Case Report

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Multiple failures of internal fixation for treatment of periprosthetic femoral refracture: a case report and literature review

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Abstract

We herein report a case involving three failures of internal fixation after periprosthetic femoral fracture (Vancouver type B1). The patient had low bone mass (T-score of −1.7) and was overweight (body mass index of 28.7 kg/m^2) but had no sign of femoral stem loosening. The first open reduction with internal fixation was performed according to the recommended treatment. Unexpectedly, three treatment failures subsequently occurred, after which the patient finally attained endurable walking activity. A literature review indicated that the intrinsic biomechanical problems of Vancouver B1 fractures have not been thoroughly addressed. Choosing the correct surgical strategy for Vancouver B1 fractures is essential to avoid complications and ensure healing. A sufficient locking plate and cable system should be used after the first failure if revision was not performed the first time.

Keywords

Total hip arthroplasty, periprosthetic femoral fracture, internal fixation failure, Vancouver B1, reoperation, bone mineral density

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Introduction

The demand for total hip arthroplasty (THA) has greatly increased in recent years.[1] Most patients attain excellent hip function; however, some patients, especially elderly patients, develop complications.[2] Periprosthetic femoral fracture (PFF) is

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one such complication and is a common cause of early reoperation.[3] An epidemiologic study showed that postoperative PFF occurred in 3.5% of patients in the long-term follow-up after THA and increased to 7.7% when an uncemented stem was used.[4]

PFF is difficult to manage in patients with poor bone quality and periprosthetic bone loss. Additionally, it can result in various comorbidities and dysfunctions.[5] Although many treatments have been described, the most effective treatment has not been established.[6,7] Cerclage wire techniques are widely used and produce satisfactory results.[8]

We herein describe a patient who developed a PFF and experienced three subsequent internal fixation failures. We also present a literature review of relevant reports.

Case presentation

A 67-year-old man with a body mass index of 28.7 kg/m^2 had experienced hip pain for more than 5 years. He had developed both aseptic necrosis of the femoral head and hip arthritis and therefore agreed to undergo THA with ideal positioning of the prosthesis (Figure 1). The prosthetic femoral stem was a No. 12 CORAIL Stem (Johnson & Johnson Medical Devices, New Brunswick, NJ, USA). The Dorr femoral bone classification was type A, and the T-score of bone mineral density was −1.7. The patient underwent rehabilitation from partial to full weight bearing in 1 to 5 days. PFF occurred by a fall about 2 months after THA, and the patient subsequently underwent three failed open reduction with internal fixation (ORIF) procedures. The timeline of the failed procedures is shown in Figure 2. The PFF was classified as a Vancouver type B1 fracture (Figure 3(a)). The first ORIF involved the use of a locking plate with cable system and was performed 3 days after the fracture. Implant failure occurred upon partial weight bearing, and the patient reported lateral hip pain 2 days after the first ORIF procedure (Figure 3(b)). The second ORIF procedure involved multiple cables at the proximal end and was performed 2 days after the first failure (Figure 3(c)). The patient recovered his activities of daily living, but an internal plate fracture occurred 3 months after the second ORIF procedure (Figure 3(d)). The third ORIF procedure involved a locking plate and cable system and was performed 2 days after the second fracture (Figure 3(e)). The patient's rehabilitation involved delayed weight bearing after 2 weeks of bed rest. Ultimately, we found that the internal failure had been caused by

Figure 1. Preoperative and postoperative radiographs of total hip arthroplasty.

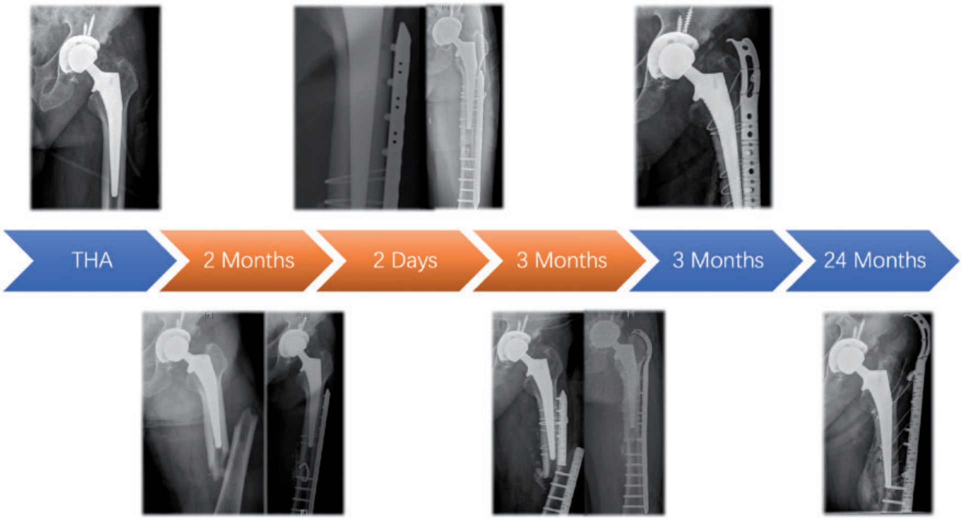

Figure 2. Timeline of treatment failure.

proximal cable cut-out in which the cable had cut into the bone and stopped because the stem was metal on the medial side. Additionally, malunion and hypertrophic osteogenesis were found at the fracture site (Figure 3(f)). At 12 months after the third ORIF procedure, the patient had a Harris hip score of 69 and a Medical Outcomes Study 36-Item Short Form Survey score of 75 (Figure 4).

Discussion

PFF is a critical and clinically challenging issue after THA. The incidence of PFF ranges from 0.9% at 5 years to 1.7% at 10 years and may reach 3.5% at 10 years after primary THA.[4,9] Treatment of PFF is associated with a high rate of failure due to nonunion and refracture. The treatment outcome depends on the bone quality, status of the prosthesis, location of the fracture, and type of prosthesis.[10] Treatment of re-PFF is negatively influenced by various factors including bone quality, stem loosening, previous surgeries, patient age, and comorbidities.[11]

The Vancouver classification of PFF is used to classify fractures and guide treatment.[12] This classification system subdivides PFF after THA into type A (fracture of the greater or lesser trochanter, incidence of 34.7%), type B (fracture around the stem, incidence of 48.2%), and type C (fracture below the stem, incidence of 17.1%) (Figure 5).[4] Type B fractures are further subdivided into type B1, B2, and B3 with an incidence of 14.5%, 24.5%, and 9.2%, respectively.[4] In previous studies, among 77.4% of patients with a type B1 fracture who underwent ORIF, only 4.5% experienced treatment failure.[13] Among 3.9% of patients with a type B2 fracture who underwent ORIF, 59.0% experienced treatment failure. Among 1.9% of patients with a type B3 fracture who underwent ORIF, almost all experienced treatment failure.[4,14] However, among 7.6% of patients with a type A fracture who underwent ORIF, none experienced treatment failure. Among 63% of patients with type C fracture who underwent ORIF in another study,[15] only 18% experienced treatment failure.[15] In one treatment algorithm,

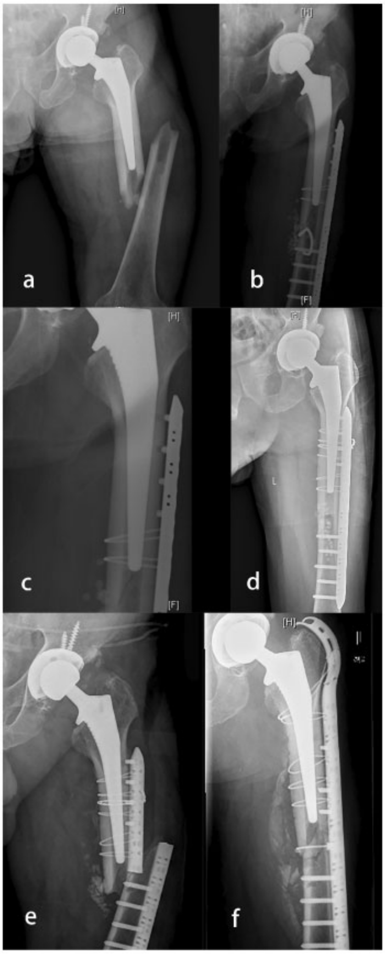

Figure 3. Treatment failures and each open reduction with internal fixation procedure. (a) The first fracture was Vancouver type B1. (b) First ORIF procedure. (c) Second failure. (d) Second ORIF procedure. (e) Third failure. (f) Third ORIF procedure.
ORIF, open reduction with internal fixation.

ORIF was recommended for type A, B1, and C fractures and nonoperative treatment was recommended for type A fractures. Meanwhile, revision arthroplasty was recommended for type B2 and B3 fractures and for patients with any sign of stem loosening.[15]

Our patient had a Vancouver type B1 fracture, for which the standard of care in contemporary practice is ORIF.[12] Type B1 is described as implant-stable and should be treated with ORIF, while type B2 is described as stem loosening and should be treated with revision (Figure 5).[16] However, one study showed that ORIF was associated with an extremely high failure rate because of suspected stem loosening in Vancouver type B1 fractures.[17] Additionally, about 59% of type B2 fractures were misclassified as type B1 because of the shortcomings of radiographic examination.[17–19] Moreover, type B2 fractures were associated with a higher reoperation rate.[20] In another study, the use of a revision stem was associated with a lower rate of complications for type B1 fractures.[21]

Our patient was treated with ORIF and experienced three treatment failures; however, he finally attained endurable walking activity. We reviewed his clinical course and came up with three questions. First, did we misclassify the fracture as type B1 when it was actually type B2, or did we neglect the presence of stem loosening? One study showed that ORIF for Vancouver B1 fractures was associated with an extremely high failure rate, and the authors suspected that this was due to stem loosening.[17] However, we found no signs of stem loosening in our patient. We considered that the treatment failure was due to biological issues, not mechanical issues, when the low-energy fractures occurred (similar to an atypical fracture).[22] The femoral stem was solid with no signs of loosening even after three treatment failures. We considered that all three failures were caused by insufficient rigid fixation, medial stress concentration, bone nonunion, and a decline in the balance of muscle strength. ORIF was inadequate in this patient: cable wires can resist bending but not torsion; the cable close to the fracture can only help to maintain reduction, not provide counteracting forces

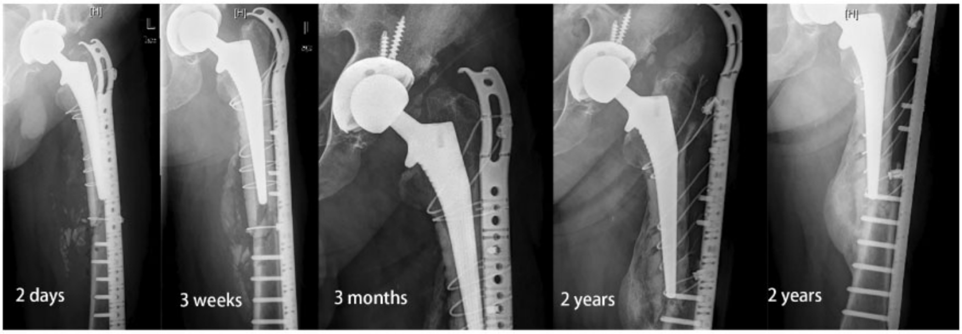

Figure 4. Final outcome. Durable hip function was achieved.

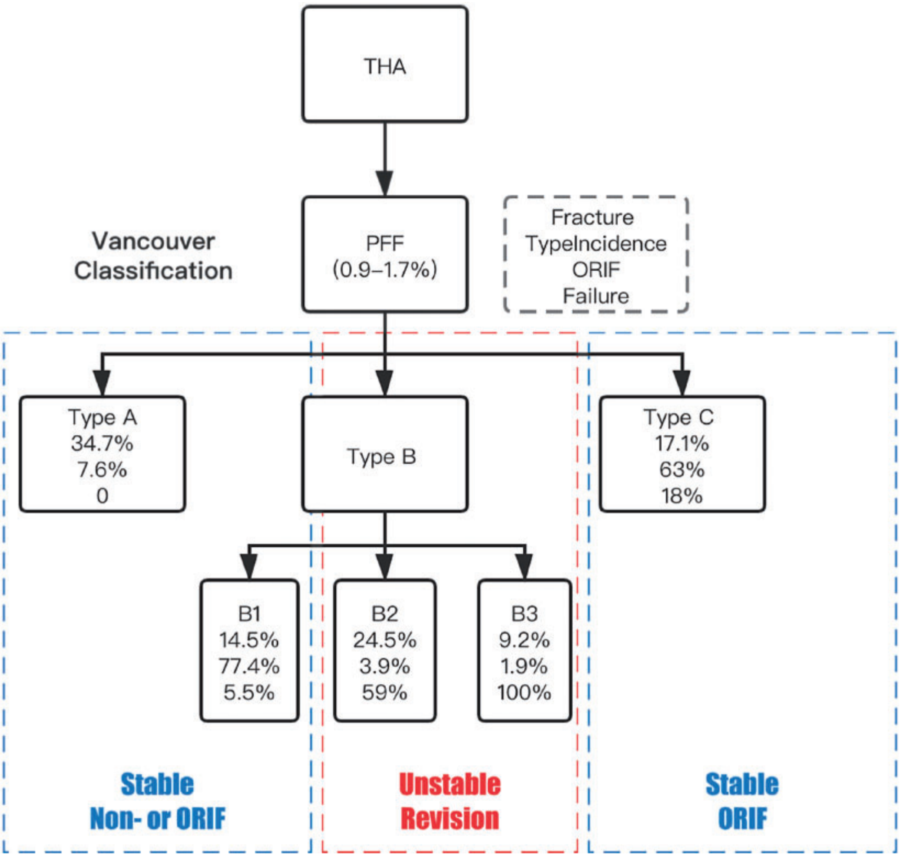

Figure 5. Incidence, treatment recommendation, and failure after open reduction with internal fixation according to the Vancouver classification.
THA, total hip arthroplasty; PFF, periprosthetic femoral fracture; ORIF, open reduction with internal fixation.

(short lever arm); and the use of monocortical screws is an additional risk factor. Moreover, the second ORIF procedure involved very rigid concentrating forces at fracture site, resulting in a broken plate. Second, what treatment strategy should be used to avoid repeated ORIF failures? One report indicated that a medial and/or anterior structural graft should be considered after two failures.[23] Another report indicated that a locking compression plate is not a valid treatment option for B2 fractures.[24] Our patient experienced three treatment failures and two nonunion fractures. The first ORIF failure occurred because of insufficient rigid fixation; if the technique used in the second or third ORIF had been performed in the first procedure, the outcome might have been successful. After the second failure/fracture, we presumed that the use of a long femoral stem in the third ORIF would be effective. Third, which factors were ignored and require more attention in the future treatment of PFF? The Vancouver type B1 fracture was difficult to treat in this patient, and the bone mass and stability of biomechanics might not receive adequate attention in such cases.[11] Biaxial fixation using two plates has been recommended for greater mechanical stability of fracture fixation than uniaxial single-plate fixation.[25] Thus, a femoral stem design that allows for more stable internal fixation and avoids stress concentration is very important.

PFF is a clinically challenging condition, and ORIF is associated with a high risk of failure. In particular, Vancouver B1 fractures require more attention to their intrinsic biomechanical problems. Choosing the optimal surgical strategy for Vancouver B1 fractures is essential to avoid treatment failure and ensure healing. We consider that a locking plate and cable system should be used after the first treatment failure if revision was not performed the first time.

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Declaration of conflicting interest

The authors declare that there is no conflict of interest.

Ethics

This report was approved by the ethics committee of The First Affiliated Hospital of Zhejiang Chinese Medical University. Written informed consent was obtained from the patient.

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