Arthroplasty Today xxx (2017) 1–8

Contents lists available at ScienceDirect

Arthroplasty Today

journal homepage: http://www.arthroplastytoday.org/

Surgical technique

Circular hexapod external fixation for periprosthetic tibial fracture

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ARTICLE INFO

Article history:
Received 14 January 2017
Received in revised form
8 March 2017
Accepted 8 March 2017
Available online xxx

Keywords:
Periprosthetic fracture
Arthroplasty
Gradual correction
External fixation
Taylor spatial frame
Total knee arthroplasty

ABSTRACT

A poor soft tissue envelope often accompanies periprosthetic tibia fracture around a well-fixed total knee arthroplasty and the tibial stem leaves little room for screw fixation. This article describes the practicability and effectiveness of a novel surgical technique using circular hexapod external fixation, in patients with this clinical scenario. It was applied for fixation of periprosthetic tibia fracture in 2 patients. Contact between the external fixation pins and the prosthesis was avoided. Using a web-based software program, a gradual reduction in all planes was achieved. Adequate fixation, stability, reduction, and quick healing were obtained in the 2 cases, with minimal complications. The patients returned to their activity level a few months after external fixation removal.

Introduction

The incidence of periprosthetic fractures following total knee arthroplasty (TKA) is up to 5.5% and is continuously rising because of an increasing number of knee joint replacements [1]. This results in an increase in revision arthroplasty number and further risk of fracture from periprosthetic bone loss [2]. A series of over 17,000 TKAs reported by the Mayo Clinic Joint Registry published in 1999 indicated that postoperative tibia fractures occurred in 0.4% of the cases after primary TKA [3].

Felix et al classified periprosthetic tibial fractures into 4 types based on the anatomic location and proximity to the prosthesis as well as the status of the prosthetic fixation (Table 1) [4].

Open reduction and internal fixation (ORIF) is mainly indicated for displaced periprosthetic proximal tibia fractures associated with a well-fixed component. However, plate and screw construct rigidity is limited by the available space between the tibial stem and surrounding bone to pass bicortical screws, which can lead to insufficient fixation and the need for adjunctive fixation [5]. Although proximal tibial locked plating constructs are favored especially in osteopenic bone, these devices have little flexibility for screw placement and trajectory. Multiple incisions also increase the risk of skin necrosis and deep infection [5].

To the best of our knowledge, the use of circular hexapod external fixation (CHEF) to treat periprosthetic tibial fractures has not been reported in the English literature. This method was adopted to overcome the difficulties and complications associated with the more common ORIF treatment.

Surgical technique

After obtaining proper consent and confirmation of the surgical site, the patient undergoes neuraxial or general anesthesia. A fluoroscopy machine is positioned on the contralateral side of the table and used throughout the case to guide external fixation pins positioning. Usual skin disinfection and draping of the limb is performed. The fracture is fixed with CHEF using a 2-ring construct, positioned orthogonal to the desired mechanical axis of both the proximal and distal segments; the proximal ring is fixed using multiple wires and 1 or 2 hydroxyapatite half-pins as dictated by

One or more of the authors of this paper have disclosed potential or pertinent conflicts of interest, which may include receipt of payment, either direct or indirect, institutional support, or association with an entity in the biomedical field which may be perceived to have potential conflict of interest with this work. For full disclosure statements refer to http://dx.doi.org/10.1016/j.artd.2017.03.001.

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http://dx.doi.org/10.1016/j.artd.2017.03.001

Table 1
Felix classification for periprosthetic tibial fracture.

Type I	Fracture of the tibial plateau with involvement of the prosthesis-implant interface
Type II	Fracture of the meta-diaphyseal transition
Type III	Fracture distal to the tibial component
Type IV	Fracture of the tibial tuberosity
Subtype A	Stable prosthesis
Subtype B	Loose prosthesis
Subtype C	Intraoperative fracture

fragment size and bone quality, taking great care to avoid contact with the prosthetic components (Fig. 1). The distal ring is fixed with 3 multiplanar half-pins. The fragments are manually reduced intraoperatively, fixed with 6 telescopic struts, and residual correction (Fig. 2) can be done postoperatively to achieve desired alignment using the CHEF software. Postoperative long bilateral legs standing radiographs are obtained to assess mechanical alignment.

Range of motion exercises of the knee are started from the first postoperative day. The patient is allowed progressive weight bearing as tolerated. Deep venous thrombosis prophylaxis is ordered for 4 weeks after surgery. The fixator is removed when full radiological consolidation is observed.

Case 1

A 48-year-old female with past medical history of seronegative rheumatoid arthritis and osteoporosis sustained a right periprosthetic Felix type 2A tibial fracture following a road accident as a pedestrian (Fig. 3). She had undergone a right TKA 3.5 years earlier. She denied any history of knee pain prior to the accident and there was no radiological sign of aseptic loosening of the tibia component. Because of her poor bone quality as well as the small size of the proximal fragment, it was judged that an ORIF would yield poor fixation. CHEF was elected as a method of choice to obtain rigid fixation and provide accurate reduction.

The fixator was removed after 13 weeks and there were no pin tract infections during treatment. At follow-up 18 months after injury, the patient was mobilizing independently, with a knee range of motion of 0°-120° and has resumed her prefracture level of activity (Fig. 4). The latest radiographs show good fracture healing with 5° of "procurvatum" in comparison to the left normal side (Fig. 5).

Case 2

A 78-year-old woman with past medical history of post-traumatic left knee osteoarthritis and patellectomy sustained a left closed periprosthetic proximal tibia and fibula fracture around a well-fixed TKA implant from a fall from her height (Fig. 6). Her soft tissue envelope as well as poor bone stock did not make her a good candidate for ORIF (Fig. 7). She was treated with CHEF and gradual reduction of the fracture (Fig. 8). Intentional "recurvatum" was built in the correction to allow locking of the knee in full extension, for a functional position as she had a flexed femoral component. This is explained by a previous supracondylar femoral fracture healed in flexion, as noted by the medial meta-diaphyseal callus overlying the cortical border (Fig. 9). Weight bearing as tolerated was allowed while she was in the frame. The external fixator was removed 5 months later after radiologic confirmation of complete fracture healing. Within 2 weeks she progressed to full weight bearing. At 10-week follow-up, she had obtained a stable range of motion from 0° to 90°. At 7-month follow-up, she was ambulating with a walker and a drop lock hinged knee brace for her long-standing quadriceps insufficiency. One instance of superficial pin tract infection was noted 1 week prior to frame removal and was treated with a course of oral doxycycline and wire removal.

Discussion

There is no clear treatment protocol for the management of displaced periprosthetic tibial fractures. Operative reduction and stabilization is indicated for displaced periprosthetic proximal

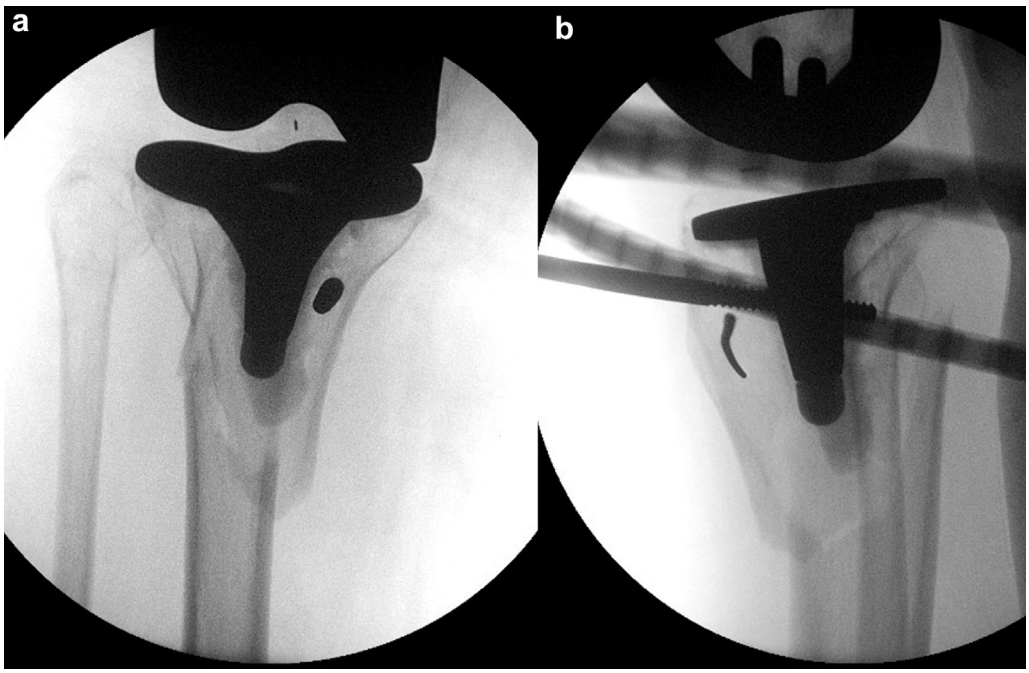

Figure 1. Intra-operative antero-posterior (a) view of the proximal tibia showing clearance between the 6 mm half-pin and the prosthesis. Lateral view (b) showing clearance of the Ilizarov wire.

Please cite this article in press as: M.J. Assayag, et al., Circular hexapod external fixation for periprosthetic tibial fracture, Arthroplasty Today (2017), http://dx.doi.org/10.1016/j.artd.2017.03.001