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Surgical technique

External fixator immobilization after extensor mechanism reconstruction in total knee arthroplasty

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ABSTRACT

Extensor mechanism disruption after total knee arthroplasty is a complicated problem that typically requires surgical reconstruction. After extensor mechanism failure, reconstruction is typically indicated to restore active knee extension and provide a stable limb for ambulation. Immobilization of the knee in extension is vital in the initial postoperative period after extensor mechanism reconstruction. We describe a series of 4 patients who underwent extensor mechanism reconstruction followed by external fixator application to maintain the knee extended in the initial postoperative period. Our results have been favorable. However, close follow-up is important to monitor for the development of pin site infections.

Introduction

Extensor mechanism disruption in the setting of total knee arthroplasty (TKA) is associated with considerable morbidity and represents a challenging surgical problem [1-3]. After extensor mechanism failure, reconstruction is typically indicated to restore active knee extension and provide a stable limb for ambulation. Numerous reconstructive techniques have been described with varying results [3-9]. Difficulty obtaining consistently good outcomes is common among them. Although it is a rare complication, extensor mechanism failure after TKA will become more prevalent as the number of TKAs performed continues to rise [10]. Therefore, methods of improving outcomes in these patients are desirable.

During the initial postoperative period after extensor mechanism reconstruction, immobilization of the knee in full extension is critical to allow soft tissue healing and graft incorporation. Inadvertent knee flexion can result in stretching of the repair, subsequent extensor lag, and rerupture. Braces have been used to immobilize the knee [11], but they allow knee flexion if removed. Casting has also been described [9], but these can be difficult to apply to large extremities and can result in wound complications. We recently incorporated external fixation as a means of maintaining knee extension in the initial postoperative period and have found it advantageous. The following report describes our experience with 4 patients.

Surgical technique

We reconstruct the extensor mechanism with synthetic polypropylene mesh, as described by Browne and Hanssen [9]. Briefly, the previous anterior knee incision is used. The extensor mechanism is identified and the quadriceps muscle and tendon are mobilized. If necessary, the patella is mobilized and brought down to an anatomic position. The mesh is tubularized and cemented into a trough placed in the anterior proximal tibia. Once the cement is dry, an additional screw and washer are inserted for supplemental fixation. The graft is passed through the patellar remnant and underneath the quadriceps musculature. With the knee in extension, the graft is placed under tension and sewn securely into the extensor mechanism such that it is covered by the quadriceps muscle and tendon. The remaining extensor mechanism is repaired as anatomically as possible. The wound is then closed in layers.

The external fixator is then mounted using 2 half pins in the proximal femur, using a standard percutaneous technique.

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Figure 1. Photograph of external fixator mounted after extensor mechanism reconstruction. Note that pins are placed far from the knee joint to prevent contamination of total knee components.

Care must be taken in this area to avoid injury to branches of the superficial femoral artery (SFA) and lateral femoral circumflex artery. Blunt dissection is performed down to the femur, and drilling and pin insertion are performed using a soft tissue protecting triple sleeve. Two bicortical half pins are then placed in the anterior tibia, keeping them well distal to the tibial prosthesis. The frame is then assembled and secured with the knee in full extension (Fig. 1). Pin care commences on postoperative day 2 and consists of gentle cleansing with a 1:1 mixture of water and hydrogen peroxide. The external fixator is removed after 4-6 weeks and the knee is then immobilized with a brace in extension for an additional 4 weeks. Range of motion is gradually progressed thereafter.

Case 1

A 66-year-old female with an incompetent right extensor mechanism after TKA was seen after multiple failed attempts at extensor mechanism repair as well as reconstruction with an Achilles tendon allograft. Because of the extensor mechanism deficiency and a severely arthritic contralateral left knee, her mobility was greatly limited. On examination of the right knee, she had an extension lag of 50°. Passive range of motion was 10°-110°. Radiographs demonstrated well-fixed right total knee components and patella baja as well as end-stage arthritis of the left knee. Three months after successful left TKA, the patient was taken to the operating room for extensor mechanism reconstruction of the right knee, as described above. At the time of surgery, the quad tendon and prior allograft reconstruction were intact, but had stretched rendering the construct incompetent. At the completion of the case, an external fixator was placed. It was removed after 4 weeks. At 9 months' follow-up, she was ambulating independently and had a 10° flexion contracture of the right knee with no quad lag (Video 1).

Case 2

A 66-year-old female with morbid obesity was referred to our clinic after a failed attempt at primary repair of a quad tendon rupture 5 years after TKA. On initial presentation, she had significant right knee pain and had difficulty ambulating short distances with a walker. On examination, there was a palpable defect in the quad tendon and she was unable to actively extend at the knee. She underwent extensor mechanism reconstruction as described above. At the completion of the case, an external fixator was mounted as described above. It was removed after 4 weeks. At 6 months' follow-up, active range of motion was 10°-100°, with no extensor lag.

Case 3

A 56-year-old male, 3-month status after revision TKA for instability presented to the clinic complaining of knee pain and inability to extend his knee after hearing a “pop.” On examination, he was unable to extend the knee against gravity. Radiographs demonstrated patella alta consistent with patellar tendon rupture. He underwent extensor mechanism reconstruction with external fixator application, as described above. At 6 months' follow-up, range of motion was 0°-100° with a 10° extensor lag (Fig. 2).

Case 4

A 71-year-old female 1-year status after revision TKA presented to our clinic complaining of an inability to extend the knee. Before presentation, she had undergone multiple operations for debridement and an attempted extensor mechanism reconstruction with synthetic mesh. On examination, she had no active knee extension and a palpable defect in her patella tendon. Radiographs demonstrated revision total knee components with cemented stems and marked patella alta (Fig. 3). An infection work-up was negative. Revision extensor mechanism reconstruction was performed and an external fixator was applied for postoperative immobilization. Because of the presence of stemmed components, fixator pins had to be placed very proximal in the femur and distal in the tibia. In addition, a cerclage cable was used to assist in

Figure 2. Active extension 6 months status post extensor mechanism reconstruction. This patient had a 10° extensor lag.

Figure 3. Lateral radiograph of the knee demonstrating stemmed revision total knee components and marked patella alta consistent with this patient's patellar tendon rupture.

reducing the patella (Fig. 4). At 3 weeks' follow-up, a superficial pin site infection was diagnosed. This resolved with a 7-day course of oral cephalexin. The external fixator was removed after 5 weeks. She has not yet begun progressive range of motion, but we included her case to highlight the potential complication of pin site infection.

Discussion

Maintaining the knee fully extended after extensor mechanism reconstruction is essential during the initial postoperative period. Casts and braces have been used and both have pros and cons. A properly applied cast can effectively maintain the knee extended and greatly reduce concern of patient noncompliance with immobilization protocols. However, casts have several disadvantages, including inability to monitor the surgical site; potential to cause skin irritation; difficulty with showering and maintaining proper personal hygiene; inability to monitor for venous thromboembolism; and inability to accommodate changes in swelling leading to complications from casts that are too loose or tight. In addition, applying an effective long leg cast in obese patients can be challenging. Alternatively, removable braces facilitate monitoring of the surgical incision, can be adjusted to accommodate swelling, and easily removed to allow for hygiene. However, flexion of the knee can occur either inadvertently or intentionally if the patient removes the brace.

As an alternative, we suggest that external fixation offers the best of both worlds while minimizing disadvantages. Rigid external fixation eliminates concerns about patient noncompliance resulting in knee flexion. In addition, the surgical site is easily monitored as no overlying wrap obscures the incision. Changes in swelling are readily accommodated as long as the bars are applied 2-3 finger-breadths above the skin. Showering and personal hygiene can be performed with the external fixator in place. Although 3 of the 4 patients in this series underwent revision reconstructions, we suggest considering using the external fixator in both primary and revision reconstruction settings. We believe it can be particularly useful for patients with whom compliance is a concern, including inadvertent noncompliance in elderly patients.

The potential for pin site infections is a unique complication associated with external fixation. Although we observed only one superficial pin site infection in our series, pin site infections are common. Although definitions vary, rates of superficial pin site infections have been reported from 2%-100% [12]. However, these are generally easily treated with oral antibiotics. More serious deep infections are much less common [13,14]. Egol et al [13] reported only one deep infection in a series of 41 closed proximal tibia fractures treated with temporary spanning external fixation. Nevertheless, methods to reduce infections at pin sites are important. Although pin site care is controversial and no superior method has been demonstrated [15], we recommend cleansing pin sites with a 1:1 mixture of hydrogen peroxide and water beginning postoperative day 2. In addition, it is vital that pin sites be kept far from the surgical site so that pin site infections do not result in contamination of implants or grafts. Placing definitive internal fixation at sites of previous external fixator pins has been shown to increase the risk of deep infection [16]. Although no safe distance has been defined for pin placement around total joint components, we aim to place them as far from the implants as is reasonably possible. This can require placing pins proximally in the femur and distally in the tibia to minimize the risk of implant contamination (Fig. 1). This results in a long working distance for the construct that may allow micromotion at the knee joint. However, because the external fixator's sole purpose is to maintain the knee extended, a long working distance is less of a concern than it is with fracture fixation.

We define pin site infection according to the Checketts-Otterburn classification [17]. Minor infection includes redness, tenderness, and a small amount of drainage. We treat this with a 7-day course of oral antibiotics. If the infection fails to respond to oral antibiotics, we would recommend external fixator removal, pin site curettage, and a course of broad spectrum oral antibiotics.

It is our protocol to maintain the external fixator for a period of 4-6 weeks because in our experience, the femoral pins often loosen at this time. This is likely related to high stresses placed on the pins because of the frame's long working distance. Loose pins lead to soft tissue irritation and increase the risk of developing pin site infections [18]. Therefore, we aim to remove them before this becomes a problem. In addition, after 4-6 weeks in strict extension, the knee is usually suitably stiff to avoid problems associated with inadvertent knee flexion, and bracing is appropriate at this time.

External fixator pins can be placed in the proximal femur in a 90° arc from directly lateral to anterior. It has been our preference to place both femoral and tibial pins from directly anterior to posterior because it allows for simple frame constructs and minimizes costs associated with additional bars and connecting clamps more elaborate frames require. We also believe that anterior frames are better tolerated by patients because they easily accommodate sitting, which can be challenging for patients with laterally based femoral frames. Regardless of where pins are placed, considerable care must be taken during their insertion to avoid iatrogenic injury to deep vascular structures, including the SFA, lateral femoral circumflex artery, and branches of the profunda femoris artery [19]. Although rare, SFA injury after insertion of femoral external fixator

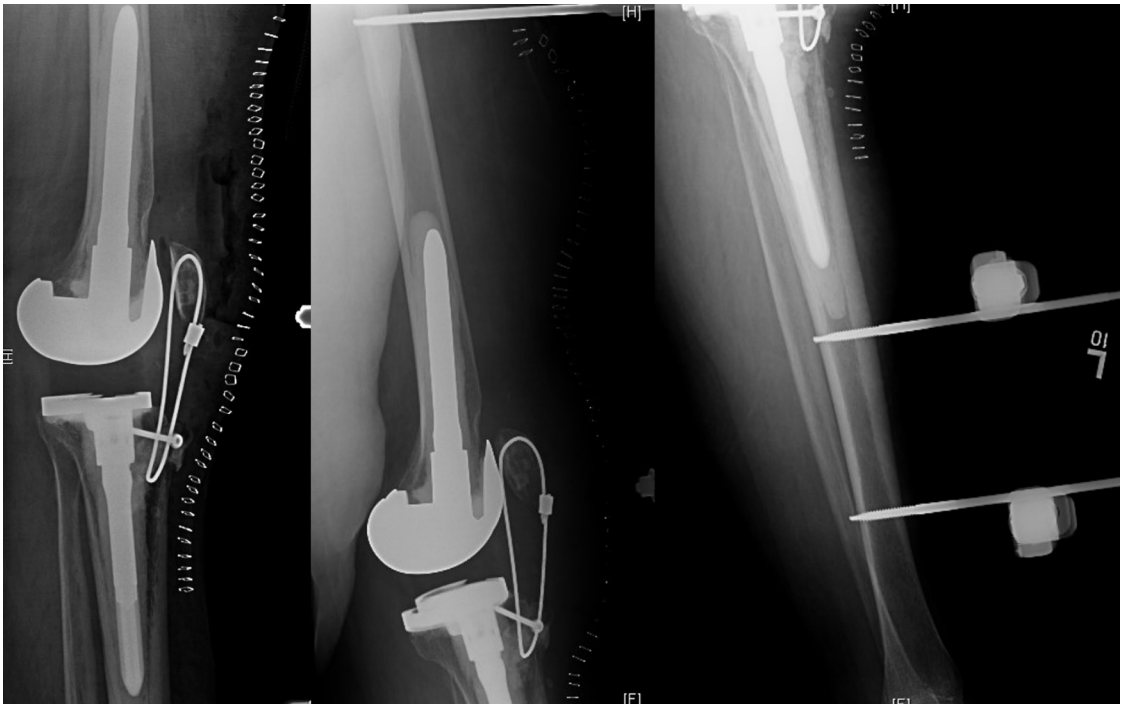

Figure 4. Postoperative radiographs of the same patient demonstrating a cerclage cable used to assist in reducing the patella. Note the most distal half pin in the femur is placed proximally, outside the surgical field. Likewise, the tibial half pins are placed distal to the cement plug of the tibial component to reduce the risk of contamination of the components.

pins has been reported [20]. SFA injury has also been reported from insertion of a distal interlocking screw in a short femoral nail for an intertrochanteric fracture [21]. Regardless of what path is chosen, meticulous percutaneous technique with careful blunt dissection through muscle down to bone must be performed in the proximal thigh. All drilling and pin insertion should be performed through a soft tissue protecting sleeve to avoid the potential for injury to adjacent neurovascular structures. Alternatively, a mini open approach can be performed to allow safe placement of the pin under direct visualization.

Summary

We have found external fixation offers a reliable, safe method of maintaining the knee extended after extensor mechanism reconstruction. In our experience, it is extremely effective at maintaining immobilization, whereas also allowing hygiene and monitoring of the incision and soft tissues. However, close clinical follow-up is recommended because pin tract infections can occur and should be treated expeditiously with oral antibiotics to prevent more serious infection.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.artd.2016.11.007.

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