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Ankle Arthrodesis Using the Ilizarov Technique in Difficult Situations – a Prospective Study with Mid-to Long-term Follow up

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SUMMARY

Background. Although various operative techniques are available for ankle arthrodesis, it is not rare to see orthopaedic surgeons facing difficult situations with ankles that cannot be reliably treated by any conventional methods other than the Ilizarov technique. This study was conducted to measure the outcome in such patients using the Ilizarov Ring fixator.

Material and methods. Sixteen patients (average age 47.5 years) had primary or revision unilateral ankle arthrodesis using the Ilizarov technique. Among the 16 patients the pathology included severe difficult post-traumatic arthritis with diabetes mellitus (n=7), failed arthrodesis with internal fixation (n=4), difficult post-septic arthritis (n=3) and 1 case each of rheumatoid arthritis and post-polio residual palsy with instability. The primary outcome was bony union and ankle alignment. The clinical results were further evaluated according to the American Orthopaedic Foot and Ankle Society scoring (AOFAS) System at 6 months and yearly till final follow-up.

Results. All ankles achieved arthrodesis at an average of 14 weeks (range 12–18 weeks). The average duration of follow-up was 5.7 years (range 4– 10 years). No major complication was seen except for 5 cases of superficial pin track infections, wound dehiscence in 1 patient and chronic discharging sinus in 1 patient. The average AOFAS score improved from an average of 35.25 (range 20- 44) points pre-operatively to an average of 78.37 (range 72–89) points at final follow-up.

Conclusion. Ankle arthrodesis using Ilizarov technique shows a high fusion rate with no major complications and operative failures even in difficult and complicated situations.

Key words: Ilizarov technique, ankle arthrodesis, infections, external fixator

BACKGROUND

There has been a drastic change in the management of patients with advanced arthritis around the ankle that is unresponsive to conservative treatment. Several treatment options are available for pain and disability management due to arthritis and deformity of the ankle. In the present scenario, various attractive options available for surgeons include various arthroscopic procedures, osteotomies, reconstructive procedures and arthroplasty [1-3]. Although these procedures have shown promise when used in selective cases, ankle arthrodesis is a time tested and gold standard procedure in majority of patients. Among the options available for ankle arthrodesis, the use of internal fixation devices has shown good results and is a favourable technique in most of the cases [4]. However, in certain situations, it is difficult to achieve optimum results using internal fixation and such cases are fraught with complications and failure. In such cases, the only solution is the use of external fixation [5-7].

In the past, technique of the Ilizarov ring fixation was used only in few selected centres but now the technique has penetrated majority of institutions worldwide due to its necessity in a variety of cases. An added advantage with the technique is the early weight bearing to tolerance soon after the surgery. At our centre, after having satisfactory results with the use of Ilizarov technique, we carried a prospective study to analyse its effectiveness in difficult situations of ankle arthrodesis in patients with arthritis around the ankle of different aetiologies.

The primary outcome of our study was bony union and alignment, which was assessed radiologically on standard antero-posterior and lateral radiographs of the ankle. The secondary aim was to assess the complications arising thereof.

MATERIAL AND METHODS

The study was a prospective study conducted, after the institutional review board approval at our institute, on patients operated from April 2003 to March 2009 and included a total of 16 patients of ankle arthrodesis using Ilizarov ring fixator in patients with ankle arthritis of different aetiologies (Table 1). Only patients with ankle arthritis in difficult situations were included in this study. Difficult situations were defined as having ankle arthritis associated with extensive soft tissue scarring, presence of discharging sinus, associated co-morbidities such as diabetes and neurovascular compromise, previous failed internal fixation and failed multiple surgeries on ankle in the past which could have direct or indirect impact on the final outcome. Sixteen ankle fusion procedures were performed over a 6-year period. The indication for surgery, any past surgical interventions, complete medical history, age, gender, and side, time taken for union and fusion and any complications were all recorded. There were 10 men and 6 women with the right side more frequently involved in 11 cases as compared to the left side in 5 cases. The age ranged from 28 to 65 years with an average of 47.5 years. Among the 16 patients, the pathology included severe difficult posttraumatic arthritis with diabetes mellitus (n=7), failed arthrodesis with internal fixation (n=4), postseptic arthritis (n=3) and one case each of rheumatoid arthritis and post-polio residual palsy with instability. A total of 4 previous surgeries had been performed for arthrodesis using internal fixation devices, screws in 3 patients and plate fixation in 1 patient. Associated co-morbidities included active infection in 6 patients, diabetes mellitus 7 patients, rheumatoid arthritis 1 patient and 9 out of 16 cases being chronic smokers. Plain radiographs in two planes (AP and lateral views) were used to assess the extent of joint destruction and for pre-operative planning. One patient with failed arthrodesis post firearm injury had to be assessed preoperatively for peripheral circulation using Doppler ultrasound.

The operative technique used was determined by the underlying pathology, presence of infection and condition of skin. The surgery was performed under spinal anaesthesia. The patient was placed in a supine position on a radiolucent operation table and the leg was draped. A tourniquet was used in all cases. The ankle was approached through a standard antero-lateral approach and after preparing the surfaces for arthrodesis temporary fixation was performed using a few Kirschner wires. In the presence of an infected pathology a meticulous debridement of any infected tissue was carried out. A two ring construct of Ilizarov rings was then mounted using fixation in the distal tibia and the talus. Primary compression across the arthrodesis was performed after the removal of temporary Kirschner wires. At this stage, stability and alignment of ankle was assessed and adjustments performed if deemed necessary. Wound was closed over a suction drain and tourniquet deflated. An additional ring and a proximal metaphyseal corticotomy was needed in a 28-year-old female with underlying osteomyelitis and a limb length discrepancy of 4 cms.

Patients were ambulated on the first post-operative day and discharged after teaching them intermittent compression across the arthrodesis site. All patients were allowed weight bearing for ambulation as tolerated immediately after surgery. Hospital stay ranged from 2 to 9 days with a mean of 5 days. The

Tab. 1. Demographic and other patient details

Sno.	Age	Gender	Side	Diagnosis Osteoarthritis secondary to	Significant Medical History/ Associated conditions	Previous Treatment Received	Hospital stay	Time to Bony Union (weeks)	Follow-up (months)	Complications	AOFAS Score (pre-op)	AOFAS Score (final follow-up)
1	45	M	R	Post traumatic	Diabetic, Chronic smoker	Conservative casting for bimalleolar fracture	5	14	120	Pin tract infection	38	82
2	28	M	R	Septic arthritis (TB)	Active infection	Multiple debridements	5	12	94	Pin tract infection	33	79
3	47	F	L	Posttraumatic	Diabetic	Casting for fracture distal tibia	5	12	86	-	44	89
4	58	M	R	Failed arthrodesis	Chronic smoker	Arthrodesis with plates	5	14	78	-	32	80
5	62	M	R	Post traumatic	Chronic smoker	MIPPO for pilon fracture	5	12	74	Pin tract infection	28	79
6	65	M	L	Failed arthrodesis	Diabetic, Poor skin condition	Arthrodesis with plates	8	18	70	Chronic discharging sinus	20	69
7	32	M	L	Septic arthritis	Active infection, Chronic smoker	Multiple debridements	4	12	70	-	40	80
8	48	F	R	Posttraumatic	Diabetic	Casting for Distal Tibia fracture	3	14	64	-	38	77
9	61	F	L	Failed arthrodesis	Chronic smoker	Arthrodesis using screws	5	15	64	-	32	82
10	49	M	R	Posttraumatic	Chronic smoker	ORIF Pilon fracture	4	12	62	-	40	82
11	28	F	R	OM, Septic arthritis	Active infection, LLD 4 cm	-	9	15	56	-	42	79
12	48	F	R	Failed arthrodesis	Active infection	Arthrodesis with plates	4	14	56	-	38	73
13	32	F	L	Residual poliomyelitis with instability	-	Triple arthrodesis	6	16	54	Skin dehiscence	37	67
14	65	M	R	Posttraumatic	Active infection, Chronic smoker	Plating for distal tibia fracture	3	17	50	Pin tract infection	28	79
15	44	M	R	Rheumatoid Arthrites	Chronic smoker	-	5	15	50	Pin tract infection	35	77
16	48	M	R	Posttraumatic	Chronic smoker, Active infection	ORIF Bimalleolar fracture	3	12	48	-	39	80

M; Male, F; Female, R; Right, L; Left, LLD; Limb length discrepancy

patients attended regular clinical examinations and at an average final follow-up of 5.7 years. Any post-operative malalignment was addressed by differential distraction.

The clinical results were evaluated according to the American Orthopaedic Foot and Ankle Society scoring (AOFAS) System (Table 2) at 6 months and yearly till final follow-up. Statistical evaluation was done by unpaired t test and p value of < 0.05 was considered statistically significant.

RESULTS

The average duration of follow-up was 5.7 years (range 4–10 years). Fusion was determined clinically and radiographically. All ankles achieved arthrodesis at an average of 14 weeks (range, 12–18 weeks). At the time of the last follow-up, 12 patients had no pain while 4 had mild pain. Among 16 patients 9 patients had no limitation in recreational or daily activities and 7 patients had limitation in recreational but not daily activities. 9 patients had no difficulty walking on any surface and 7 had some difficulty on uneven terrain and stairs. All but one patient showed an obvious limp. No patient had ankle instability. Complications such as damage to neurovascular structures, non-union, malunion and failure of the procedure were not seen in this study. Superficial pin track infection was seen in a total of 5 patients and was managed by daily dressings and antibiotics. Other complications included wound dehiscence in 1case that was managed by antibiotics and daily dressings and finally the wound healed by secondary intention. One patient had a chronic discharging sinus that had not healed at the time of final follow-up.

Tab. 2. The American Orthopaedic Foot and Ankle Society scoring System (AOFAS)

Pain (40 points)	
• None	40
• Mild, occasional	30
• Moderate, daily	20
• Severe, almost always present	0
Function (50 points)	
Activity limitations, support requirement	
• No limitations, no support	10
• No limitation of daily activities, limitation of recreational activities, no support	7
• Limited daily and recreational activities, cane	4
• Severe limitation of daily and recreational activities, walker, crutches, wheelchair, brace	0
Maximum walking distance, blocks	
• Greater than 6	5
• 4-6	4
• 1-3	2
• Less than 1	0
Walking surfaces	
• No difficulty on any surface	5
• Some difficulty on uneven terrain, stairs, inclines, ladders	3
• Severe difficulty on uneven terrain, stairs, inclines, ladders	0
Gait abnormality	
• None, slight	8
• Obvious	4
• Marked	0
Sagittal motion (flexion plus extension)	
• Normal or mild restriction (30° or more)	8
• Moderate restriction (15°-29°)	4
• Severe restriction (less than 15^0)	0
Hindfoot motion (inversion plus eversion)	
• Normal or mild restriction (75%-100% normal)	6
• Moderate restriction (25%-74% normal)	3
• Marked restriction (less than 25% normal)	0
Ankle-hind foot stability (anteroposterior, varus-valgus)	
• Stable	8
• Definitely unstable	0
Alignment (10 points)	
• Good, plantigrade foot, midfoot well aligned	10
• Fair, plantigrade foot, some degree of midfoot malalignment observed, no symptoms	5
• Poor, nonplantigrade foot, severe malalignment, symptoms	0

The average AOFAS score improved from an average of 35.25 (range 20- 44) points preoperatively to an average of 78.37 (range 72–89) points at final follow-up, which was statistically significant (p value < 0.05).

DISCUSSION

The use of the Ilizarov technique for ankle arthrodesis may be the only option when orthopaedic surgeons face difficult situations [6-8] and, moreover, presence of co-morbidities such as diabetes, infections, smoking and leg length discrepancy can make an ankle fusion complex and may be associated with lower rates of healing [8]. Ankle arthrodesis is the traditional operative treatment for ankle osteoarthritis that provides the development of a painless, plantigrade and stable foot [9]. There are at least 30 different methods that have been reported to date [10], although Albert first described ankle fusion in the late 19^{th} century, Charnley brought the technique into the modern era with a 1951 discourse on the successful use of uniplanar external fixation in compression arthrodesis [11]. The results of arthrodesis of large joints with this technique have been quite satisfactory and since that time this concept has gained

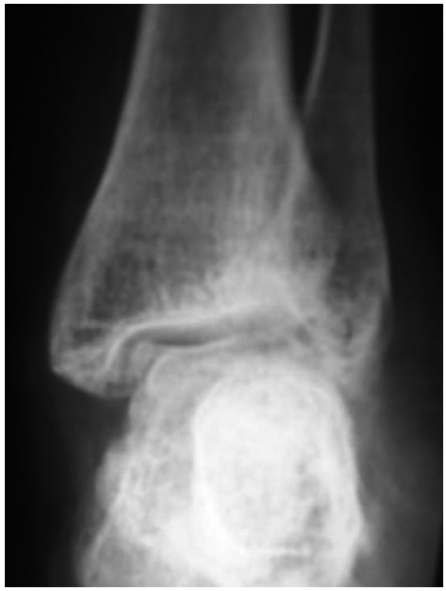

Fig. 1. A/P radiograph of patient No.13 a case of polio with ankle instability and osteoporosis

Fig. 2. Lateral radiograph of same patient demonstrating previous triple arthrodesis

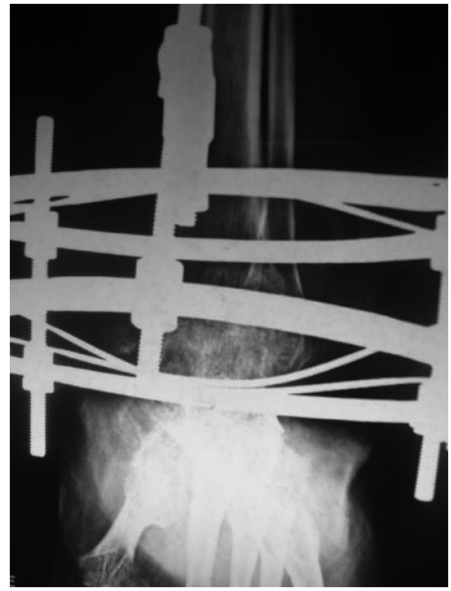

Fig. 3. Intra operative AP and lateral radiographs with Ilizarov ring fixator in place

Fig. 4. Intra operative AP and lateral radiographs with Ilizarov ring fixator in place

wide acceptance. However, biomechanical studies showed that even though the Charnley device is able to produce sufficient compression forces, the single axis fixator does not produce rigid external fixation in all planes. Calandruccio in an attempt to improve rigidity of ankle fusion developed a triangular compressive device that provides rigid external fixation in three planes [12]. Screw fixation may be prone to implant migration and was demonstrated to have a low union rate [13]. Ilizarov has been proven to provide stable immobilisation of the joint in three planes with protection against shear and torsion stress, while allowing axial loading [14]. The Illizarov technique has been described as a good method for ankle fusion especially in the presence of infection, bone defects or shortening and may be an alternative and effective means of neuropathic ankle arthrodesis, especially when the usage of internal fixation has some limitations [15, 16]. Axial loading with early ambulation and immediate weight bearing allows micro-movements in the axial plane, which stimulates new bone formation and enhances osseous healing [17-20]. Several au-

Fig. 5. Final radiograph showing solid arthrodesis achieved for ankle stability

thors have reported their series with variable rates of successful primary fusion. The illizarov reconstruction has even been found to achieve solid union and plantigrade foot in malunions and non-unions of an ankle fusion site associated with pain, osteomyelitis, limb length discrepancy and deformity [21]. Feihel and Uhthoff from Ottawa reported a series with four patients using the Ilizarov technique, in which the fusion rate was 75% [22]. Others have also achieved high rates of fusion using external fixation, with Berman et al., Midis and Conti and Katsenis etal reporting fusion rates of 91%, 100%, and 100%, respectively [6,23,24]. The chances of union are higher when the fixation is rigid. Hawkins *et al* reported 21 cases of ankle arthrodesis by external fixation with the Ilizarov ring and attained solid fusion in 80% and resolution of the associated underlying pathologies [25]. Johnson *et al* reported 6 cases of compression ankle arthrodesis using the Ilizarov external fixator due to failed infected ankle fusion in four cases and posttraumatic degenerative arthritis in two cases. Successful fusion was obtained in five cases, one of which subsequently sustained a refracture [14]. Salem KH et al. reported two non-unions among 22 cases of complex ankle arthrodesis that healed after revision and renewed frame application [26]. They concluded that the Illizarov frame provides a successful salvage method that offers solid bony fusion, optimal limb length, and eradication of infection in complex ankle pathology or failed previous arthrodesis. The efficacy of the current treatment method using the Ilizarov Ring fixator was demonstrated by the fusion rate of 100% and the significant improvement of the AOFAS scores. Although other studies have demonstrated excellent fusion rates using the Ilizarov technique, the high fusion rate of 100% in our study could be attributed to almost 20 years of experience with the Ilizarov technique at our institution.

In our study, the most common complication of pin tract infection was managed with daily dressings and oral antibiotics without any need of change in the treatment plan. Most other studies have also reported pin tract infection as the most frequent complication [23-25]. Malunion occurring at the fusion site has been reported as a complication in most of the studies of ankle arthrodesis, especially with internal fixation devices [13]. No malunion at the fusion site occurred in our study. This is attributed to the versatility of the Ilizarov technique with a provision for correction using differential distraction in the postoperative period and makes it an effective and dynamic means of treating difficult cases of ankle arthrodesis [27]. In fact, the possibility of postoperative alignment has been described as “fine-tuning” by Eylon S et al [28] in his study entitled “Outcome of illizarov ankle arthrodesis”. In recent times many authors have described arthroscopy in ankle fusion as a less-invasive means of preparing the bony surfaces at the fusion site [29]. This is a technique that we have not yet employed with our method of the Ilizarov ring fixation. However, the authors in the coming years are looking forward to study this approach of using arthroscopy combined with Ilizarov, which would improve soft-tissue management and could prove useful in conjunction with the reduced dissection and lack of indwelling hardware involved in our technique.

CONCLUSIONS

1. Ankle arthrodesis in difficult situations using Ilizarov technique shows a high fusion rate and allows early weight bearing with no major complications and operative failures.
2. Apart from providing a dynamic compression across the fusion site, the added advantage of using an Ilizarov fixator is the adjustments that can be made in the fixator in the post-operative period, thus correcting any errors that could occur during the surgery.
3. Based on these facts, Ilizarov arthrodesis is recommended for ankle in difficult situations and in the presence of multiple complexities.

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