixation was performed using unicortical locking screws, cables, and a 3.5-mm locking attachment plate (Synthes, Oberdorf, Switzerland). Four locking screws were fixed on the distal segment and a chip bone allograft was grafted around the fracture site. Postoperative radiographs showed good fracture alignment with a medial cortical gap noted after the removal of sclerotic bone (Fig. 4b).

Although the patient was discharged 2 weeks postoperatively and instructed to conduct partial weight bearing, implant failure of the femur occurred, while he was lying down in bed (Fig. 5a). Refixation of the fracture was performed the following day with a long locking plate as well a bigger additional plate than the previously utilized reduction plate and screws but using the same technique (Fig. 5b). The patient was allowed to ambulate with partial weight-bearing of his operated lower limb on discharge and he discharged unevently. However, he returned to the outpatient clinic 6 weeks later complaining of pain. Plain radiographs showed a broken plate at the fracture site with angulation and some signs of callus or consolidations of the previous allograft (Fig. 6a). Reoperation was suggested but the patient refused any further surgery. We recommended a thigh cuff cast with LIPUS but only a thigh cuff cast was applied because the patient also refused LIPUS treatment. Callus development was seen 3 weeks later and the pain

Fig. 4 Vancouver C periprosthetic fracture in a 56-year-old man. **a** Implant failure developed after open reduction and internal fixation for periprosthetic femoral fracture. **b** Long locking plate fixation was carried out with minimal intraoperative soft tissue damage
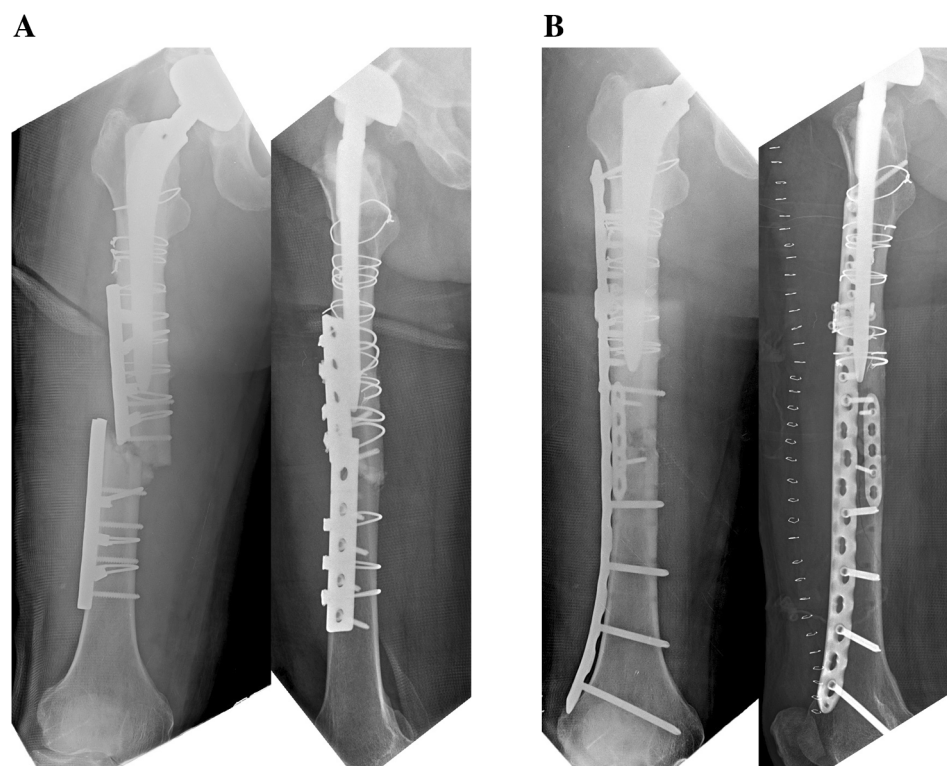
Fig. 5 **a** At 4 weeks postoperative, locking plate breakage developed at the fracture site without noticeable trauma. **b** Refixation of the fracture was performed with the long locking plate and an additional plate using the same technique
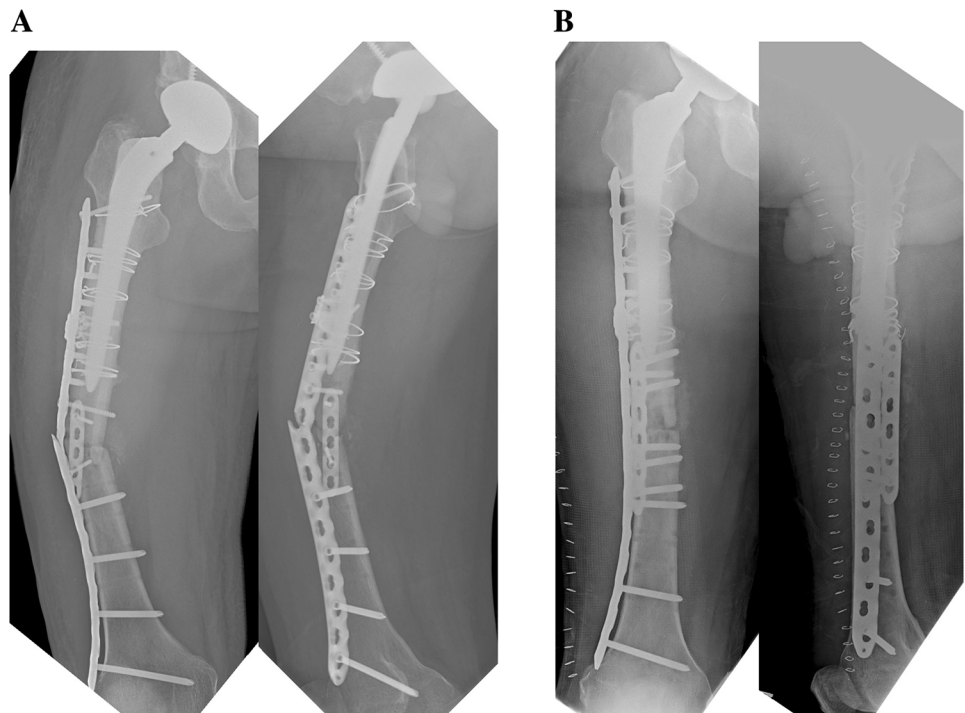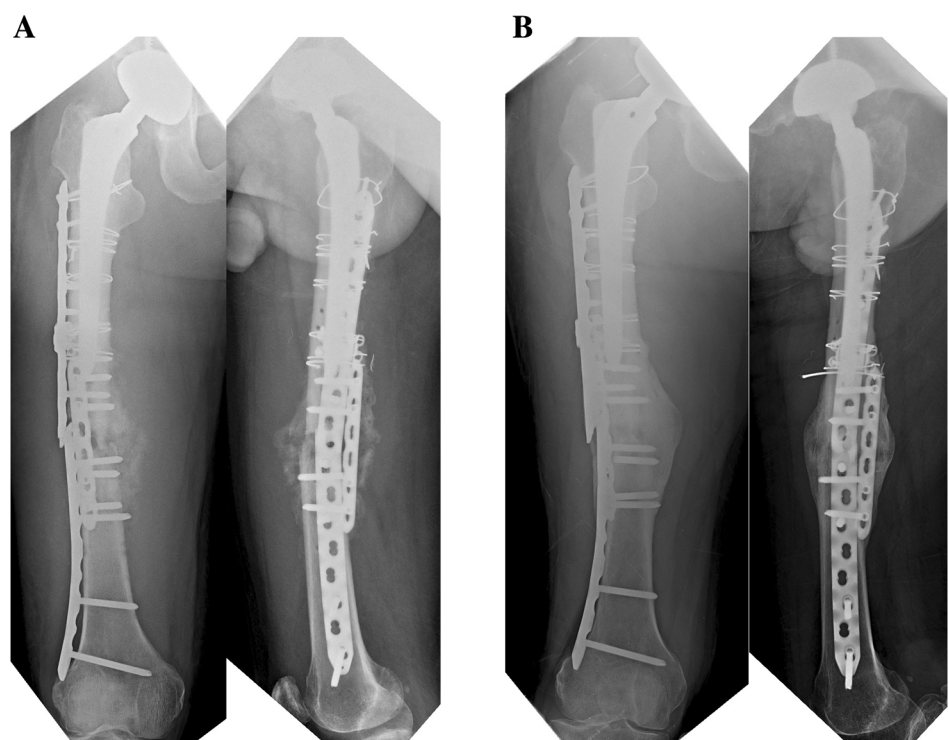

Fig. 6 **a** The patient returned to the outpatient clinic 6 weeks later complaining of pain. Plain radiographs showed a broken plate at fracture site with some signs of callus formation or consolidation of the previous allograft. **b** The radiographs at the last follow-up showed solid bony union after conservative treatment with the thigh cuff cast

subsided with time. The thigh cuff cast was removed after 2 months with confirmation of union. Four months after the last implant failure, solid union with abundant callus and full ranges of motion on both hip and knee joints were achieved (Fig. 6b).

Discussion

The Vancouver group consolidated the three most important issues in periprosthetic fracture of the femur, which are: fracture location, implant stability, and bone quality.

They have created a reliable and valid femoral fracture classification system [11]. The treatment of periprosthetic fracture with unstable stem requires complex revision arthroplasty, but periprosthetic fractures with well-fixed stems can be managed effectively using osteosynthesis principles [9]. However, strict application of the fracture treatment principle is required. Management is more difficult compared to that of simple femur fractures because the presence of a metal stem rules out intramedullary fixation. This makes plate and screw fixation difficult and the presence of cement may obstruct anatomic reduction and make osteosynthesis strictly dependent on the periosteal blood supply [8].

To provide enough stability on the proximal fragment that contains the femoral stem, newer devices such as the 3.5-mm locking attachment plate or various cable systems have been introduced as alternative options in combination with the locking plate. Mechanical stability should be combined with a well-preserved blood supply around fracture site as well as meticulous dissection and handling of the soft tissue to obtain a successful result. Therefore, the current recommendation in the management of periprosthetic fractures around a well-fixed total hip arthroplasty is the use of either compression or locking plate fixation following indirect fracture reduction using a minimally invasive technique [9]. In retrospect, after conforming to these principles of fracture care in difficult periprosthetic femoral fractures, we found the main cause of the implant failure at the fracture site.

The Vancouver B1 fracture had a higher failure risk compared to the Vancouver B2 fracture because the surgeons misinterpreted the stability of the stem and classified a Vancouver B2 as Vancouver B1 fracture, and which was subsequently treated surgically with plate fixation without revision of the stem [7]. In the first case, therefore, we were supposed to perform a plate fixation with exchange of the polyethylene liner along with the revision of the long femoral stem because of periprosthetic fracture with some osteolysis around the stem. Postoperative radiographs of the two cases showed a medial gap at the fracture site and the distance between the proximal and distal screws near the fracture site was too close, which could act as a stress riser on the plate at the fracture level in relatively simple transverse fracture patterns. Of course, we can choose the implant between compression plate and locking plate but that does not mean the only extreme one side option. Although we chose the locking plate, we should have made compression on fracture site to increase successful rate because implant should cover the whole strain and fracture healing would be delayed without compression on fracture site, especially simple transverse fracture like our two cases. Therefore, we think that we could get the unions

after auto-dynamization by breaking the implants. Moreover, both procedures were at risk of implant failure due to a variety of reasons including hidden infections, inappropriate postoperative care, and significant trauma on the operative site.

In the event of an implant failure, reoperation is difficult because this would involve a very traumatic surgery requiring a large incision, considerable blood loss, and a long anesthetic time. In our cases, we had planned to remove the broken plate and perform revision surgeries involving autogenous bone graft, but the patients refused another potentially traumatic surgery and opted for less invasive treatments. Conservative treatment is a viable option in cases with a stable prosthesis [6]. A previous study treated patients conservatively with bed rest and traction for 6 weeks [10]. However, such treatment bears the risk of pulmonary and thromboembolic complications as well as the development of decubitus ulcers in elderly patients. Although mechanical failure occurred in both cases, the fractures were only slightly displaced and angulated; there were visible callus formation around the fracture sites, suggesting that the biology around the fractures were well preserved. Therefore, we decided to apply well-molded thigh cuff casts to both patients and recommended partial weight bearing with bilateral crutches.

The first patient had been using LIPUS since the initial fracture and this was continued after the implant failure [2, 4]. The use of LIPUS might have helped union but this is very difficult to prove since in only one case. Although the second patient refused LIPUS due to financial reasons, union still occurred. Furthermore, LIPUS can be beneficial only in accelerating the time to radiological and clinical union not in reducing the incidence of nonunions [5]. Therefore, we could suggest LIPUS might have helped in fracture union but it is not the only reason for success. Since the mainstay of the treatment was cast application, both fractures healed through secondary bone formation resulting in abundant callus formation [8].

Conclusion

Failed osteosynthesis after implant failure in periprosthetic fracture would be a serious complication for both surgeon and patient and would necessitate a more energy consuming procedure. However, successful bone healing occurred in both cases, which might have resulted from the preservation of the biology around the fractures at the initial operations. Thus, we would like to recommend conservative treatment as an alternative option in failed periprosthetic fracture fixation with preservation of the biology around fracture site instead of difficult and potentially traumatic revision surgery.

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