

Deformity Correction Using the “Sandwich” Technique for a Non-Union Hoffa Fracture

Dear Editor,

Fredrich Busch was the first author to describe a coronal plane fracture of the lateral femoral condyle. It was, however, Albert Hoffa who was credited with discovering this fracture. Recent recommendations have been made to rename isolated, intra-articular, coronal plane fractures of the distal femur, or the “Hoffa fracture” to “Busch-Hoffa fractures”.¹ These fractures have been reported to more commonly involve the lateral side.² The configuration of this fracture causes it to be inherently unstable; hence poor outcome is usual with non-operative management, with malunion being recognised as a common late complication even after surgical management.^{2,3,4,5} This paper discusses the case of a young adult male presenting with a grade II (Letenneur classification)⁹ Hoffa fracture—his management, complications and outcomes.

Case Report

A 34-year-old male construction worker presented after a 300 kg concrete beam fell from a crane onto his thighs. He sustained a right closed mid shaft of femur fracture and left closed Hoffa fracture (Fig. 1). The right femur fracture was fixed with a retrograde intramedullary nail. Stable and adequate reduction was achieved, and the Hoffa fracture was fixed with a percutaneous 4.5 mm partially threaded cannulated cancellous screw (Fig. 2), utilising a minimally invasive surgical technique so as to minimise deep tissue dissection.

Postoperatively, he was allowed to full weight-bear on the right lower limb. He was not allowed to weight-bear

for a month on the left lower limb, before the transition to partial weight-bearing.

At the 3 month follow-up mark, he complained of a valgus deformity of the left lower limb. Radiographs (Figs. 3 and 4) showed a non-united fracture with implant loosening. A long leg film revealed a valgus deformity of 8 degrees. The decision was made for surgical revision to correct the deformity and to provide stable fixation for healing of this intra-articular fracture.

The fracture site was approached via an anterolateral incision during the revision operation. This extensile approach allowed for direct visualisation of the lateral femoral condyle and fracture site, direct reduction and screw fixation via the same exposure. There was evidence of fibrous non-union at the fracture site, and a 2 mm articular step deformity. The fracture site was separated, freshened and elevated to restore the height of the articular surface. It was noted that the fracture fragment had undergone disuse osteolysis, and hence was reduced in size and height. An autologous tricortical anterior iliac crest bone graft was then harvested and fashioned to be used as a strut and “sandwiched” into the fracture site between both condylar segments to maintain the articular height (Fig. 5). The fixation was temporarily reduced with a Kirschner-wire (K-wire). The cable technique was then used to assess the patient’s lower limb alignment, which was found to be satisfactory. This was followed by the definitive fixation with two 4 mm headless compression screws that were applied in a posterior to anterior, caudal to cranial direction to secure the graft and fracture fragments.

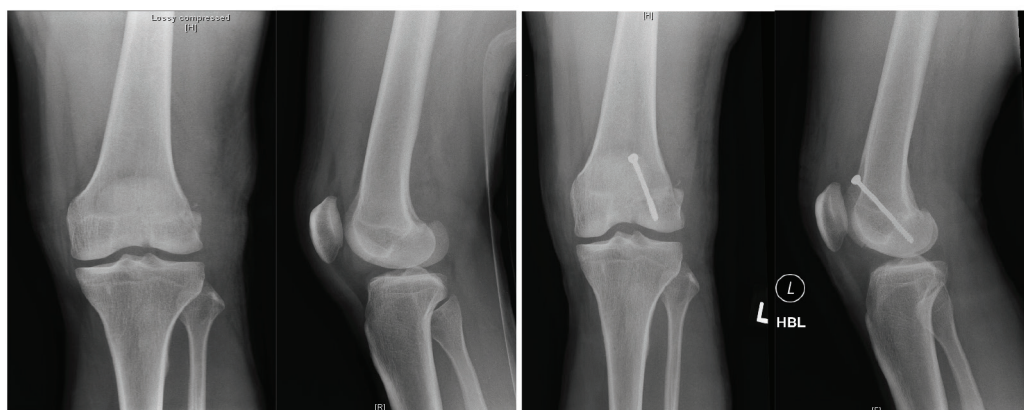


Fig. 1. Hoffa fracture of left femoral condyle, before and after index operation (left and right, respectively).

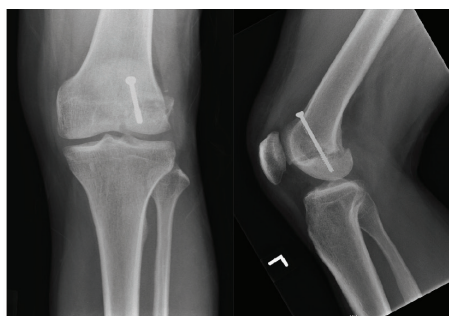


Fig. 2. Radiograph at 3 months showing malunion with implant loosening.

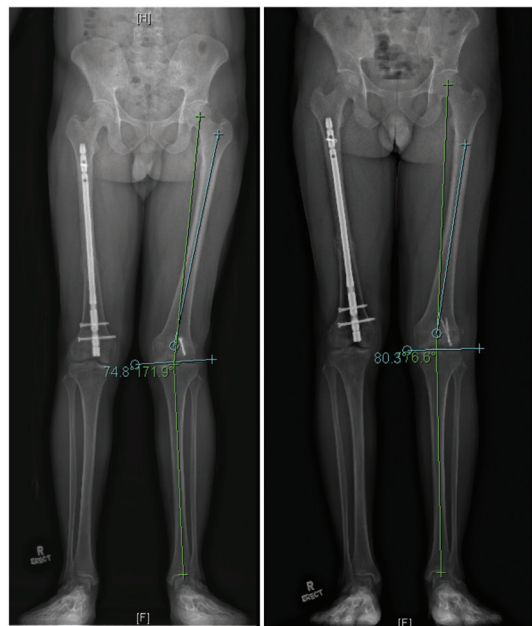


Fig. 3. Long leg film showing genu valgus deformity due to malunion, and its rectification following revision surgery (left and right, respectively).

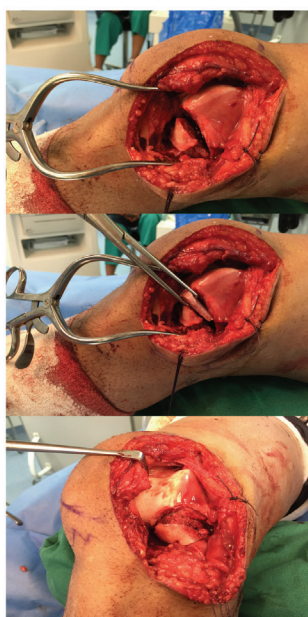


Fig. 4. Steps of revision surgery. Top image: Defect after debridement and correction of the step deformity. Middle image: Tricortical autologous iliac crest insertion. Bottom image: Restoration of articular height after graft sandwiched into fracture site.

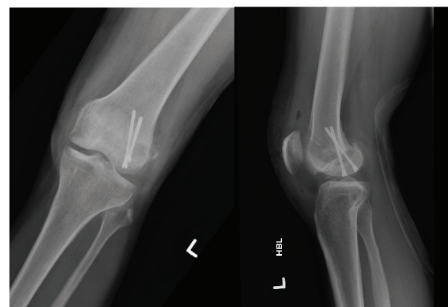


Fig. 5. Postoperative (revision surgery) radiographs showing restoration of lateral condyle.

Postoperative radiographs showed restoration of the lateral femoral condyle surface and correction of the valgus deformity (Fig. 6). He was allowed gentle range-of-motion of the knee but was kept non-weight-bearing on the left lower limb.

At 3 months, radiographs showed that the fracture had healed with good anatomical restoration. He also demonstrated knee range-of-motion of 10 to 130 degrees. He was allowed to fully bear weight at this point. No early complications such as infection and loss of reduction were noted postrevision surgery.

Discussion

A Hoffa fracture is characterised as an intra-articular fracture in the coronal plane of the posterior aspect of the femoral condyle. These fractures are rare and account for less than 1% of distal femoral fracture and generally result from direct high energy trauma⁶ resulting in a shearing force on posterior femoral condyle.⁷

In this case, the mechanism of injury was likely that the patient had his knees flexed beyond 90 degrees when the concrete beam fell onto his thighs. High impact forces were thus transmitted to the lateral femoral condyle, resulting in it bearing an axial loading force.

Hoffa fractures are commonly missed (up to 31%),⁸ with many conservatively treated cases resulting in common complications of malunion or non-union.² Malunion of such fractures can lead to progressive joint deformity and secondary degenerative joint disease. Surgical fixation is

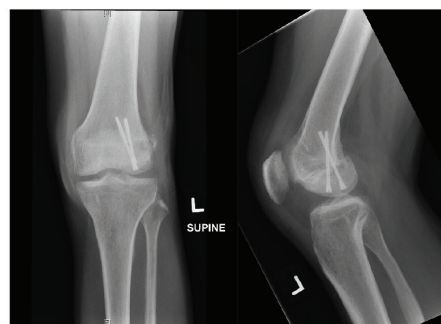


Fig. 6. Three months postrevision surgery.

hence the recommended method of treatment for Hoffa fractures.^{2,3,4,5} This would allow the stable reconstruction of the affected femoral condyle, restoring joint congruence. This restoration will enable early postoperative motion of the knee⁹ which speeds up the rehabilitation process. Various case reports have suggested treating Hoffa fracture malunion with corrective osteotomy¹⁰ and xenogenous bone grafting.¹¹ These case studies briefly described similar patients with Hoffa fractures which had gone untreated or the complication of non-union, who had undergone salvage surgery using xenogenous bone grafts to restore anatomical reduction and articular congruence, with good outcome.^{11,12,13}

We report the early results of a technique for deformity correction in a non-united Hoffa fracture. Literature has suggested that corrective osteotomy is effective in the correction of malunited intra-articular of various long bones.^{9,14} Our paper highlights the novel surgical method of using a bone graft alone to elevate the depressed articular cartilage, without the need for a larger procedure like an osteotomy. We have included intraoperative photographs on the surgical steps to provide detailed demonstration on how to perform this technique. Close follow-up and hence early detection of the non-united fracture allowed for prompt intervention. The old fracture line was therefore easily identified and separated, hence avoiding the need for a larger procedure such as an osteotomy. The result was that of complete bony union at the fracture site, with good anatomical restoration. Radiographs showed reduction of the valgus knee deformity. The patient also reported resolution of knee pain and was able to demonstrate an improvement in knee flexion to 130 degrees.

Recent literature has closely examined Hoffa fractures and provided suggested treatment approaches based on the fracture configuration. Xie et al¹⁵ reviewed 75 Hoffa fractures, characterising them based on their configuration and reconstruction. Its findings support the knowledge that the fracture more frequently occurs in the lateral femoral condyle, extending in the anterolateral to posteromedial direction. Articular comminution is more commonly seen in lateral condyle fractures and concentrated on the weight-bearing zone of the articular surface, suggesting higher likelihood of subsequently developing osteoarthritis. Such findings were noted in our patient's case.

Previously, there had been no standardised surgical approach in the treatment of Hoffa fractures, except by Holmes et al¹⁶ which described an anterior midline approach with parapatellar arthrotomies according to fracture location. Recently, Pires et al¹⁷ proposed a treatment algorithm for Hoffa fractures based on the modified Letenneur classification of coronal plane distal femur fractures. In this paper, for type II fractures, Pires et al proposed a posterolateral approach to fix the fracture fragment with

screws in the posterior to anterior direction, furthermore recommending against the anterior approach due to difficulty in holding the small osteochondral fragments with a few screw threads. Our index operation, however, was approached via a parapatellar incision, holding the fracture fragment with a K-wire prior to securing the fracture fragment with a screw inserted in the anterior to posterior direction. Busch-Hoffa fractures are treated using the principle of absolute stability, which was achieved in our index operation with our surgical approach. Achieving stability would enable early range-of-motion and satisfactory functional outcomes. Though Jarit et al¹⁸ demonstrated in a cadaveric study that the posterior to anterior orientation of screws provide more strength to failure than antero-posterior oriented screws, the study also estimated the ultimate axial strength of antero-posterior oriented screws to be 1025N after 100,000 cycles of loading. Such large amounts of force are seldom encountered during the rehabilitation process; hence we believe that either direction of insertion is feasible.

The parapatellar approach, via a midline incision was decided in our index operation to reduce soft tissue disruption via percutaneous fixation. The screw was inserted in an anterior to posterior direction, which offered extra-articular fixation. The principle followed here is that the intra-osseous blood supply to the posterior femoral condyle is tenuous, and is likely disrupted in displaced fractures, making preservation of the extra-osseous blood supply.¹⁹ Minimising surgical vascular insult potentially minimises the risk for condylar avascular necrosis and non-union. We, however, identify that this approach may limit visualisation of posterior comminution and the ease of reduction.

Literature has also suggested that posterior to anterior screws may offer more biomechanical advantage and further improve rotational stability,² but placement might be difficult, and it has to be ensured that screw heads are countersunk if they are inserted from a cartilage-bearing. Pivoting on this point, it was decided that the salvage surgery utilised countersunk screws inserted in the posterior to anterior direction.

Postsalvage operation radiographs revealed that the screws appear to cross on the lateral film, while remaining divergent on the antero-posterior film. We acknowledge that perfectly parallel screws in both planes, if inserted perpendicular to the fracture line, offer highest degree of compression.²⁰ However, as these are shear fractures, this configuration of screws may predispose to failure if exposed to excessive shear forces, especially in comminuted fractures.²¹ Moreover, fracture geometry and the size of fragments may preclude this in some cases.

Onay et al²² reported a 54% incidence of osteoarthritis and a mean Knee Society Score of 78.4 (range, 53-95 points) in patients who sustained Hoffa fractures. Patients with

such injuries have an increased likelihood of developing osteoarthritis following injury due to the high-energy forces from the trauma sustained. Our patient had gone 3 months with the complication of fracture non-union, which raises his probability of developing osteoarthritis. Moreover, the use of a tricortical bone graft in contact with the articular surface further predisposes to osteoarthritis developing. However, it was important in our case to restore anatomical reduction, and hence knee stability, to enable early range-of-motion and satisfactory functional outcomes, which would otherwise not be possible given the non-ideal state of the bone stock in the fracture non-union site.

We identify the short follow-up duration of the patient as a limitation. This was due to our patient being a foreigner, who had returned to his home country postsurgery, and subsequently defaulted follow-up appointments after that at 3-months. We recommend a reasonable follow-up duration for a fracture to be at least 1 year, and ideally 2 years, to verify and manage early and late complications, if any.

Conclusion

We wish to highlight the importance of a stable and accurate anatomical reduction of Hoffa fractures in the index surgery to prevent complications such as malunion and non-union. This will aid in the rehabilitation and restoration of motion and function of the knee. In addition, we recommend close follow-up to detect complications promptly, and allow for early intervention. This may prevent the need for a larger procedure such as corrective osteotomy. The above described novel “sandwich” technique of inserting a bone graft into the fracture site is a viable treatment option for malunited Hoffa fractures.

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