ABSTRACT

Background: Arthrodesis of the ankle for diabetic complications such as Charcot neuroarthropathy (CN) and osteomyelitis is a distinct entity that requires various surgical techniques for optimal outcomes. When comparing external fixation and ankle arthrodesis nail-mounted compression devices, higher compression is reached and maintained in the case of the ankle arthrodesis nail-mounted compression device.

Aim of the study: The current study aimed to assess both functional and clinical outcomes of retrograde intramedullary locking nailing of ankle arthrodesis in diabetic arthropathy patients, as regard alignment, function, union, and rate of complications.

Patients and methods: This is a prospective clinical research including 12 diabetic individuals who had advanced ankle and subtalar joint instability and/or deformity due to ankle arthropathy. Patients underwent ankle arthrodesis using retrograde intramedullary locking nail to evaluate the clinical and functional outcome of retrograde intramedullary locking nailing of ankle arthrodesis in diabetic arthropathy patients, including function, alignment, union, and complication rate.

Results: The union duration of the studied group was (9.4±2.1) weeks ranged, most of the studied group (83.3%) had healing time. There was a highly statistically significant improvement in all items of the AOFSA Score post-operatively, mainly AOFSA pain, function, and alignment. About two-thirds (75.0%) of the studied group did not have pain post-operatively, (16.7%) of them had mild pain, while only (8.3%) of them had moderate pain. Almost all (91.7%) of the studied group did not have any difficulty on any surface, (8.3%) had some difficulty, and no one (0.0%) had severe difficulty. Most (83.3%) of the studied group had a normal gait, (16.7%) had obvious gait abnormality, and no one (0.0%) had marked gait abnormality. The entire studied group (100.0%) had severe restricted sagittal plane motion without any flexion or extension. Most of the studied group (83.4%) did not have any complications, (8.3%) of them had Periprosthetic fracture and (8.3%) had superficial infection.

Conclusion: The current study established that ankle arthrodesis with a retrograde intramedullary locking nail is an exceedingly successful salvage method for diabetic individuals with ankle and hindfoot problems. This technique results in a high level of functional improvement and pain reduction. When performed properly, it is a relatively safe procedure with favorable clinical results and a minimal chance of below-knee amputation.

Keywords: Ankle Arthrodesis, Retrograde Intramedullary Locking Nail, Diabetic Patients.

I. INTRODUCTION:

Arthrodesis of the ankle for diabetic complications such as Charcot neuroarthropathy (CN) and osteomyelitis is a distinct entity that requires various surgical methods for effective outcomes (I).
Diabetes mellitus is the most frequent cause of neuroarthropathy at the moment. Inappropriate nociception and proprioception result in gradual joint destruction. Despite technological advancements in treatment methods, definitive surgical management of arthropathy remains challenging. Ankle neuroarthropathy occurs in between 3% and 10% of diabetes patients. This results in severe ankle mortise instability, fracture, and collapse, and a high risk of lower limb amputation (2).

The medical state and various comorbidities of this population imply an increased risk of complications, which should be carefully considered before contemplating ankle arthrodesis (3).

Prior to any surgical repair, medical optimization via a multidisciplinary approach is advised. It has been demonstrated that hyperglycemia and/or peripheral neuropathy in diabetic patients results in variations in wound and bone healing (3).

Tibiotalocalcaneal (TTC) arthrodesis is recommended when the tibiotalar and subtalar joints are together irreparably damaged, in order to avoid the affected foot amputation. The reconstruction goal is to realign the foot and ankle in a plantigrade position, greatly lowering the risk of ulceration (4).

There have been reports of TTC arthrodesis using a variety of fixation techniques, including angled blade plates, screws, staples, intramedullary nails, plates, Steinmann pins, and external fixators (5).

Stable fusion is essential but hard to perform using conventional plates, pins, and screws because of the low bone quality and significant soft-tissue and bone loss accompanying the disease (6).

Since their introduction in the ankle arthrodesis field, intramedullary nails have been modified from simple straight nails to specially modified nails having suitable curvatures and internal compression capability (7).

They have been demonstrated to have a greater bending stiffness, better rotational stability, and a greater capacity for dynamic compression than crossed lag screws, external fixators, and blade plates (8).

Additionally, when compared to external fixation, an ankle arthrodesis nail-mounted compression device achieves and maintains higher compression. When utilized for tibiotalocalcaneal arthrodesis in diabetic arthropathy patients, studies have shown that the retrograde intramedullary nail usage resulted in an increased percentage of effective limb salvage, ranging between 50% and 90%. Infection, malunion, pseudoarthrosis, and hardware failure are all possible causes of failure (9).

The current study aimed to assess the functional and clinical outcome of retrograde intramedullary locking nailing of ankle arthrodesis in diabetic arthropathy patients as regard alignment, function, union, and rate of complications.

II. PATIENTS AND METHODS

2.1. The current study was a prospective clinical trial involving 12 diabetic patients with ankle arthropathy who had an advanced degree of ankle and subtalar joint instability and/or deformity and were admitted to the Orthopedic Department, Faculty of Medicine, Zagazig University between November 2020 and May 2021 after receiving approval from institutional review board (IRB) of Zagazig University.

2.2. Before the study was conducted, each subject signed a permission form approved by the Zagazig University council on human rights in research. The study was conducted in line with the World Medical Association Code of Ethics (Declaration of Helsinki) for human subject’s research.

2.3. The research involved diabetic patients with ankle arthropathy who had an advanced degree of ankle and subtalar joint instability and/or deformity, were in a quiescent phase of the disease stage II/III Charcot neuropathy according to the Eichenholz radiographic classification, and had adequate distal circulation.

2.4. All patients who were not diabetic, who had an active infection, stage 1 Charcot neuropathy, peripheral obstructive vascular disease, dementia or mental disorders, and who had clinical or radiologic signs of osteomyelitis were excluded from the study.
2.5. The patients who were suitable candidates and fulfilled the inclusion criteria of the study have been subjected to:

**Complete personal history:** name, age, gender, occupation, residence, and marital status.

**General Examination:**
A detailed examination of the body was conducted in order to rule out any related medical problems.

**General investigation.**
- Complete blood count (CBC).
- Fasting blood glucose.
- Hemoglobin A1c (HBA1c).
- Kidney functions, including blood urea nitrogen (BUN) and creatinine (CREA).

**Radiological evaluation:**
To identify the stage of illness and whether an active disease is present or whether the joint is stable (monitor serial radiographs).

Also, it assists in the identification of periarticular bone fragmentation, dislocations, fractures, osteopenia, and subluxations.

**Operative technique of arthrodesis with nail:**
The procedure was performed with the patient supine and wearing a tourniquet and was generally performed under regional or general anesthesia. The entire limb is prepared above the knee joint and draped.

Over the lateral malleolus, a lateral transfibular approach was applied. It was curved anteriorly towards the sinus tarsi beginning from a position approximately 6 cm from the lateral malleolus tip. A minor medial incision is frequently made to prepare the joint surface from the medial side in order to provide optimal bone-to-bone contact. The medial malleolus distal half is excised and utilized as a bone graft. The fibula is osteotomized, the fibulo-calcaneal ligament is cut, and the lateral malleolar fragment is posteriorly reflected. The posterior soft tissue is maintained to ensure the piece utilized as a strut graft maintains its vascularity. An osteotome is used to create bone cuts.

The foot's position in relation to the tibia was critical for fusion. The foot was positioned tibiotalar joint into 0° dorsiflexion, 5° valgus, and slight external rotation.

![Figure I](image)

**Figure (I):** (A) Intraoperative photographs showing lateral transfibular approach is used over the lateral malleolus. (B) The bony cuts are made by osteotome.

**Finding Nail Insertion Point**
On the foot plantar surface, a guidewire is used to indicate the beginning point (entry portal) for retrograde nailing. A line is drawn connecting the medial and lateral malleoli points. It is often located near the heel pad distal, somewhat lateral to the midline.
Another easy method of identifying the entry site is to keep a guidewire over the skin, in the dead center of the AP and lateral views of the tibia, as seen on the image intensifier. The guidewire should run through the talus body and through the ankle center.

Figure (II): (A) Intraoperative photographs showing Place of a guidewire in line with the center of the line joining medial and lateral malleoli, usually anterior to heel pad, guidewire placed in line, (B) guidewire pass through the body of the talus and through the center of the ankle.

Nailing Technique

At the insertion site, a vertical incision is made in the skin. The plantar fascia is incised. The soft tissues are stretched up to the calcaneal surface using artery forceps. Through the calcaneus, a guidewire is introduced into the tibia.

Neutral or mild dorsiflexion of the ankle was maintained. Precautions were taken to avoid heel varus and plantar flexion of the foot. Visual and fluoroscopic confirmation of the intended fusion site. It is critical to precisely set the guidewire to avoid postoperative malposition. Through the calcaneus, talus, and into the tibia, a 10 to 12 mm entrance reamer was utilized. Reaming was performed sequentially until the canal was about 1 mm bigger in diameter than the nail diameter to avoid tibial fracture. The nail was assembled over the zig and carefully hammered into the calcaneal surface, only a few millimeters inside to allow for compression. This is necessary because the nail protrudes from the calcaneal surface when the fusion site is compressed. It makes little difference if it is proud by 2 to 4 mm; because the calcaneal pitch was typically 30, the nail does not bear bodyweight directly. The tip is elevated above the surface that bears weight. A short nail might result in a stress riser fracture. It is necessary to use a longer nail.

After the nail is inserted, the fusion site is compressed manually. Certain companies have internal compression arrangements that include internal fixation, rod tightening, and external devices.
Prior to placing the calcaneal screw, the foot's position is assessed for varus/valgus and flexion/extension. Following completion of the compression process, the distal screw of the Calcaneus was inserted from lateral to medial with the target device. Compression was applied manually or, if available, via an internal/external compression device. The second screw, the talar screw, is introduced from the lateral to the medial aspect using the target device.

**Tibial Screws**

We used two screws into the tibia from medial to lateral or one from anteroposterior for the locking, which depends on the nailing system.

**Figure (III):** (A) Intraoperative photographs showing place of the guidewire in the exact position, (B) Entry of the reamer is used through the calcaneus, talus and into the tibia. Sequentially and, (C) Nail is a few mm inside the calcaneal surface to allow for compression.

Calcaneal and Talar screws

Prior to placing the calcaneal screw, the foot's position is assessed for varus/valgus and flexion/extension. Following completion of the compression process, the distal screw of the Calcaneus was inserted from lateral to medial with the target device. Compression was applied manually or, if available, via an internal/external compression device. The second screw, the talar screw, is introduced from the lateral to the medial aspect using the target device.

Tibial Screws

We used two screws into the tibia from medial to lateral or one from anteroposterior for the locking, which depends on the nailing system.
Fibular Strut Graft

The medial surface of the osteotomized lateral malleolar fragment was decorticated and stabilized with two cancellous screws, one in the distal tibia and one in the talus. The fibular grafts and Cancellous bone were placed between the talus and tibia as a bone graft. The incision was closed in layers over a drain, and a below-knee back slab was applied.

Postoperative Care

Following the operation, cold packs were used for four days with the limb elevated, and a splint was applied for about ten days. When the edema resolves, a below-knee plaster cast was applied, and the patient was instructed to avoid weight-bearing for six weeks. At 14 days, the dressing and sutures were removed. After that, gradual weight-bearing began. After three months, full weight bearing is permitted. After then, the patient was permitted to walk as tolerated. If required, shoe adjustments with a rocker bottom were offered.

Postoperative follow-up

After two weeks, six weeks, three months, and six months, follow-up was performed. At each visit, patients were clinically evaluated for wound healing, the neurovascular status of the limb, and infection. Additionally, the ankle area was examined radiographically for bone healing and alignment.

Blood glucose levels were monitored post-operatively to maintain adequate control. Throughout the follow-up phase, HbA1c values were determined every three months. The patients were evaluated for wound healing, wound condition, union, loosening, tract infection, construct stability, and screw loosening.
Post-operation complication as superficial wound infection was treated with 3rd generation cephalosporin antibiotic and regular dressing and advised to control of reading of blood sugar.

Delayed union was defined as the inability to achieve union within 30 weeks.

Nonunion was defined as the inability to achieve union by 40 weeks post-operatively and needing surgical intervention.

2.6. Statistical analysis:

Microsoft Excel software was used to code, input, and analyze data collected during the history, basic clinical examination, laboratory tests, and outcome measures. The data were then imported and analyzed using the Statistical Package for the Social Sciences (SPSS version 20.0) software. Depending on the kind of data, qualitative data were represented as numbers and percentages, while quantitative data were represented as mean ± standard deviation. The following tests were performed; The Chi-square test (X2) is used to determine the difference and association of qualitative variables, and the t-test was used to determine the differences between quantitative independent groups. P values of <0.05 were used to indicate significant results, while P< 0.001 indicated highly significant results.

RESULTS:

The age of the studied group was (55.9±4.7) years, ranging from 50 to 68 years. More than half of the group (58.3%) had ages ranging from 50 to 55 years. Among the studied group, 58.3% were males and 41.7% were females. One-quarter (25.0%) of the studied group were smokers, while 75.0% of them were non-smokers.

Two-thirds (66.7%) of the studied group were type II D.M, while 33.3% of them were type I D.M. Creatinine level of the studied group was (1.09±0.05) mg/dL, fasting blood glucose was168.9±55.1and HbA1c was (7.6±0.8).

The commonest surgical indication among (50.0%) of the studied group was Bimalleolar fracture 2ry osteoarthritis followed by avascular necrosis talus post dislocation, (25.0%) of the studied group Charcot neuropathy or peripheral neuropathy (16.7%) and lastly Ankle and subtalar arthritis with sever Varus deformity (8.3%) (Figure 1).

The union duration of the studied group was (9.4±2.1) weeks ranged from 6to14 weeks, most of the studied group (83.3%) had healing time ranged from 6 to 10 weeks (Table 1).

Time of full weight-bearing among the studied group was (14.4±1.5) weeks ranged from 9 to 17 weeks, most of the studied group (75.0%) had healing time ranged from 9 to 13 weeks (Table 2).

All items of the AOFAS Score post-operatively, mainly AOFAS pain, function, and alignment, showed a highly statistically significant improvement (Table 3).

About two-thirds (75.0%) of the studied group didn't have pain post-operatively, (16.7%) of them had mild pain, while only (8.3%) of them had moderate pain. Concerning function, most (83.4%) of the studied group could do their activity without limitation nor support and showed that (8.3%) had limitation of recreational activities without limitation of daily activities nor support and did their activity without protection, and (8.3%) had limited daily activities, and needed support and no one had severe limitation of daily and recreational activities.

Regarding maximum walking distance in blocks, this table shows that most of the studied group (83.3%) could walk more than 6 meters, (16.7%) could walk from 4 to 6 meters, and no one (0.0%) less than 4 meters. In regard to walking surfaces, almost all (91.7%) of the studied group didn't have any difficulty on any surface, (8.3%) had some difficulty, and no one (0.0%) had severe difficulty. Most (83.3%) of the studied group had a normal gait, (16.7%) had obvious gait abnormality, and no one (0.0%) had marked gait abnormality. The entire studied group (100.0%) had severe restricted sagittal plane motion without any flexion or extension (Table 4).

The entire studied group (100.0%) had stable hindfoot and marked restriction on motion inversion/ eversion without any motion. In regard to alignment, almost all (91.7%) of the studied group had a good alignment, (8.3%) had a fair alignment, and no one (0.0%) had a poor alignment (Table 5).
There was a highly statistically significant improvement (increase) in total AOFAS Score postoperative as it is concerted from NOV/2020 to MAY/2021 with (65.9%) overall percent of improvement in AOFAS Figure (2).

Most of the studied group (83.4%) did not have any complications. Only 8.3% had a periprostatic fracture, and 8.3% had a superficial infection (Table 6).

Table (1): Time of union among the studied group.

<table>
<thead>
<tr>
<th>Variable</th>
<th>The studied group (12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of union (Weeks):</td>
<td></td>
</tr>
<tr>
<td>mean ± SD (Range)</td>
<td>9.4±2.1 (6-14)</td>
</tr>
<tr>
<td>median</td>
<td>7.5</td>
</tr>
<tr>
<td>Variable</td>
<td>NO(12)</td>
</tr>
<tr>
<td>Time of union</td>
<td></td>
</tr>
<tr>
<td>6-10 weeks</td>
<td>10</td>
</tr>
<tr>
<td>10-14 weeks</td>
<td>2</td>
</tr>
</tbody>
</table>

Table (2): Time of full weight bearing among the studied group

<table>
<thead>
<tr>
<th>Variable</th>
<th>The studied group (12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of full weight bearing (Weeks):</td>
<td></td>
</tr>
<tr>
<td>mean ± SD (Range)</td>
<td>14.4±1.5 (9-17)</td>
</tr>
<tr>
<td>Median</td>
<td>13.5</td>
</tr>
<tr>
<td>Variable</td>
<td>NO(12)</td>
</tr>
<tr>
<td>Time of full weight bearing</td>
<td></td>
</tr>
<tr>
<td>9-13 weeks</td>
<td>9</td>
</tr>
<tr>
<td>13-17 weeks</td>
<td>3</td>
</tr>
</tbody>
</table>

Figure (1): Pie chart for surgical indications among the studied group

Table (3): Pre and post-operative AOFAS Score among the studied group.

<table>
<thead>
<tr>
<th>AOFAS Score (Max.=40)</th>
<th>Pre-operative mean ± SD (Range)</th>
<th>Post-operative mean ± SD (Range)</th>
<th>Test</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>50.00%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25.00%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.70%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.30%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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| Pain score (Max.=40) | 12.8±5.5 (0.0-30) | 36.8±2.5 (20-40) | 12.6 | 0.001** |
| Activity limitation (Max.=7) | 3.1±0.7 (0.0-4) | 6.8±0.03 (4-7) | 9.8 | 0.001** |
| Maximum distance walking (Max.=5) | 1.7±0.01 (0.0-2) | 4.3±0.03 (2-5) | 4.9 | 0.002* |
| Walking surface (Max.=5) | 1.9±0.05 (0.0-3) | 4.6±0.03 (2-5) | 4.5 | 0.003* |
| Gate abnormality (Max.=8) | 2.1±0.8 (0.0-4) | 7.6±0.2 (4-8) | 7.9 | 0.001** |
| Sagittal motion (Max.=8) | 3.2±0.6 (1-4) | ----- | ----- |
| Motion inversion/ eversion (Max.=6) | 1.9±0.05 (1-3) | (0.0) | ----- | ----- |
| Hind-foot instability (Max.=8) | 2.1±0.08 (0.0-3) | 7.9±0.001 (7-8) | 8.3 | 0.001** |
| Alignment (Max.=7) | 2.1±0.8 (0.0-7) | 6.8±0.001 (6-7) | 7.5 | 0.001** |

Table (4): Post-operative AOFAS Score (walking distance and surfaces, gait abnormality & Sagittal plane motion) among the studied group.

<table>
<thead>
<tr>
<th>AOFAS Score</th>
<th>Variables</th>
<th>The studied group(12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum walking distance in blocks (meter)</td>
<td>&gt;6 (meter)</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>4-6(meter)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1-3(meter)</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>&lt;1 meter</td>
<td>0.0</td>
</tr>
<tr>
<td>Walking surfaces</td>
<td>No difficulty on any surface</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Some difficulty</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Severe difficulty</td>
<td>0.0</td>
</tr>
<tr>
<td>Gait abnormality</td>
<td>None/ slight</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Obvious</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Marked</td>
<td>0.0</td>
</tr>
<tr>
<td>Sagittal plane motion (F/E)</td>
<td>Normal or mild restriction (&gt; 30°)</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Moderate restriction (15 to 29°)</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Severe restriction (&lt; 15°)</td>
<td>12</td>
</tr>
</tbody>
</table>

Table (5): Post-operative AOFAS Score (Motion inversion/ eversion, hindfoot instability & alignment) among the studied group

<table>
<thead>
<tr>
<th>AOFAS Score</th>
<th>Variables</th>
<th>The studied group(12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motion inversion/ eversion</td>
<td>Normal/ mild restriction (75 to 70%)</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Moderate restriction (25 to 74%)</td>
<td>0.0</td>
</tr>
<tr>
<td></td>
<td>Marked restriction (&lt; 25%)</td>
<td>12</td>
</tr>
<tr>
<td>Hind-foot instability</td>
<td>Stable</td>
<td>12</td>
</tr>
</tbody>
</table>
Diabetic patients are prone to all common ankle diseases that cause intractable pain and loss of function. When conservative methods or other less invasive treatments fail, surgical intervention should be considered. Ankle arthrodesis or tibiocalcaneal arthrodesis is the most reasonable surgical option in such patients because diabetics are exposed to lower limb vascular and neurologic complications, ulcers, and infections. Tibiocalcaneal arthrodesis is a well-known salvage surgical procedure that became popular with the introduction of retrograde intramedullary ankle nails into clinical practice. Its goal is to restore proper foot-ankle-leg alignment in order to provide the patient with stable and painless support. Its indications are restricted as a consequence of the noticeable loss of function owing to the sacrifice of the ankle and subtalar movement.

Tibiocalcaneal arthrodesis with intramedullary nail fixation has demonstrated good short- and long-term clinical outcomes in general practice. However, few studies have investigated outcomes in diabetic patients, and most of them considered Charcot arthropathy alone.

The age of the studied group in the current study was (55.9±4.7) years, ranging from 50 to 68 years. More than half of the group (58.3%) had ages ranging from 50 to 55 years, 7 patients (58.3%) of the studied group were males, and 5 patients (41.7%) were females. This is close to the Verdin and Rao (11) who reported that the mean age was 58.1 (20-71) years, but regarding sex, it was in contrast to our results where 4 patients (25%) were males, and 12 patients (75%) were females.

Siebachmeyer et al. (12) also reported that the mean age of the patients was 62.6 years (46 to 83). Among the studied group, 12 patients (60%) were males, and 8 patients (40%) were females.

The current study showed that 3 patients (25.0%) of the studied group were smokers while 9 patients (75.0%) were non-smokers. Chraim et al. (9) found that 7 patients (38.88%) were smokers, and 11 patients (61.12%) were non-smokers.
The current study showed that the commonest surgical indication among 50.0% of the studied group was Bimalleolar fracture 2ry osteoarthritis followed by avascular necrosis talus post dislocation (25.0%) of the studied group Charcot neuropathy or peripheral neuropathy (16.7%) and lastly, Ankle and subtalar arthritis with sever Varus deformity (8.3%). On the other hand, Wukich et al. (2) reported that the commonest surgical indication was Charcot neuroarthropathy in 44 patients (72.13%), ankle and subtalar joints osteoarthritis in 8 patients (13.12%). Traumatic arthritis in 6 patients (9.84%), Failed total ankle replacement in one patient (1.64%) and Revision arthrodesis in 2 patients (3.28%).

The current study showed that the union duration of the studied group was (9.4±2.1) weeks ranged from 6 to 14 weeks, most of the studied group (83.3%) had healing time ranged from 6 to 10 weeks. But Suo et al. (13) reported that 14.83 ± 2.14 weeks was the mean time to bone union.

The current study showed that the time of full weight-bearing among the studied group was (14.4±1.5) weeks ranged from 9 to 17 weeks, most of the studied group (75.0%) had healing time ranged from 9 to 13 weeks. DeVries et al. (14) reported that the average time to partial and full weight-bearing was 70.6 ± 25.4 days, and 100.6 ± 35.5 days, respectively.

Cianni et al. (15) reported that the functional outcomes according to the AOFAS score were good, with a full weight-bearing in a mean of 4 months. Mendicino et al. (16) reported that the average time to full weight-bearing was 130 days.

The current study showed a highly statistically significant improvement as regards all items of the AOFSA Score post-operatively, mainly AOFSA pain, function, and alignment.

El-Mowafi et al. (17) reported that at the last follow-up, none of the patients included in the study experienced ankle pain, and the mean AOFAS score was improved significantly from 34.6 ± 6.8 to 66.4 ± 4.5 (P = .032). Lee et al. (4) reported that of the 20 patients, 76.9% had improvement in their activity post-operatively. Also, 81.8% were able to resume their pre-operative work after a mean of 7.89 (range 3 to 24) months.

Mosca et al. (18) reported that all patients returned to daily activities, with an average time of 24.7 ±8.7 weeks. 6 patients could return to their previous work activity, with an average time of 23.6 ±6.3 weeks.

Most (83.3%) of the studied group had a normal gait, (16.7%) had obvious gait abnormality, and no one (0.0%) had marked gait abnormality. The entire studied group (100.0%) had severe restricted sagittal plane motion without any flexion or extension.

Elgohary and Elghaffar (19) reported that the foot function index showed a significant improvement (P <0.01) from a pre-operative mean of 77 (range: 70.6 to 84) points to 30.1 (range: 32.4 to 27.6) points by the last follow up.

Vitiello et al. (10) reported that all patients with Charcot arthropathy had good functional recovery with full weight bearing on the affected side. In all cases, satisfactory consolidation was observed. Three cases of bone union and one case of firm fibrous union were observed. All patients (100%) had good alignment and stability. The current study showed that the initial pre-operative AOFSA Score of the studied group was (24.6±9.5) improved to 90.5 ± 9.06 postoperative with a highly significant difference in total AOFSA Score postoperative. Vitiello et al. (10) reported that the mean overall improvement in the AOFAS score was 72.5% (preoperatively: 40 points versus post-operatively: 69 points [range: 48-83 points]), with a highly statistically significant difference (p<0.001).

Lee et al. (4) reported that the AOFAS AHS score showed a significant improvement (p<0.001). from 54.20 ±15.71 preoperatively to 76.0 ± 11.63 post-operatively

The current study showed that most of the studied group (83.4%) didn't have any complications, (8.3%) of them had a periprostatic fracture, and (8.3%) had superficial infection.

Infected patients recovered with antibiotic treatment and aseptic dressings, and the infection did not appear to have any long-term effect on bone healing or the patient's rehabilitation.
Wukich et al. (2) reported superficial (mild) infection in 8 patients (13.1%), deep (major) infection in 10 patients (16.4%), and a tibia fracture at or above the proximal nail tip in 4 patients (6.56%). The great difference may be due to the large number of patients included in their study (61 patients).

V. CONCLUSION

It can be concluded, on the basis of the current study, that Ankle Arthrodesis with Retrograde Intramedullary Locking Nail in Diabetic Patients is an incredibly effective salvage method for ankle and hindfoot problems in diabetic patients. This procedure results in a high level of functional improvement and pain reduction. It is relatively safe with favorable clinical results and a minimal chance of below-knee amputation, when correctly indicated.

Further studies in multi-center studies with a large number of patients and a long period of follow-up are needed to confirm our findings.

Conflict of Interest: No conflict of interest.

REFERENCES