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A Systematic Approach to Primary Non-Hinged Knee Replacement in Patients with Comminuted Periarticular Fractures about the Knee

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In a very select group of patients with pre-existing knee arthritis and comminuted periarticular fractures about the knee joint, the benefits of primary total knee replacement and simultaneous fracture fixation can outweigh the risks. We outline a systematic approach following sound principles of arthroplasty and fracture fixation in order to reconstruct periarticular fractures about the knee. By utilizing these principles, acute TKA can address both the fracture and the arthritic knee joint and result in good clinical outcomes with low complication rates.

Periarticular fractures about the knee have traditionally posed significant challenges to the patient as well as the surgeon. Recent improvements in implants and surgical techniques have allowed for improved fracture fixation and early range of motion[1, 2]. However, there is subgroup of patients with distal intra-articular fractures, comminution, osteopenia, and pre-existing knee arthritis who may benefit from simultaneous fracture fixation and total knee arthroplasty. We present two illustrative cases where primary non-hinged total knee replacement (TKR) was performed in patients with pre-existing knee arthritis and comminuted intra-articular knee fractures. The purpose of this paper is to outline a systematic approach to simultaneous fracture fixation and non-hinged knee arthroplasty in patients with periarticular fractures about the knee joint.

Case 1: Distal Comminuted Supracondylar Femur Fracture

LH is a 54 year old female with severe rheumatoid arthritis who presented with knee pain and inability to bear weight following a twisting knee injury and fall. Prior to her injury, the patient had been having significant knee pain and disability. She had undergone several intra-articular steroid injections and physical therapy for her knee pain. Radiographs revealed a distal supracondylar femoral fracture with extension distally into the medial femoral condyle and proximally into the distal femoral shaft (Figure 1). A CT scan of the distal femur confirmed comminution with intra-articular extension and displacement of the medial femoral condyle (Figure 2).

The patient underwent simultaneous total knee arthroplasty and open reduction and internal fixation of her distal femur (Figures 3 and 4). The patient was allowed immediate range of motion and full weight-bearing postoperatively. At six weeks, the patient was ambulatory without gait aides and with a knee range of motion of 0-110 degrees.

Case 2: Comminuted Bicondylar Tibial Plateau Fracture

AF is an 82 year old female community ambulatory with osteoporosis who presented with knee and elbow pain following a fall from standing height onto her left knee and left elbow. Prior to surgery, this patient had symptoms of significant joint arthrosis requiring frequent corticosteroid injections. Plain radiographs and a CT of the left knee revealed osteopenia and a comminuted bicondylar tibial plateau fracture (Figure 5). In addition, she sustained a left elbow fracture dislocation requiring open reduction and internal fixation.

Due to the concomitant injury to her left elbow, more conservative treatment options

Figure 1. Case 1: Plain radiographs of distal supracondylar femoral fracture in a patient with severe pre-existing knee arthritis of the knee.

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Figure 2. Case 1: CT scan of distal supracondylar femoral fracture showing comminution, intra-articular extension, and medial femoral condyle displacement. Reconstruction in this case would have required open knee arthrotomy in addition to lateral plating in order to address both the articular and distal femoral shaft components of the fracture.

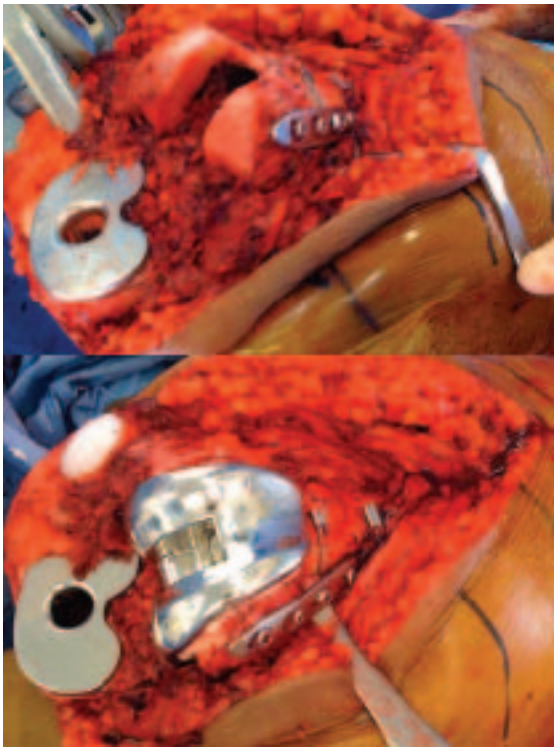

Figure 3. Case 1: Intra-operative photographs showing stabilization of diaphyseal fracture with cerclage wires and reconstruction of the medial column with a 4.5mm reconstruction plate before insertion of the femoral component.

Figure 4. Case 1: Post-operative radiographs after simultaneous total knee arthroplasty and open reduction and internal fixation of distal femoral fracture.

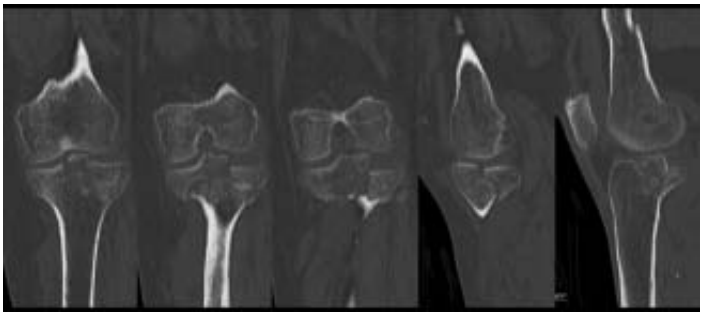

Figure 5. Case 2: CT scan of a comminuted bidoncylar tibial plateau fracture in an elderly patient with an ipsilateral elbow fracture-dislocation.

such as casting or limited open reduction and internal fixation would have confined her to bed to chair transfers because of her inability to bear weight on her left knee. Therefore, the patient underwent primary total knee arthroplasty with open reduction internal fixation of the tibial plateau fracture to allow for immediate weight bearing (Figure 6). Intraoperatively, the medial tibial plateau fragments were secured using 4.0mm cancellous screws, and a stemmed non-constrained PS knee was used to reconstruct the articular surface (Figure 7).

Postoperatively, the patient was allowed to weight bear as tolerated on the left knee. At six weeks, her knee range of motion was 0-90 degrees, and she resumed independent living and ambulation with the assistance of a cane.

Figure 6. Case 2: Post-operative radiographs after total knee arthroplasty and open reduction and internal fixation of tibial plateau fracture. Cancellous screws were used in this case to reconstruct the medial tibial plateau.

Treatment Options

Primary knee arthroplasty should not be performed routinely in patients with periarticular fractures about the knee. Technical challenges that complicate TKR in this setting include collateral ligament instability/disruption, loss of column/plateau support requiring additional augmentation, and the possibility of fracture non-union or malunion. All these factors can negatively affect the longevity and outcome of TKR.

However, there are instances when the benefits of primary TKR and simultaneous fracture fixation may outweigh the risks. Patients with severe pre-existing knee arthritis, comminuted intra-articular fracture patterns not amenable to traditional plate or screw fixation, and bone osteoporosis can benefit if a TKR is performed acutely following sound principles of arthroplasty and fracture fixation. In our study, primary knee replacement was recommended for the following reasons. Patient 1 had significant knee arthritis and a medial distal fracture pattern with shaft extension that would have been difficult to control with a lateral periarticular plate. Similarly, our second patient had pre-existing arthritis, severe osteoporosis, and a fracture pattern involving both tibial plateaus that would have required both a medial and lateral tibial plate for stabilization. In both instances, we felt that the benefits of arthroplasty (i.e. immediate weight bearing and range of motion) outweighed the alternatives of either fracture fixation or non-operative treatment (i.e. non-weightbearing, casting, and stiffness).

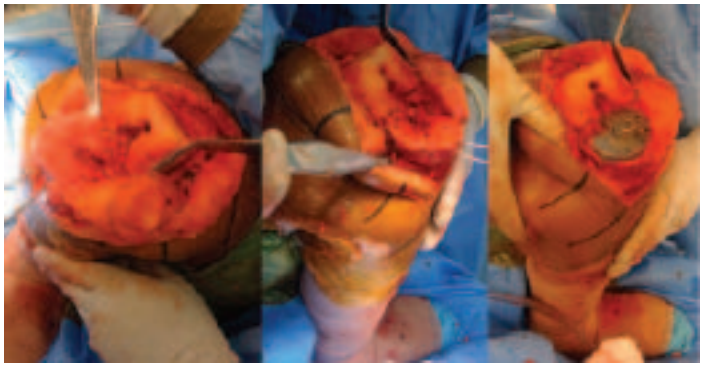

Figure 7. Case 2: Intra-operative photographs showing provisional fixation of the medial tibial plateau fragments, and reconstruction of the tibial platform using 2 posterior-anterior 4.0mm cancellous screws.

Surgical Technique

A systematic approach following sound principles of arthroplasty and fracture fixation are necessary in order to successfully reconstruct these knees.

1. The knee is exposed through a midline incision and a medial parapatellar approach. This approach allows for extension of the exposure both proximally and distally as needed. A complete synovectomy is performed and the medial and lateral gutters are cleared in order to completely visualize the distal surface of the femur. In the proximal tibia, subperiosteal dissection of the MCL is carried out in order to expose the tibial fracture.
2. The first step is to prevent the propagation of the fractures and to allow for safe instrumentation of the knee joint. In cases where preoperative imaging suggests extension of the fracture into the shaft, stabilization of the shaft fragment with cerclage wires will prevent further fracture displacement and propagation during knee arthroplasty.
3. Once proximal and/or distal fracture stabilization is achieved, the next step is to evaluate the integrity and to reconstruct the medial/lateral femoral columns and/or the medial/lateral plateaus to provide a solid platform for the eventual knee arthroplasty. Preliminary reduction and fixation can be achieved using K-wires or Steinmann pins. In cases where the articular surface is completely dissociated from the shaft, the continuity can be restored using a contoured 4.5mm reconstruction plate. When there is a shelf of bone still contiguous with the shaft, bone stock can be restored by securing the fracture fragments using 4.0mm cancellous screws.
4. Reconstruction of the joint follows standard knee arthroplasty principles. The tibial platform is first reconstructed, then the rest of the knee is prepared.

Intramedullary guides are useful in these instances for the following reasons: first, it allows the surgeon to reference the cuts from normal anatomy away from the fracture site, and second, it adds stability to the knee construct during the surgery by stabilizing the femoral and/or tibial shafts respectively.

5. The joint line must be restored in order to optimize knee kinematics. The distance from the femoral epicondyle to the joint line averages 22-25mm, and the typical posterior condylar offset of the femur averages 25mm[3].
6. The stems used in these cases should be press-fit. The length of the stem should allow for diaphyseal fixation and bypass the fracture by at least 2 cortical diameters.
7. Due to potential collateral ligament disruption/dysfunction, modular femoral and tibial components with the ability to accept constrained polyethylene should be used in these cases. Ideally, the TKR can be balanced as to allow for use of a non-constrained PS articulation as it may impact the durability of the implant[4, 5].
8. Postoperatively, the patients are allowed early range of motion and to weight bear as tolerated. There are no restrictions in range of motion of the knee, and no bracing is required.

Discussion

Primary total knee replacement in the setting of acute periarticular knee fracture is rarely indicated. Advances in periarticular plate systems and surgical techniques have improved fracture fixation and allowed for early postoperative range of motion. There are a few instances when fracture pattern, poor bone quality, articular comminution, and the presence of pre-existing joint arthritis prevent adequate fixation and preclude satisfactory clinical outcomes. In these rare instances, a primary total knee replacement and simultaneous fracture fixation may be indicated.

A hinged knee arthroplasty has traditionally been used to treat these complex fractures. Bell et al. described a series of 14 supracondylar and intercondylar femur fractures in elderly patients treated with primary hinged knee prosthesis[6]. Addressing both the fracture and the painful joint allowed patients a quicker rehabilitation from their injuries with good results. However, hinged TKR is not as durable as non-hinged knee prosthesis and their use should be limited in young patients[7, 8]. Few authors have described simultaneous fracture fixation and total knee replacement using a non-hinged TKA[9, 10]. None of these studies have outlined a strategy for joint reconstruction.

Bone loss, collateral ligament deficiency, and distorted anatomy can pose significant technical challenges to knee arthroplasty and reconstruction. However, a successful clinical outcome can be achieved if a systematic approach based on sound principles of joint arthroplasty and fracture fixation is followed. First, stabilization and fixation of any diaphyseal fractures is accomplished using cerclage wires. Second, reconstruction of column support (femoral condyle or tibial plateau) is carried out in order to provide a stable platform for the eventual prosthesis. Third, the knee replacement is completed following sound revision principles, which include restoring both the joint line and posterior femoral condylar offset. Finally, long press-fit stems bypassing the fracture and engaging in the femoral/tibial diaphysis are used to unload stress at the fracture site(s).

In a select subgroup of patients with arthritis and periarticular fractures about the knee joint, primary knee arthroplasty and simultaneous fracture fixation can allow early weight-bearing and joint mobilization. A rational, systematic approach to these fractures based on principles of fracture fixation and knee arthroplasty can simplify these complex cases and provide a roadmap for achieving a successful joint reconstruction.

References

1. **Haidukewych G, Sems SA, Huebner D, Horwitz D, Levy B.** Results of polyaxial locked-plate fixation of periarticular fractures of the knee. *J Bone Joint Surg Am.* 2007 Mar;89(3):614-20.
2. **Ricci WM, Loftus T, Cox C, Borrelli J.** Locked plates combined with minimally invasive insertion technique for the treatment of periprosthetic supracondylar femur fractures above a total knee arthroplasty. *J Orthop Trauma.* 2006 Mar;20(3):190-6.
3. **Laskin RS.** Joint line position restoration during revision total knee replacement. *Clin Orthop Relat Res.* 2002 Nov(404):169-71.
4. **Lachiewicz PF, Soileau ES.** Ten-year survival and clinical results of constrained components in primary total knee arthroplasty. *J Arthroplasty.* 2006 Sep;21(6):803-8.
5. **Lombardi AV, Jr., Berend KR, Leith JR, Mangino GP, Adams JB.** Posterior-stabilized constrained total knee arthroplasty for complex primary cases. *J Bone Joint Surg Am.* 2007 Oct;89 Suppl 3:90-102.
6. **Bell KM, Johnstone AJ, Court-Brown CM, Hughes SP.** Primary knee arthroplasty for distal femoral fractures in elderly patients. *J Bone Joint Surg Br.* 1992 May;74(3):400-2.
7. **Bohm P, Holy T.** Is there a future for hinged prostheses in primary total knee arthroplasty? A 20-year survivorship analysis of the Blauth prosthesis. *J Bone Joint Surg Br.* 1998 Mar;80(2):302-9.
8. **Knutson K, Lindstrand A, Lidgren L.** Survival of knee arthroplasties. A nation-wide multicentre investigation of 8000 cases. *J Bone Joint Surg Br.* 1986 Nov;68(5):795-803.
9. **Patterson RH, Earll M.** Repair of supracondylar femur fracture and unilateral knee replacement at the same surgery. *J Orthop Trauma.* 1999 Jun-Jul;13(5):388-90.
10. **Yoshino N, Takai S, Watanabe Y, Fujiwara H, Ohshima Y, Hirasawa Y.** Primary total knee arthroplasty for supracondylar/condylar femoral fracture in osteoarthritic knees. *J Arthroplasty.* 2001 Jun;16(4):471-5.