Short-term Results of arthroscopic arthrodesis of Ankle with excessive varus deformity by complete deltoid release technique

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Abstract

Purpose

The objective of our study is to provide a better treatment option to patients with degenerative ankle deformities with varus of greater than 25^0 to achieve painless mobilization.

Methods

Our senior Surgeon performed arthroscopic fusion for varus ankle deformities of larger than 25 degrees in 64 of our patients. Prior to surgery, we managed our patients conservatively for a period of 6 months. Following surgery, we follow the patients for 6 up to 18 months. We used the curved curetteor and microfacture tool to release the deltoid ligament allowing us to fix larger degree of deformities. X-ray was used pre-operatively to assess the damage and deformity of the ankle and post operatively to assess the union during follow up. SPSS 17.0 windows software (Chicago,IL) was used for statistic to compare our group of patients with a groups of patients with ankle deformities of less than 25^{0}. The Wilcoxon Signed Rank (WSR) test was used for repeated measures. Categorical variables were compared using Fisher's Exact (FE) test and the Mann−Whitney (MW) test was used to analyze pre-and postoperative AOFAS. We used the modified Mazur Grading System to evaluate the ankle union.

Results

The Union rate achieved in both Groups was ≥ 90%.

Conclusion

This technique is successful in treating varus ankle arthritis larger than 25 degrees.

1 Introduction

The ankle joint, which absorbs more force per square centimeter of surface area than any other joint in the body, is the most often injured joint in the body. Trauma to the ankle joint, such as Weber A to C fractures, pilon fractures, osteochondral injuries to the talus, as well as lateral ankle ligament sprains and laxity, are the most prevalent contributing causes to the development of ankle arthritis. In advanced ankle osteoarthritis, the most noticeable symptoms are primarily painful walking and significantly limited ankle mobility, both of which have a negative impact on the patient's overall quality of life.[1] Ankle osteoarthritis, in contrast to hip arthritis and knee arthritis, is mostly induced by trauma and is thus classified as a secondary osteoarthritis. It is responsible for around 75% of all ankle joint disorders.[2] Osteoarthritis secondary to other conditions, such as rheumatoid arthritis, neuropathic joint disease, pigmentation, and post-infection lesions, accounts for about 12% of all occurrences of the condition.[3] Advanced ankle osteoarthritis is a clinical chronic degenerative condition that affects many people. It is characterized by cartilage deterioration, subchondral osteosclerosis, the formation of periarticular osteophytes, and the deformity of the joints. The most common signs are persistent discomfort and abnormalities of the joints. The effectiveness of nonsurgical therapy for advanced ankle osteoarthritis is often insufficient, and surgical treatment options are many and versatile.

Ankle arthrodesis is the “gold standard treatment” to treat degenerated painful ankles which could not be treated with the conservative methods. The purpose of ankle arthrodesis is to correct the deformity, minimize or eliminate the pain from the degenerative joint and achieve plantigrade position of the foot to ensure painless movement.[4],[5] Ankle arthrodesis was developed to achieve better results than the traditional open fusion methods by using minimally invasive procedures, which help to preserve talar bone blood supply as well as minimizing damage to the surrounding soft tissues. Arthroscopic technique held several advantages over the open approach as it is minimally invasive, thus it has low risk of complication, decreased morbidity postoperatively, small amount of blood loss, absence of limb-threatening complications, earlier hospital discharge, quicken time for rehabilitation and mobilization as well as less time to union.[6]

Over the years we have revised our technique repeatedly to treat patients more efficiently by decreasing post surgical complications. The main indication was to treat varus ankle deformity with degrees of less than 25^0. Our aim is to use our surgical technique to release the deltoid ligament in order to treat patients with varus ankle deformities of more than 25 degrees.

2 Materials and Methods

The procedure was performed for arthroscopic fusion of varus ankle arthritis of our institution directly under the supervision of our senior surgeon. The patients were grouped into group A (deformities larger than 25 degrees in 34 pataients) and group B (less than 25 degrees in 30 patients). The patients complained of swelling and pain in the right foot without apparent cause one year ago. The X-ray examination showed degenerative changes in the right foot and abnormal signals in the subtalar joint. The Chief complaint for most patients were right foot pain with limited movement for more than one year. Before patients underwent surgery, they were treated conservatively for at least six months by anti-inflammatory medication, orthoses, bracing, and walking aids.

Inclusion criteria: patients with ankle deformity in the coronal plane with primary osteoarthritis, rheumatoid arthritis, post-traumatic arthritis as primary diagnosis were included.

Exclusion criteria: subtalar arthritis were excluded because a combined surgery procedure was needed. Cases with concomitant diseases, sensory neuropathy, tuberculosis, arthritis Charcot’s disease, active infection, and tumour were all excluded due to various factors that may influence prognosis.

We performed our procedure on 64 feet of 64 patients as shown in Table 1. We followed the patients for a minimum period of 6 months up to 18 months, with an average follow–up of 12months.

Table 1
Causes of the ankle deformities in both groups of patients

Causes of arthritis	Post-traumatic Osteoarthritis	Primary Osteoarthritis	Osteonecrosis AVN	Rheumatoid arthritis	Osteochondral lesion
All cases (n = 64)	32 (50.0%)	13 (20.3%)	5 (7.8%)	11(17.2%)	3 (4.7%)
Group A (n = 34)	17 (50.0%)	7 (20.6%)	2 (5.9%)	2 (14.7%)	3 (8.8%)
Group B (n = 30)	15 (50.0%)	6 (20.0%)	3 (10.0%)	6(20.0%)	0

Post-traumatic was the most common cause of disabling ankle pain in both groups A and B ($p < 0.001$).

Group A: patients with varus ankle deformity with degrees > 25^0.

Group B: patients with varus ankle deformity with degrees < 25^0.

Between the two groups, the null hypothesis was suggested that the fusion time (weeks), rate of fusion, unplanned aprocedures, complications and outcome of clinical subjective were significantly different between the two respective groups. The mean operating age was 47.39 ± 5.93 (35 to 63 range) years. Regarding the above parameters, no difference existed between the two parameters by the alternative hypothesis. Thirty-five patients (35 ankles) were males, and (29 ankles) twenty-nine were females. Thirty-three ankles were right ankle, and Thirty-one left ankles were fused. The preoperative condition was post-traumatic osteoarthritis in 32 ankles (50.0%), primary osteoarthritis in 13 ankles (20.3%), rheumatoid arthritis in 11 ankles (17.2%), osteonecrosis of the talus in 5 ankles (7.8%), an osteochondral defect of the talar dome in 3 ankles (4.7%).

2.1 X-ray measurement

Postoperative review of radiographs and medical records for all ankle examinations with clinical and radiographic union, the presence of severe residual pain, complications, metal removal if necessary, unanticipated operational procedures, and subjective clinical outcomes. A blinded observer who is not a surgeon measured before and postoperative radiographs. Label details were covered, and both preoperative and postoperative radiographs for the patients were not inspected sequentially. Laboratory and instrument inspection X-ray examination showed degenerative changes in the foot and abnormal signals in the subtalar joint. Figure 1 below shows the preoperative and postoperative radiographs.

2.2 Surgical technique

In our arthroscopic procedure, the patient was placed in a supine position while undergoing the process of general anaesthesia or a region block. The patient was administered with intravenous antibiotics preoperatively (often first-generation cephalosporin). Then supports (lateral support was added with the help of clamp and sockets) were placed laterally on the hip of the operating side. Marking lines were drawn around the medial and lateral malleoli using a surgical pen and imaginary lines were drawn on the location to be cautious during surgery (Fig. 2). Tourniquet was applied on the thigh to maintain the bloodless field. It was inflated during the time of surgery. Prepping and draping were done according to the standard procedure by creating skin incision portals, using a blunt dissection technique for subcutaneous tissue to avoid the formation of painful neuroma. Before approaching the joint, 10-20ml of 0.9 percent normal saline was injected into it using an 18-gauge needle to increase the space. This is done so as to know the position of the flexible needle refilling of the syringe corridor at the passive capsular to confirm the correct needle position, by first establishing an anteromedial portal (AMP) (medial to the anterior tibialis tendon) as shown in Fig. 2b.

A blunt hemostat is used to dissect the medial aspect of the joint after creating a minor longitudinal incision of 2 to 3 mm through the skin. The fluid is extraverted out of the joint as the joint is pierced with a sharp hemostat, showing that the joint cavity has been reached. After that, the arthroscopic cannula is inserted. The introducer was then withdrawn, and a 3.0 to 4.0-mm, 30° angled arthroscope (Dyonics Smith and Nephew, Andover, MA) was positioned, with fluid flow regulated by an arthroscopy hydraulic pump at 50 mmHg pressure.

For the next step involving the anterolateral portal (ALP) (Fig. 2d), the marked 18-gauge needle was placed again at the central aspect of the joint at the lateral site of the extensor digitorum communis tendon. The needle can be seen via arthroscope to make sure that it is on the lateral site. Then by removing the needle, a laterally anterolateral portal (ALP) was created by allowing all the instruments direct access at the centre. That's how two ports were ready to access for debarment of the synovium from the joint. While making the anterolateral portal (ALP), always pay attention towards superficial peroneal nerve for it must not be damaged.

The third portal, anterocentral portal (ACP), was formed as an additional portal next to the anteromedial portal on the lateral side of the portal to assist the surgeon in more accurate view of the portal established between medially (extensor hallucis longus muscle) and laterally (Extensor digitorum longus muscle) as shown in Fig. 2c. To prevent injuring the anterior tibial neurovascular bundle, extreme caution must be used. This portal is used to distract by putting a big blunt trocar into the joint. To ensure of being on the medial side (Extensor digitorum longus muscle), (EDL) tendon was located and used as guide all the time we do this procedure to avoid injuring the anterior tibial neurovascular bundles. We usually complete maximum process with arthroscope through the anteromedial portal(AMP), and for the instrument, we typically use the anterolateral portal (ALP).

We used an alternating manner for both portals of the instrumentation and for viewing. Synovectomy and debridement was initially done to the fibrous scars tissues carefully by using a 4-mm synovial resector

(Dyonics) to visualize and examine properly inside the joint. Poor debridement on the ankle joint can compromise the ankle fusion rates as it was suggested in several previous studies and investigations.[7],[8] After that, to freshen the joint surface, a 4-mm acromioplasty burr (Fig. 3b), a shaver, and multi-angled curettes were used on the joint surface of the tibia and the talus, including the medial and the lateral gutters at articular cartilage to remove all the osteophytes in the lateral drain to make room for talus lateral relocation. Then, we preserved the subchondral bone, and removal of the calcified cartilage had been done till the cancellous bone is visualized at both of the tibiotalar surfaces. Once it is visible, the instruments were exchange in the ports as this helped to freshen and visualize the zone. Always we paid attention and cared for the anatomy and the geometry of the joint as previous technique described; fibular intraarticular resection was performed too. [9],[10] Posterior to interosseous ligament, debridement was done to protect sinus tarsi vasculature and must be visible for adequate joint debridement (Fig. 3c,d). No bone graft was done. We added the medial midline portal to the anterior tibial tendon to view the medial deltoid ligament clearly. The deltoid ligament was totally cut by a basket punch, which was inserted from the anteromedial portal anteriorly until the posterior tibial tendon was visualized. This vital technique step is a unique configuration that causes the release of the deltoid ligament, which allows us to fix larger degree of deformities through the lateral gutter of articular cartilage. This is our innovative idea to achieve arthroscopic fusion for varus ankle arthritis larger than 25 degrees to preserve the talus' curvature and avoid being exposed unnecessary when freshening the anterior part of the tibial plafond. We don't use bone graft in this procedure, and the skin of the portals can be sutured

2.2.1 Screw fixation technique:

As shown in Fig. 4, an adequate amount of bleeding had been observed in the tubercular bone; then, we can introduce three guiding pins. Here we explain in details how does it go. First, it is necessary to keep the foot in the neutral position for the varus deformities as with internal rotation of the talus. The traction is released so the foot can be in the neutral position. The pin is introduced following through the coronal plane of the foot passing through calcaneus, talus and then into the tibia to maintain the foot into dorsiflexion neutral position, with 0° to 5° hindfoot valgus and external rotation equal to that of the opposite side. The use of this pin is to guide the surgeon and maintaining the foot in its neutral position.

However, if on the opposite sideof the ankle the flexor hallucis longus muscle is aberrant we put the operative ankle in a 5° to 10° external rotation position (Fig. 4a). [11],[12] The first pin was drilled percutaneously from the tibial fold into the talus anteromedially. This pin is 3 cm away from the ankle. The second pin must be drilled anteriorly to the talus while being careful not to harm the anterior tibial neurovascular bundle. The two pins (k wire) had been connected in parallel (or in some cases almost parallel). The first pin was placed in the talus to correct the varus deformity as well as the internal rotation of the talus on the medial side of the tibia, while the second pin was placed 1cm proximal and 0 to 1 cm anterior to the first. Proximal to distal, posterior to anterior, and medial to lateral are the orientations. It is vital to examine the position of the pins to ensure that they are in their right location, which is in the tibia and the talar dome. If not, it may be reintroduced and their placements confirmed using guided fluoroscopy.

The third pin was then drilled percutaneously anterior to the fibula through the tibia and anterolaterally into the talus, taking care not to injure the superficial peroneal nerve during this procedure. Always remember that the pins should not cross one other (Fig. 4b). Drilling too near to the centre of the ankle must be avoided. Once the reduction has been attained, the surgeon's hands may perform a reduction technique to secure the talus in place. If the pin location and length are correct, the guided pin that was drilled to direct the surgeon and preserve the stability and position of the foot may be withdrawn. Small insertions were then created around the pins to act as an entrance point for the screws.

To achieve the goal of fixation, three large cannulated interfragmentary compression percutaneous screws were used. AutoFix 6.5- or 7.0 mm compression screws were used for the fix arthrodesis (Fig. 4c,d). Every steps were monitored under fluoroscopy. All three pins were removed after fixing the screws, and then skin incisions were closed by standard sutures. Before completing the last incision, platelet rich plasma (PRP) was injected into the joint and sterile bulky dressing with a posterior splint was applied.

2.3 Postoperative care

Postoperatively, instruction was given to the patient for immobilisation without weight bearing for 6 weeks and a cast was applied below-knee level. The patient can be discharged 5–8 days after surgery, depending on the patient's condition. The cast was removed after six weeks, then partial weight bearing was allowed. Then with the assistance of crutches, walking was allowed for 4–6 weeks. Progressive weight-bearing training was allowed in a swimming pool until radiographs conclusively showed union and no pain with ambulation in the patients. Patients - follow-ups were done regularly at two weeks, six weeks, ten weeks, three months, six months, and one year (see Fig. 5). Also, patients’ radiological fusion was monitored. Usually, most of them achieved total fusion within 3–6 months in all patients.

2.4 Statistical analysis

Statistical analysis was performed using SPSS 17.0 windows software (Chicago, IL). The Wilcoxon Signed-Rank (WSR) test was used for repeated measures. Categorical variables were compared using Fisher’s exact (FE) test. The Mann–Whitney (MW) test, was used for statistical analysis of pre-and postoperative AOFAS. The significant level was defined as $p < 0.05$.

3 Results

There were 64 patients with mean age of 47.39 ± 5.93 (35 to 63 range) years old in this study. While performing the arthroscopic procedure, there was no need to switch to open ankle arthrodesis in any of the cases. We divided the patients into two groups (Group A > 25° & Group B < 25°). In Group A, we included 34 patients with varus ankle deformities of > 25°and 30 patients in Group B with varus ankle deformities of < 25°. Both groups were matched and sub-divided into Gender (M/F), Operation side (R/L), Age, No. of days admitted, time for union (weeks), Union rate, Follow up (months), Mazur score (mean). The combined average no. of days patients were admitted to the hospital was 5.36 (range 2–11 days). The results is summarised in Table 2.

Table 2
Results of arthroscopic fusions

	Total cases	**Group A > 25°**	**Group B < 25°**	***P* value**
Gender (M/F)	35/29	18/16	17/13	-
Operation side (R/L)	33/31	19/15	14/16	-
Age	**47.39 ± 5.93**	**47.88 ± 5.97**	**46.9 ± 5.9**	-
No. of days admitted	**5.36 (2–11)**	**4.32 (2–10)**	**6.4 (2–12)**	0.0026 **
Time for union (weeks)	**14.47 (8.5–21.5)**	**12.71 (7–19)**	**16.23 (10–24)**	0.0007 ***
Union rate (> 90%)	64	34	30	< 0.0001****
Follow up (months)	**38.10 (9–72)**	**54.29 (8–90)**	**21.90 (10–54)**	< 0.0001****
Mazur score (mean)	**81.88 ± 7.42**	**85.38 ± 6.911**	**78.37 ± 7.924**	< 0.0001****

Summary of the results of the study, mean values are presented in bold. SD – standard deviation, MW – Mann–Whitney test,, $p < 0.05$, * = significant, ns = not significant.

Group A: patients with varus ankle deformity with degrees > 25^0.

Group B: patients with varus ankle deformity with degrees < 25^0.

The mean stay for patients in Group A was 4.32 days (range 2–10) compared to a mean of 6.4days (range 2–12) in Group B **which is statistically significant (p < 0.05)** (Fig. 6a). There were 24 and 10 patients with hospital stay of less than 5 days in Group A and B respectively and there were 10 and 20 patients with hospital stay of more than 5 days in Group A and B respectively **which was statistically significant (p = 0.0054) indicating that Group A had better outcome compared to B** (Fig. 6b).

The combined time of union of the two groups occurred at a mean of 14.47 (range 8.5–21.5 weeks). The mean time of union for patients in Group A was 12.71 weeks (range 7–19) compared to a mean of 16.23 weeks (range 10–24) in Group B **which is statistically significant (p < 0.05)** (Fig. 6c). There were 28 and 12 patients with time for union of less than 15 weeks in Group A and B respectively and there were 6 and 18 patients time for union of more than 15 weeks in Group A and B respectively which **was statistically significant (p = 0.0007) indicating that Group A had better outcome compared to B** (Fig. 6d). The union rate achieved in both groups were > 90% as shown in Table 2.

The follow-up averaged for a combined mean of 38.10 months for the two groups (range 9–72 months); The mean time of followup for patients in Group A was 54.29 months (range 8–90) compared to a mean of 21.90 months (range 10–54) in Group B **which is statistically significant (p = < 0.0001)** (Fig. 6e). The follow up of < 24 months was observed in 10 and 20 patients in Group A and B respectively and a follow up of > 24 months was observed in 24 and 10 patients in Group A and B respectively **which was statistically significant (p = 0.0054) indicating a better follow up outcome in Group A** (Fig. 6f).

The mean Mazur score was 81.88 ± 7.42 for all 64 patients. The mazur score mean ± SD was 85.38 ± 6.91 in Group A and 78.37 ± 7.924 in Group B and *p* value is < 0.0001 and is **statistically significant** (Fig. 6g). The mazur score of 92% was observed in 8 and 0 patients in Group A and B respectively, score of 87–92% was observed in 16 and 10 patients in Group A and B respectively, score of 65–87% was observed in 10 and 20 patients in Group A and B respectively which was statistically significant (p = 0.0054) indicating a **better follow up outcome in Group A** (Fig. 6h). The fusion rate of 90% was observed in 4 and 22 patients in Group A and B respectively and a rate of > 90% was observed in 30 and 8 patients in Group A and B respectively which **was statistically significant (p = < 0.0001) indicating a better outcome in Group A** (Fig. 6i).

4 Discussion

During the 1994 meeting of the Arthroscopy Association of North America, a review of 9 patients who had arthroscopic subtalar arthrodesis was presented.[13] Since then, many surgeons have performed arthroscopic subtalar arthrodesis in patients using supine or later positions through anterolateral and posterolateral portals.[13],[14],[15] Long-term follow-up for the treatment of ankle arthritis through the arthroscopic procedure used in ankle arthrodesis offered long-lasting results.[16],[17] Excessive stiffness in the soft tissues might make it impossible for the reduction. Thus, while patient is under general anaesthesia, intraoperative fluoroscopy and stress radiography, combined with clinical examination are performed to determine whether deformity is correctible before the surgical procedure. It is necessary to inform the patient that the presence of coronal ankle malalignment correction will be done arthroscopically by fusion. Sometimes, the deformity in some patients seems to be uncorrectable arthroscopically. Therefore open surgery will be done and patients ought to have been briefed already.

Debridement posterior to interosseous ligament and removal of the cartilage of posterior subtalar joint was done; it was a standard practice, commonly performed by fusing posterior facet in arthroscopic isolated subtalar arthrodesis allowing for proper bony fusion of the subtalar arthrodesis. [18],[19],[20],[21] Furthermore, we should bear in mind that persistent talar tilt may promote hindfoot destabilization and the development of peritalar instability, hence talar rotation has been shown to be critical for appropriate ankle fusion.[22]

Arthroscopy is not recommended if a joint is misaligned. Nonetheless, some investigators attempted to go on with the procedure. [12],[23] In all arthroscopic fusion procedures, it is necessary to apply force under the foot in an upward direction, which helps in maintaining compression on the talus and the tibia as described in other studies.[17] There are over 40 techniques reported in the literature, such as external fixation devices, intramedullary nails (IMNs), open crossed screw constructs and plates. [24],[25] Knowing the indications and contraindications for arthroscopic arthrodesis, only screws are usually chosen. Ferkel et al. [26],[27] described the insertion of two cannulated screws, one from the medial malleoli and the other from the lateral malleoli. Other researchers employed two screws that originated from the posterior part of the malleoli and were oriented 30° inferiorly and 30° anteriorly via two cannulated percutaneous ACE 6.5-mm screws. The screws were maintained parallel on both AP by entering them medially from the tibia into the talus, as described by Winson et al. [12], and the lateral views may be seen on imaging. Arthrodesis was repaired using four 6.5-mm cancellous lag screws, according to Zwipp et al. [28]

Contrarily to the other methods, our technique uses three cannulated percutaneous screws of 7.0 mm to achieve arthrodesis. We received 100% union rate by placing all three screws in inverted triangle shape manner appearances of screws in anterior posterior view of foot in in flouroscpoie. This technique is an essential step as the release of the deltoid ligament can help clean the osteophyte and stabilize the screws to correct deformities obtained through the lateral gutter, which allows us to fix even larger degrees of deformities. We used a modified Mazur Grading System to evaluate the ankle union as shown in Table 3. ([29]

Table 3
Modified Mazur Grading System

Excellent	80–90 points.
Good	70–79 points.
Fair	60–69 points.
Poor	< 60 points

In this grading scale system, 100 points means a perfect result. Note that the ankle motion scores up to 10 points. During the evaluation in our patients for arthrodesis, we achieved a maximum score of 90 points. In this Mazur ankle grading scale, out of 90 points, we gave 50 points for the pain. Other various factors were included in the Mazur ankle grading scale scoring system, such as; the use of support, function of foot, walking distance ability, ability to climb up and down the stairs, ability to walk up and down the hill.

This unique configuration is our innovative idea to achieve arthroscopic fusion for varus ankle arthritis larger than 25 degrees through the lateral gutter by releasing the deltoid ligament (Fig. 7). Compared to external fixation, internal fixation may provide a higher fusion rate and earlier recovery even for the greater degree. This method is more beneficial to patients and avoids serious complications, such as soft tissue infections.[30] Indications of the procedure may vary in different cases, like patients with ankle instability, neurological conditions, post-traumatic conditions, idiopathic cases, and we did this procedure on only correctable malaligned arthritis of the ankle. Contraindications of the procedure if patients have an active infection, have larger bone defects in some cases, stiff malalignment of the joint, autologous grafting or arthroplasty was contraindicated, and revision on previous non-union joints.

5 Conclusions

To conclude, this technique allows good visualization, presentation, preparation, and observation of the joint in arthroscopic fusion for varus ankle arthritis larger than 25 degrees**.** This arthroscopic approach also allows seeing deeper parts of the talonavicular joint and increasing the fusion rate. It aids in the natural realignment of the tibiotalar joint in ankle arthritis. Furthermore, it minimizes the likelihood of open surgical problems, especially in cases with severe yet flexible varus for end-stage arthritis. However, open reduction seems to be a more logical approach in some cases, such as severe bone deformity.

Declarations

Conflicts of Interest: The authors declare no conflict of interest.

Author Contributions: Conceptualization, Abdul Aleem Khan and Jianchao Gui; Data curation, Abdul Aleem Khan, Kaibin Zhang, Yang Li and Yiqiu Jiang; Formal analysis, Abdul Aleem Khan and Kaibin Zhang; Supervision, Jianchao Gui; Validation, Jianchao Gui; Writing – original draft, Abdul Aleem Khan; Writing – review & editing, Tianqi Tao and Jianchao Gui.

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Figures

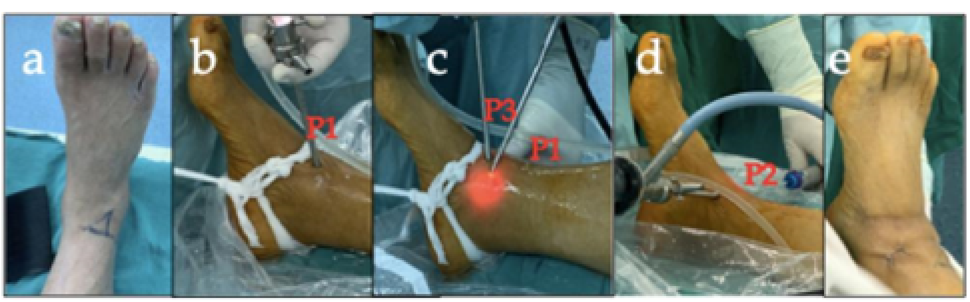

Figure 1

The radiograph of the ankle preoperatively (a,b,c) and postoperatively (d).

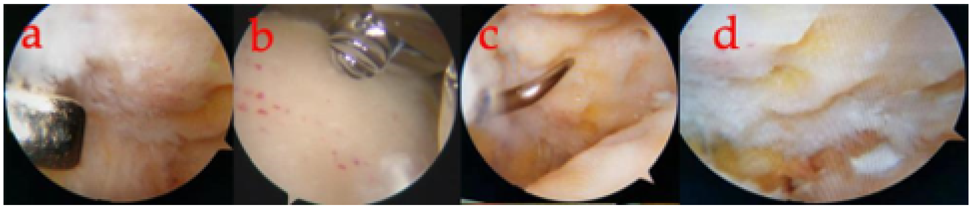

Figure 2

Making of portals

a: Marking of Imaginary lines by surgical pen.

b: Creating skin incision portals(**AMP1)** using a blunt dissection medial aspect of the joint.

c: Blunt dissection made on anterocentral aspect **(ACP3**) of the joint

d: Creating skin incision portals(**ALP2)** using a blunt dissection medial aspect of the joint.

e: Closure of all portals (P1,P2,P3) after surgery.

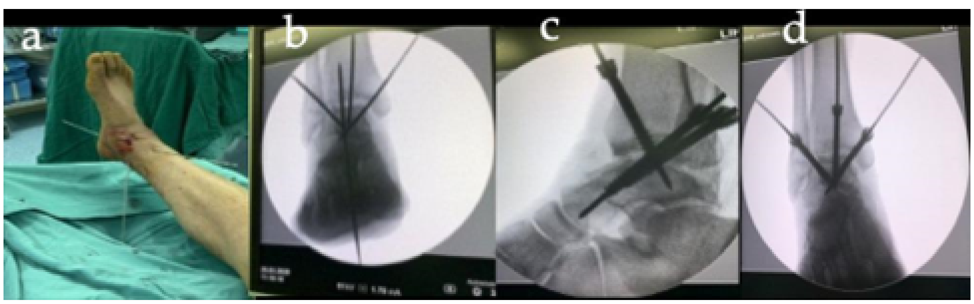

Figure 3

Arthroscopic images of intraarticular procedures

a: shows release of the deltoid ligament to fix larger degree of deformities

b: Synovectomy and debridement of the fibrous scars tissues by using a 4-mm synovial resector to examine inside the joint.

c,d: Curved curetteor tool was used to make microfacture.

Figure 4

The three guided pins.

a: All three pins were drilled percutaneously anterior to fibula through the tibia anteriolaterally in to the talus.

b: Pins monitored through fluoroscopy to ensure correct positioning.

c,d: Three large cannulated interfragmental compression percutaneous screw auto-fix 6.5- or 7.0 mm compression screws plane monitored under fluoroscopy.

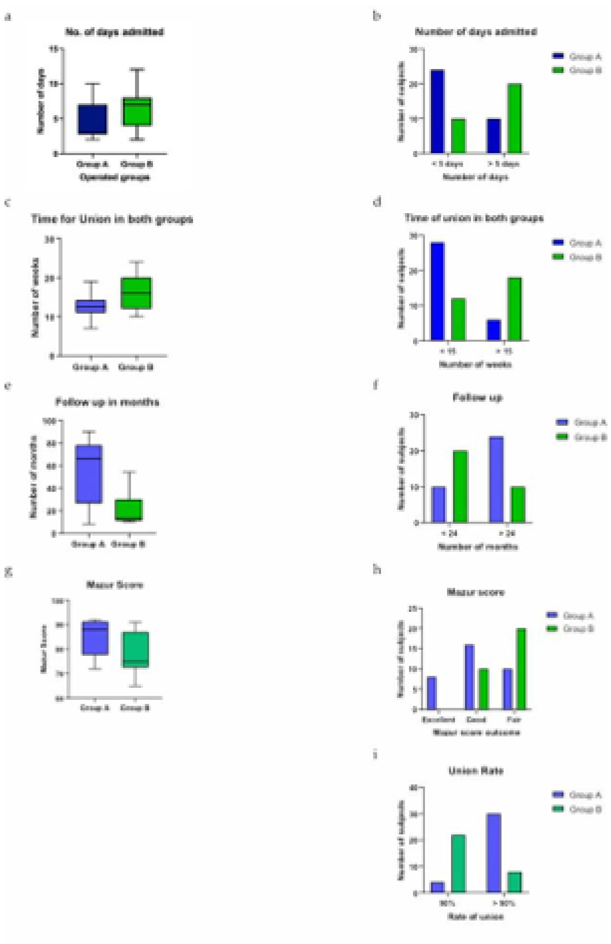

Figure 5

Follow up of the patient after 1 year with a good recovery with good aligment and good union.

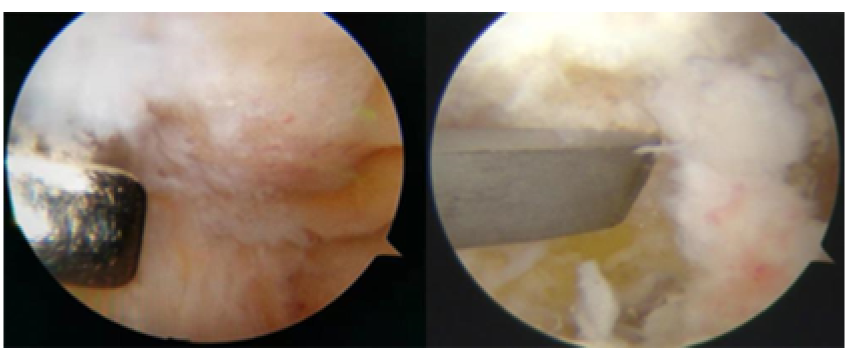

Figure 6

Graphical differentiation between Group A and Group B in the following: No. of days admitted, Time for union, Follow up, Mazur score and Union rate.

Figure 7

Release of the deltoid ligament through lateral gutter allows us to fix even larger degree of deformities.