

Arthrodesis of chronic septic knee by Ilizarov external fixator

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Abstract

Introduction

Septic arthritis is considered the most rapidly destructive joint disease. Arthrodesis of the knee is a salvage procedure that may be indicated for a patient with an infected non-reconstructable knee joint. This study aimed at evaluation of the results of knee arthrodesis using the Ilizarov external fixator to treat septic knee arthritis.

Patients and methods

This retrospective study included 11 patients with septic knee arthritis treated with a similar protocol of debridement and arthrodesis by Ilizarov fixator performed from February 2005 to December 2013. The mean age was 46.27 years. Seven patients were males. The cause of septic arthritis was postoperative in six patients, three infected open knee injuries, and two neglected traumatic dislocations. All patients had already undergone previous surgeries with a mean of 3.64 procedures. Patients were evaluated clinically and radiographically. Functional assessment was done by WOMAC index.

Results

The mean external fixation period was 5.27 months. The mean follow up period was 30.55 months. One patient sustained femoral fracture after a fall during fixation and managed by proximal frame extension. Six patients had pin track infection and one half pin was broken in a case. Arthrodesis was achieved and infection was controlled in all cases without further procedures. At the last follow-up the mean score of WOMAC index was 27.45.

Conclusions

Using Ilizarov fixator for arthrodesis of septic knees was effective in having a stable, mostly pain-free knee, and provided control of infection and improvement in the function and quality of life in such patients.

Key words

arthrodesis; external fixator; Ilizarov; septic knee.

Key messages

* Arthrodesis is one of the last options available to obtain a stable, painless knee in a patient with septic knee damage.

* Ilizarov fixator was effective in obtaining sound fusion and infection control in all cases.

* The final follow-up score of WOMAC index was 27.45.

Introduction

Septic arthritis is considered the most rapidly destructive joint disease and irreversible loss of joint function occurs in up to 25% to 50% of patients. Knee joint infection accounts for 40% to 50% of all septic arthritis in adults.[1,2] Arthrodesis is one of the last options available to treat an infected damaged knee joint that is not amenable to reconstructive measures. The operative objectives are to eradicate infection by aggressive debridement of infected tissues and to obtain a solid arthrodesis in proper alignment to restore pain-free ambulation.[3,4] Septic arthritis and osteomye-

litis are the next most common indications after failed total knee arthroplasty (TKA) for knee arthrodesis.[3]

The elements needed to achieve bony union are good viable bone contact, adequate blood supply, and rigid fixation. Several fixation techniques have been described for knee arthrodesis with variable success rates. Options for fixation of a knee arthrodesis include external fixators of various configurations, long or short intramedullary nails (IMN), and internal fixation with plates or combination of implants. Among them, the most widely used at present are nailing and external fixation.[3-6] The presence or history of in-

fection makes internal fixation and bone grafting less desirable and carries an increased risk of recurrence of infection.[7,8] External fixation is preferred in such cases.[3] The Ilizarov ring fixator offers several advantages that makes it an ideal fixation tool in such complicated cases.[4,8]

There are two general approaches to treat a persistent knee joint infection prior to arthrodesis. The first approach is a single-stage procedure including debridement and insertion of the fixation device. The second approach is a two-stage procedure, where debridement and placement of an antibiotic impregnated cement spacer is done in the first stage. Then, a course of antibiotics is given prior to the second stage, where fixation is achieved using the preferred technique.[9,10]

The purpose of this study was to evaluate the clinical, radiographic, and functional outcomes of a single-stage knee arthrodesis using the Ilizarov external fixator

in those patients who had chronic knee septic damage.

Patients and methods

This retrospective study was done at Benha University Hospital, Egypt. Inclusion criteria included patients with septic knee arthritis with destruction of articular surfaces treated by single-stage debridement and bony stabilization with Ilizarov external fixator. Aseptic knee damage, patients with a follow-up period below 18 months, and patients who lost follow-up were excluded. The study included 11 patients with chronic septic knee arthritis operated from February 2005 to December 2013 (Table 1). There were seven males and four females, ranging in age from 25 to 60 years (mean, 46.27 years; SD, 11.06). The right knee was fused in six patients and the left knee in five patients. Three patients were diabetics and five were heavy smokers.

Table 1: Patient demographics and results

| Patient No. /Age/Sex | Side | Underlying etiology | Draining or quiescent | Follow up (months) | EFP (months) | Alignment | | Satisfaction |
|----------------------|------|--------------------------------|-----------------------|--------------------|--------------|-----------|---------|-----------------------|
| | | | | | | Valgus | Flexion | |
| 1 / 57 / M | Rt | Postoperative | Quiescent | 30 | 6 | 0° | 5° | Very satisfied |
| 2 / 60 / M | Lt | infected open injury | Draining | 36 | 5 | 2° | 3° | Very satisfied |
| 3 / 50 / M | Rt | Postoperative | Draining | 36 | 5 | 0° | 2° | Very satisfied |
| 4 / 52 / M | Rt | Postoperative | Quiescent | 24 | 4 | 3° | 5° | Satisfied |
| 5 / 30 / F | Lt | Infected traumatic dislocation | Draining | 26 | 9 | 6° | 8° | Very satisfied |
| 6 / 39 / M | Rt | infected open injury | Draining | 32 | 5 | 3° | 3° | Somewhat dissatisfied |
| 7 / 49 / F | Lt | Postoperative | Quiescent | 36 | 4 | 5° | 4° | Very satisfied |
| 8 / 25 / F | Lt | Infected traumatic dislocation | Quiescent | 18 | 6 | 0° | 12° | Very satisfied |
| 9 / 55 / M | Rt | Postoperative | Draining | 40 | 5 | 3° | 2° | Very satisfied |
| 10 / 43 / F | Rt | Postoperative | Draining | 34 | 4 | 4° | 5° | Satisfied |
| 11 / 49 / M | Lt | infected open injury | Draining | 24 | 5 | 3° | 4° | Satisfied |

*M (Male), F (Female), Rt (Right), Lt (Left), EFP (external fixation period).

The underlying cause of sepsis was postoperative following open reduction and internal fixation (ORIF) of distal femoral fractures in four patients, following arthroscopy in two patients, infected open knee injuries in three cases, and infected neglected traumatic open dislocations in the remaining two. The last two cases gave history of debridement and reduction with cast stabilization. However, infection occurred and reduction was lost with lack of follow-up. Infection recurred after debridement with bad soft tissue coverage in one case that necessitated plastic surgery inter-

ference. One of these two cases had contralateral equinus foot treated by Ilizarov fixator.

Thorough clinical and radiographic evaluation was carried for full assessment of the condition. Doppler ultrasound examination was negative for deep venous thrombosis. Angiography was performed in the septic dislocations and excluded associated arterial injuries. Seven patients showed draining sinuses and four were quiescent with dry scars. Time from the initial trauma or surgery ranged from 12 to 20 months with a mean

of 15.45 months (SD 3.14). All patients had previous surgical interventions with a mean of 3.64 (SD .809; range 3-5) procedures including the original surgery, arthroscopic debridement, open debridement with or without antibiotic bone cement application, and plastic surgery. The knee was stiff and painful in all cases with deformity in the two cases of neglected dislocation.

The functional assessment was done by Western Ontario

and McMaster Universities Osteoarthritis (WOMAC) index questionnaire.[11] It is a self-administered questionnaire consisting of 24 items divided into 3 subscales which are pain (5 items), stiffness (2 items), and physical function (17 items). The test questions are scored on a five-point Likert scale (none = 0; mild = 1; moderate = 2; severe = 3; and extreme = 4). Higher scores on the WOMAC indicate worse pain, stiffness, and functional limitations. The mean preoperative WOMAC index score was 79.45 (SD 2.21; range 77-84) (Table 2).

Table 2: The functional outcome by the WOMAC index

| Patient | Preoperative WOMAC score | | | | Postoperative WOMAC score | | | |
|---------|--------------------------|-----------|-------------------|-------|---------------------------|-----------|-------------------|-------|
| | Pain | Stiffness | Physical function | total | Pain | Stiffness | Physical function | total |
| 1 | 12 | 8 | 57 | 77 | 1 | 8 | 15 | 24 |
| 2 | 15 | 8 | 61 | 84 | 3 | 8 | 16 | 27 |
| 3 | 14 | 8 | 56 | 78 | 1 | 8 | 16 | 25 |
| 4 | 13 | 8 | 56 | 77 | 1 | 8 | 18 | 27 |
| 5 | 16 | 8 | 58 | 82 | 2 | 8 | 13 | 23 |
| 6 | 13 | 8 | 58 | 79 | 3 | 8 | 27 | 38 |
| 7 | 14 | 8 | 56 | 78 | 1 | 8 | 17 | 26 |
| 8 | 13 | 8 | 57 | 78 | 1 | 8 | 17 | 26 |
| 9 | 16 | 8 | 57 | 81 | 2 | 8 | 17 | 27 |
| 10 | 14 | 8 | 58 | 80 | 1 | 8 | 19 | 28 |
| 11 | 16 | 8 | 56 | 80 | 3 | 8 | 20 | 31 |

The procedure and the various possible complications with Ilizarov external fixation were discussed in details with the patients before surgery. Preoperative explanation of the functional limitations imposed by arthrodesis was not difficult as they were in pain with severe limitations of daily activities and moving on wheelchair. Comorbidities such as diabetes were optimized preoperatively. Patients were advised to discontinue tobacco use and were informed of its detrimental effects on bone healing. Informed consent was obtained from all patients.

Operative technique:

Patients were positioned supine under general or regional anesthesia on a radiolucent operating table with fluoroscopic control. The foot was left partly exposed to control rotation and evaluate the circulation throughout the surgical procedure. A tourniquet was used during debridement. An anterior medial parapatellar approach was used with adequate thickness of soft-tissue flaps. Deep soft tissue and bone cultures were obtained. Thorough debridement of all infected and granulomatous tissue, inflamed synovium, and eburnated cartilage was done. Adequate soft tissue release was done in the cases with neglected knee dislocation to facilitate tibiofemoral reduction. The distal femur and proximal tibia were then cut using an oscillating saw till bleeding surfaces of cancellous bone were encountered leaving two flat

surfaces for compression. Thorough irrigation and wound closure over a suction drain was done. A sterile crepe bandage was applied and the tourniquet was deflated.

Next the Ilizarov frame was applied to help stabilize the soft tissues and eventually to be used to gain fusion. The standard construct in most cases consisted of a two ring block mounted on the tibia and a block of one ring and an arch mounted on the femur. Each ring was stabilized with two to three 1.8-mm wires tensioned to 130 kg. That was strengthened by one or two 5-mm or 6-mm half-pins. The arch was stabilized with 2 to 3 half-pins. Both parts were joined by at least four threaded rods that were used to apply compression across the planned arthrodesis site. The target alignment in arthrodesis of the knee was neutral rotation, a normal tibiofemoral angle of 5°-7° valgus, and flexion of 0°-10°.

Postoperative care:

Antibiotics were given at induction of anesthesia and postoperatively for six weeks based on the last culture and sensitivity testing of infected secretions. Patients with quiescent infection were given a combination of aminoglycoside and cephalosporin for three days then the cephalosporin alone for six weeks. The antibiotic was changed according to the culture results of intra-operative samples. All patients received subcutaneous

antithrombotic prophylaxis with low molecular weight heparin (LMWH).

Weight bearing as tolerated was allowed on the second postoperative day. Patients were assessed clinically and radiographically weekly for the first month, biweekly for the second month, monthly until fusion, and then every six months (Fig 1, 2). The patients

were monitored for weight-bearing, wound status, pin site care, maintenance of position and alignment, progression of fusion, and the need for further compression. The Ilizarov fixator was removed after achievement of solid arthrodesis indicated by bridging trabeculae in the two radiographic views with painless weight-bearing with a loosened frame (Fig 3). An extension knee orthosis was used for four weeks.

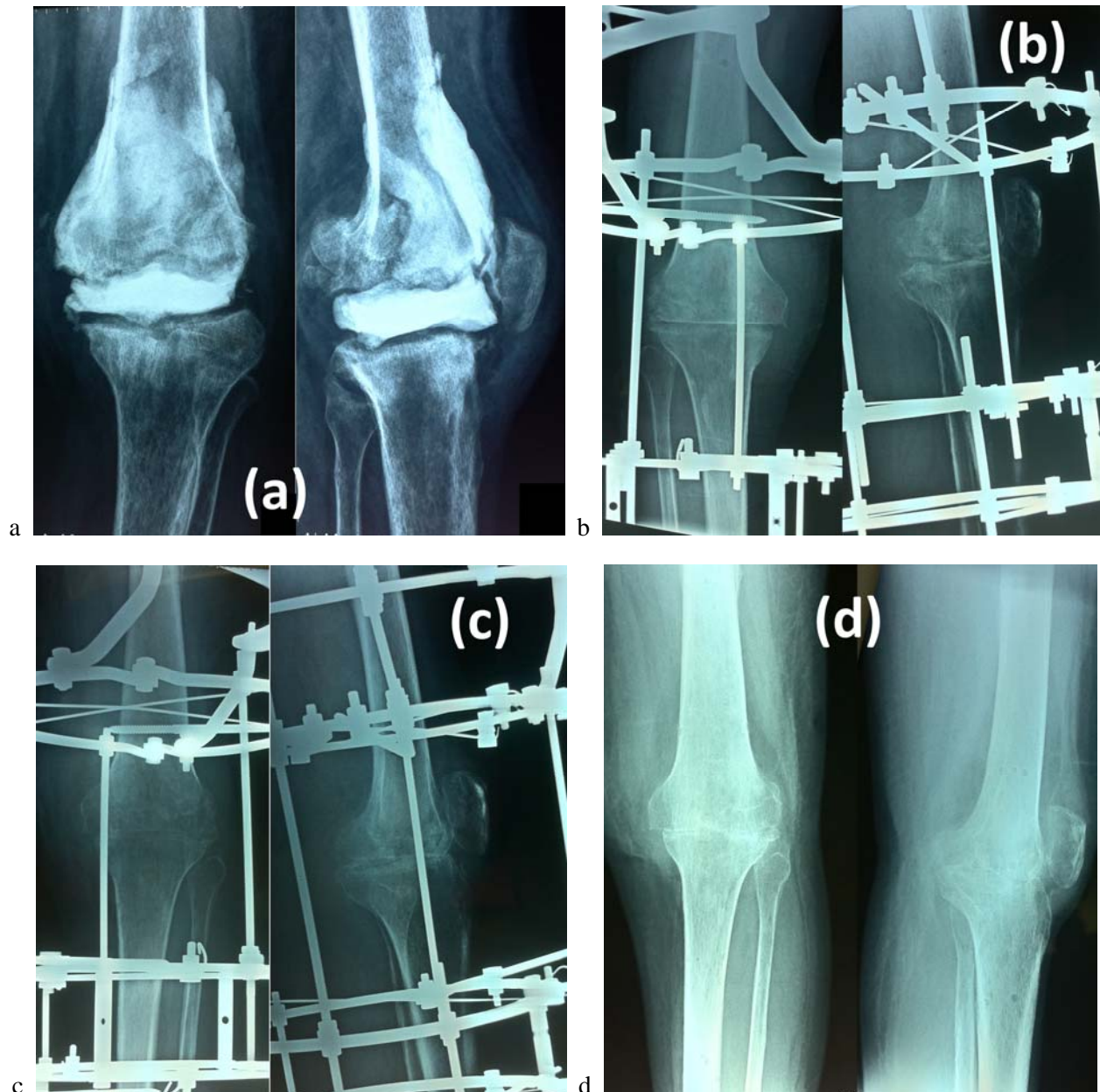


Fig 1: (a) Preoperative radiographs of a case of septic knee arthritis with failed previous debridement and antibiotic bone cement application. (b) First postoperative radiographs. (c) With progression of fusion. (d) After frame removal with sound fusion.



Fig 2: (a) Clinical preoperative photo of a case of septic neglected knee dislocation. (b) Preoperative radiographs. (c) First postoperative radiograph. (d) The patient sustained a fracture shaft femur managed by proximal frame extension. These radiographs show union of both arthrodesis and fracture. (e) After frame removal with sound fusion. (f) Last follow-up clinical photo of the previously non-ambulant patient.



Fig 3: Clinical photos showing the patient with one leg stance before and after removal of the Ilizarov external fixator.

At the final follow-up, all patients were evaluated clinically for stability, alignment, leg length discrepancy (LLD), and recurrence of infection. Radiological assessment included the success of fusion, alignment, and signs of persistent infection. Patient satisfaction was recorded as very satisfied, satisfied, somewhat dissatisfied or dissatisfied. The functional assessment was done by the WOMAC index.

Statistical analysis:

The descriptive statistics were done in the form of frequencies and percentages for categorical variables, and means, Standard Deviations (SD), and ranges for continuous variables. Statistical analysis was done to compare the mean preoperative and postoperative WOMAC index scores using Paired-Samples T Test. Level of significance was set at $p < 0.05$. The descriptive analysis and statistical analysis were performed with IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY, USA).

Results

The average follow-up duration was 30.55 (SD 6.76; range 18-40) months (Table 1). The bacteriological study of the preoperative and intra-operative samples confirmed the presence of *Staphylococcus aureus* in nine cases and of *Staphylococcus epidermidis* in the other two. Successful arthrodesis was achieved in all patients without additional operative procedures or bone grafting after a mean external fixator period (EFP) of 5.27 (SD 1.42; range 4-9) months. Stimulation of fusion was done by compression with the

Ilizarov frame. Seven patients used a cane for outdoor activities. Eight patients were unable to walk on uneven surfaces. All patients reported no pain at rest or at night. Pain was reported during walking by five patients. The mean LLD was 1.68 (SD .25; range 1.5-2) cm. None of the patients needed a shoe-lift. The coronal tibiofemoral angle ranged from 0° to 6° valgus (mean 2.64; SD 2.01). The knee flexion ranged from 2° to 12° with a mean of 4.82° (SD 2.93). Infection was controlled in all patients without recurrence till the last follow-up. Patient satisfaction was expressed as very satisfied in seven patients, satisfied in three, and somewhat dissatisfied in one. The WOMAC index score ranged from 23 to 38 with a mean of 27.45 (SD 4.08) with a statistically significant improvement from the mean preoperative score of 79.45 ($p < 0.001$) (Table 2). It was noted that patients had some difficulty in bending over, climbing stairs, getting in/out of car, putting on socks and performing heavy work. However, all were able to bathe, dress and perform light activities such as walking on smooth surfaces or shopping with a stable knee and without pain.

Complications

Three months after surgery, one patient sustained a fracture of the femoral shaft after a fall. That was managed by closed reduction under anesthesia and image intensifier with fracture stabilization by proximal extension of the frame. Sound fracture union in perfect alignment occurred after another six months in addition to sound arthrodesis, making the external

fixator period for that patient the longest (nine months) (Fig 2). One patient had a postoperative hematoma that was evacuated. Superficial pin track infection was observed in eight patients and was managed by a course of oral antibiotic and proper pin site care. Breakage of a half pin was reported in one patient. A loose half pin was changed in two patients. None of the patients developed vascular injury or common peroneal nerve injury related to inadvertent Kirschner wire penetration. No patient had a refracture after frame removal.

Discussion

Although arthrodesis of the knee joint is a last-choice surgery, this procedure is sometimes the only possibility to restore the supporting function of the limb. As an alternative to amputation, successful knee arthrodesis provides a possibility of an independent lifestyle, with a sensate, stable extremity while relieving pain.[12,13] Harris et al.[14] evaluated the functional activity after an arthrodesis, resection arthroplasty, or knee amputation and found that patients with arthrodesis had the most stable limbs and could perform the most demanding physical work and recreational activities.

Successful arthrodesis requires stable assembly ensuring optimal arthrodesis site compression, as well as eradication of the infection in septic cases. The presence of active sepsis may decrease the fusion rate.[3] The surgical means to achieve fusion remains controversial with multiple available techniques. The choice is between the classically more rigid internal fixation, with a risk of recurrence of infection, and external fixation.[3,15,16] While IM nailing has produced satisfactory results, the procedure is not advisable in patients with ongoing medullary infections. In these cases, the orthopedic surgeon must rely on external fixation.[6,17]

In contrast to plates or IMN, external fixation avoids permanent hardware that could act as a potential nidus for infection, and avoids the risk of spreading an indolent knee infection further into the medullary canals. Although conventional monoplanar fixators are easier to apply, the poor rate of fusion and the higher complication rate has resulted in their infrequent use to date.[4,6,16]

Circular frames are increasingly used in knee arthrodesis because of excellent stability allowing early weight-bearing and versatility, which allows postoperative adjustments in alignment. Arthrodesis can be achieved in the presence of active infection as a one-stage procedure. Enhancement of fusion can be done

by focal compression and distraction alleviating the need for bone grafting. The main disadvantages of the circular external fixator include the complexity of application, bulky frame, and the risk of complications such as pin-tract infection.[8,17,18]

The present study reports management of 11 cases with septic knee damage by single-stage debridement and external fixation by Ilizarov frame. Two of these cases were infected neglected dislocations. Neglected knee dislocations are extremely uncommon and their management cannot be evidence-based since only a few case reports have been published. Different treatment methods were reported including open reduction and ligament reconstruction,[19] arthroplasty,[20] two-stage treatment with gradual reduction by Ilizarov technique and subsequent ligament reconstruction,[21] and two stage external fixation and arthrodesis.[22] However, none of these reports included an infected case in contrast to the two cases in this study. Arthrodesis was considered to be the most appropriate management because of infection, and the complexity of the knee-damage.

Successful arthrodesis was obtained in all cases without additional procedures with mean EFP of 5.27 months. This was consistent with other reports using Ilizarov fixator. David et al.[23] reported solid fusion at a mean of 28 weeks (19 weeks in fixator, and nine weeks in cast) in all 13 patients in whom the Ilizarov external fixator was used for failed TKA. Salem et al.[4] reported solid fusion in all 12 patients with average EFP of 22 weeks. Rozbruch et al.[8] reported fusion in four patients with infected posttraumatic knee damage treated by knee arthrodesis with simultaneous lengthening using Ilizarov fixator. They reported EFP of 11 months owing to the associated lengthening. Oostenbroek and van Roermund[24] reported on 15 infected TKAs treated with arthrodesis using the Ilizarov ring fixator; union was achieved in all but one patient with mean EFP of 28 weeks. The lowest fusion rate using the Ilizarov frame was obtained by Garberina et al.[25] in a series of 19 patients with loose or infected prostheses, pyarthrosis, and post-traumatic arthrosis. Nonunion occurred in 6 (32%) patients. An above-knee amputation was performed in two patients

In the current series, infection was controlled in all cases till the last follow-up visit. This was consistent with some reports.[4,8,17] With adequate debridement and Ilizarov arthrodesis, the infection subsides with continuous axial compression and treatment with antibiotics.[6] Frequently, if there is a recurrence of infection the fusion will not mature and septic nonunion will occur. At that point the options include staged revision arthrodesis or above-the-knee amputation. Recurrence of infection was reported by other au-

thors. Röhner et al.[26] reported persistent infection in 13 of 26 cases of infected TKAs treated with two stage intramedullary nailing. An above-the-knee amputation was done in three of these patients. Schwarzkopf et al.[10] reported infection in 11 of 43 failed TKA and above-the-knee amputation in two cases. They used different fixation methods (IMN, plate fixation, external fixation, and cancellous lag screws) for arthrodesis in the same study.

The average LLD in the present study was 1.68 cm as there was no much bone loss as in cases of infected TKA. A slightly foreshortened, fused leg allows easier clearance during the swing phase of gait. When the leg is too short, a shoe lift may be used.[3] Rozbruch et al.[8] reported an average of 1.8 cm. Oostenbroek and van Roermund[24] reported a mean LLD of 4 cm. Leroux et al.[5] reported an LLD of 2.76 cm after two-stage knee arthrodesis with IMN and autologous bone grafting.

The arthrodesis alignment in the current study was adequate. The coronal tibiofemoral angle ranged from 0° to 6° valgus and the knee flexion ranged from 2° to 12°. The reports on the final arthrodesis alignment results are scarce. In the study of Leroux et al.[5], the mean tibiofemoral angles were 178.6° of varus and 1.9° of flexion. With long nails, the angles of tibiofemoral valgus and flexion were 3.1° and 3.5°, respectively, in one study[27] and 1.3° and 5.8° in another.[28]

In the present series, the functional outcome improved with stability and pain alleviation. The overall WOMAC index score improved significantly from 79.45 preoperatively to 27.45 at the last follow-up. That was comparable to the report of Leroux et al.[5] who reported a mean WOMAC score of 26. Tang et al.[29] reported a better WOMAC score of 13.7 points (range, 9-25) of 26 patients with end-stage knee tuberculosis treated by single-stage arthrodesis using a unilateral external fixator combined with crossed cannulated screws. Röhner et al.[26] reported a less favorable outcome with 50% persistent infection and a WOMAC score of 39±16 points.

The limitations in this study were the retrospective nature, and lack of control group. Moreover, the number of patients in the study was small due to the rarity of the condition selected for inclusion criteria. It was difficult to compare the results of this series with other arthrodesis reports. The orthopedic literature regarding knee arthrodesis deals predominantly with failed TKA. These results, however, are to be interpreted with caution. Firstly, most of the series in the literature are too small to enable comparative statistical analysis. Secondly, some reports used different treatment modalities to achieve arthrodesis in the

same series.[10,30,31] Moreover, some studies are heterogeneous, mixing septic and non-septic etiologies.[10,25,31]

Conclusions

Knee arthrodesis using Ilizarov external fixator for management of chronic septic damage of the knee achieved high fusion and infection eradication rates, despite the associated complications. With solid fusion, patients had good pain relief and satisfaction together with improvement in function and quality of life.

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