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Original Article

SYNDESMOTIC SCREW IN NEUTRAL POSITION IN ANKLE FRACTURE: A PROSPECTIVE OBSERVATIONAL STUDY

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Abstract

Background: *Syndesmotic injuries are commonly associated with ankle fractures, particularly Danis-Weber type B and C fractures. The ideal ankle position during syndesmotic screw fixation remains debated. This study aimed to evaluate the clinical and radiological outcomes of syndesmotic screw fixation performed with the ankle in a neutral position.* ***Methods:*** *This prospective observational study included 20 adult patients with closed type B and C ankle fractures accompanied by syndesmotic injury, treated at Sohag University Hospitals. All patients underwent open reduction and internal fixation with intraoperative confirmation of syndesmotic instability via the Cotton test.* ***Results:*** *The mean age of patients was 37.5 ± 15.68 years, with males comprising 55% of the cohort. Motor car accidents were the predominant mechanism of injury (80%). No major complications were recorded; 55% of patients had an uneventful postoperative course. Partial weight-bearing began at a mean of 1.57 weeks, and all patients achieved full weight-bearing by 6 weeks. Radiographic union was observed at a mean of 6.2 weeks. VAS scores declined significantly from 7.00 at 2 weeks to 0.65 at 1 year ($p < 0.0001$), while AOFAS scores improved from 48.45 to 89.75 over the same period. ROM in both dorsiflexion and plantarflexion increased significantly at each follow-up ($p < 0.0001$).* ***Conclusions:*** *Fixation of syndesmotic injuries with the ankle held in a neutral position is a safe and effective technique. It facilitates early mobilization, results in timely fracture union, significantly reduces pain, and supports favorable functional recovery and joint mobility. These findings support the viability of neutral-position screw fixation as a standard approach in the management of syndesmotic ankle injuries.*

Keywords: *Ankle fracture, Syndesmotic screw, Neutral position, Dorsiflexion, AOFAS, VAS, Functional outcome*.

1. Introduction

Ankle fractures rank among the most frequent injuries encountered in orthopedic practice. Approximately 20% of surgically managed ankle fractures are associated with syndesmotic instability [1]. In Danis-Weber type C fractures, the mechanism of injury often indicates potential disruption of the syndesmosis. Similarly, type B fractures are also commonly linked to such injuries. If not diagnosed and treated promptly, syndesmotic disruptions can lead to complications affecting ankle function, including post-traumatic arthritis, chronic residual pain, and ankle impingement syndromes. As such, early and aggressive management is essential when addressing syndesmotic instability [2]. The distal tibiofibular syndesmosis is essential for maintaining the integrity of the ankle mortise, thereby supporting weight-bearing and normal gait. During high-energy supination injuries, the lateral ankle ligaments may be compromised, and syndesmotic injuries can occur either independently or, more frequently, alongside fibular fractures. Despite its clinical significance, the optimal method for stabilizing the distal tibiofibular syndesmosis remains a matter of ongoing debate [3]. Because the extent of a fibular fracture does not always reflect the degree of interosseous membrane disruption, magnetic resonance imaging (MRI) alone is not sufficient to determine the need for trans-syndesmotic fixation. Intraoperatively, the integrity of the syndesmosis is commonly assessed using the syndesmosis stress (Cotton) test, which involves applying a lateral force to the stabilized fibula. A lateral shift exceeding 3 to 4 mm typically indicates instability, warranting fixation [4]. Most experts advocate for the insertion of a fixation screw following anatomical reduction of the syndesmosis when instability is detected, to prevent future complications. The primary aim of treating distal tibiofibular dislocation is to restore ankle joint stability while preserving its anatomical structure and function. Metallic screws have long been the standard for syndesmotic fixation and have consistently yielded favorable clinical outcomes [5]. This study aims to evaluate the clinical and radiological outcomes of syndesmotic screw fixation performed with the ankle held in a neutral position in adult patients with type B and type C ankle fractures associated with syndesmotic injury.

2. Patients and Methods

2.1. *Study design*

This prospective study was conducted on forty patients diagnosed with type B and type C ankle fractures associated with syndesmotic injuries.

2.2. *Study duration*

The study was carried out over a one-year period, from January to December 2024.

2.3. *Ethical considerations*

Prior to initiating the study, ethical approval was obtained from the Ethics Committee of Sohag University Hospitals. Written informed consent was secured from all participants.

2.4. *Eligibility criteria*

Patients were excluded if they had diabetes with peripheral neuropathy, pathological fractures, Maisonneuve fractures, significant medical conditions or psychiatric disorders that could interfere with follow-up, or if they were lost to follow-up.

2.5. *Preoperative evaluation*

All patients underwent comprehensive clinical evaluation, including general assessment following Advanced Trauma Life Support (ATLS) guidelines and localized evaluation through radiographic imaging (anteroposterior, lateral, and mortise views) covering the ankle and knee joints, along with stress views. Laboratory investigations included complete blood count (CBC), renal function tests, international normalized ratio (INR), and prothrombin time. Fractures were classified according to both the Danis–Weber and Lauge-Hansen classification systems.

2.6. *Method of research*

This study included adult patients with acute closed ankle fractures who underwent open reduction and internal fixation, in accordance with predefined inclusion and exclusion criteria. All cases demonstrated intraoperative evidence of unstable syndesmotic injuries confirmed by the hook (Cotton) test. In each patient, a syndesmotic screw was placed at a distance of two to three centimeters proximal to the ankle joint line, with the ankle positioned in a neutral alignment during fixation. Simple randomization was used to allocate patients, and only those assigned to the neutral position group were included in this analysis. Clinical outcomes were assessed at the final follow-up.

2.7. *Surgical technique (Anaesthesia and positioning)*

Spinal anesthesia was administered to the patient, who was then positioned supine on the operating table, fig. (1). A parenteral antibiotic was administered, and the tourniquet was elevated. Reduction began with the lateral malleolar fracture, followed by the posterior malleolar fracture. Next, the medial malleolar fracture was reduced, and finally, the distal tibiofibular syndesmosis was anatomically realigned.

Figure (1) The patient received spinal anesthesia and was positioned in the supine position

2.8. *Approach and reduction*

The procedure began with a lateral approach to the malleolus. After exposing the fracture site, the fibular fracture was stabilized using either a one-third tubular plate or a reconstruction plate, figs. (2 & 3).

Figure (2) **a.** A lateral surgical approach was made to access the lateral malleolus, **b.** The lateral malleolar fracture was then reduced and fixed using a reconstruction plate.

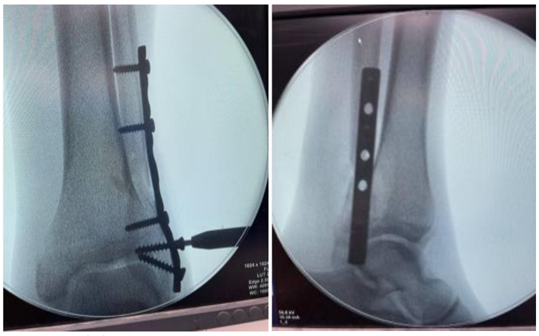

Figure (3) A radiograph was obtained following the reduction and fixation of the lateral malleolus using a reconstruction plate to confirm proper alignment and hardware placement.

When the posterior fragment involved 25% or more of the articular surface, fixation of the posterior malleolar fracture was deemed necessary. Medial malleolar fractures were addressed through a standard anteromedial incision and stabilized using either cannulated screws or tension band wiring, fig. (4, 5 & 6).

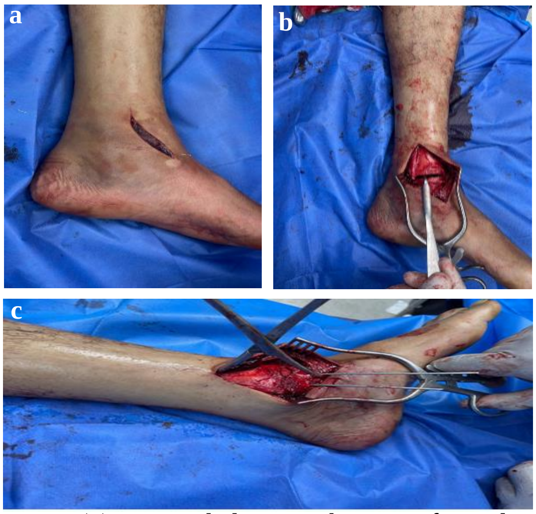

Figure (4) **a.** A medial approach was performed to access the medial malleolus, **b.** The fracture edges were cleared, and any entrapped periosteum was carefully removed to facilitate proper reduction, **c.** The medial malleolar fragment was reduced using a reduction clamp and stabilized with K-wires.

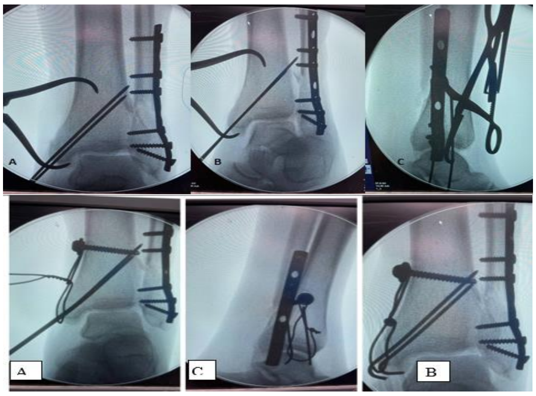

Figure (5) Radiographic images demonstrating the reduction of the medial malleolus using a clamp and fixation with K-wires; **a.** anteroposterior (AP) view, **b.** mortise view, **c.** lateral view.

To assess the stability of the syndesmosis following fixation of the tri-malleolar fractures, the Cotton test was performed intraoperatively. A distraction force was applied to the fibula using a bone hook to evaluate any separation from the tibia, thereby determining syndesmotic integrity.

Figure (6) Intraoperative radiographic imaging of the Cotton test was performed to assess the stability of the distal tibiofibular syndesmosis following fracture fixation.

Figure (7) illustrates the steps involved in securing the syndesmosis joint. A syndesmotic cortical screw was inserted at an oblique angle of 20 to 30 degrees, extending from the posterolateral aspect of the fibula to the anteromedial surface of the tibia. Typically, two or three 3.5 mm cortical screws engaging three cortices were selected for optimal stabilization.

Figure (7) Radiology syndesmosis joint held by a large pointed reduction clamp.

The syndesmotic screw was inserted while the ankle was maintained in a neutral position to ensure proper alignment and stabilization of the distal tibiofibular joint, fig. (8 & 9).

Figure (8) **a.** the syndesmotic screw was fixed with the ankle held in a neutral position, **b.** radiology syndesmosis joint held by alarge pointed reduction clamp.

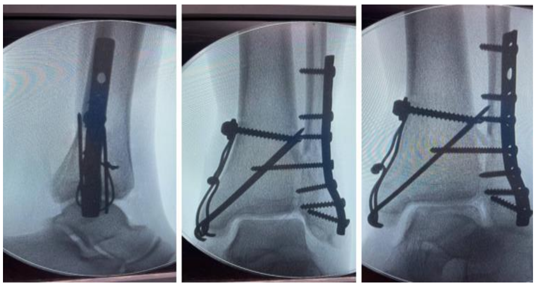

Figure (9) Intraoperative radiographic imaging demonstrates the placement of 3.5 mm diameter syndesmotic screws engaging three cortices, confirming proper positioning and stabilization; **a.** anteroposterior (AP) view, **b.** mortise view, **c.** lateral view.

2.9. *Postoperative management*

All patients received standardized postoperative care, which included the application of a slab, along with both injectable and oral antibiotics. Anti-inflammatory medications were prescribed for two weeks, and all patients were given calcium and vitamin D supplementation. Partial weight-bearing was initiated after two weeks, with progression to full weight-bearing at six weeks postoperatively. Syndesmotic screw removal was scheduled between 6 and 12 weeks following surgery, depending on individual case assessments. Patients were regularly followed up in outpatient clinics for suture removal at two weeks and subsequent evaluations at six weeks, twelve weeks, six months, one year, and continued until the final follow-up.

2.10. *Postoperative evaluation*

Clinical evaluation included assessment of pain, time to initiate weight bearing, time to radiographic fracture union, syndesmotic stability, and the presence of any screw breakage or loosening. Radiological evaluation was performed using anteroposterior (AP), lateral, and mortise X-ray views to monitor fracture healing and assess the integrity of the syndesmotic fixation.

2.11. *Clinical outcomes assessments*

At the final follow-up, clinical outcomes were assessed for all patients enrolled in the study using four validated questionnaires, including evaluation of the restricted range of motion (ROM) of the ankle. The assessment tools also incorporated the Visual Analogue Scale (VAS) for pain measurement and the American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot score to evaluate functional recovery.

2.12. *American orthopedic foot and ankle society ankle-hind foot score*

The AOFAS is a clinical rating system designed to provide a comprehensive assessment of ankle condition by combining clinician-based evaluations with patient-reported outcomes. The AOFAS score has been used as a sole instrument in different studies for reporting outcomes of different foot and ankle problems [6,7]. The scale totals 100 points and consists of nine questions categorized into three main domains: pain (1 question, up to 40 points), function (7 questions, up to 50 points), and alignment (1 question, up to 10 points). This structured approach offers a detailed and objective measure of ankle health and functional status.

2.13. *Visual analogue scale*

The VAS is a visual tool used to quantify the intensity of pain experienced by patients. It represents a continuum of pain severity ranging from "no pain" to "the worst pain imaginable." On this scale, a score of 0 indicates no pain, 1–3 points correspond to mild pain, 4–7 points reflect moderate pain, and 8–10 points indicate severe pain. This simple yet effective method enables patients to communicate their pain levels accurately.

2.14. *Restriction in range of motion*

The ROM of the operated ankle was assessed in both dorsiflexion and plantarflexion using a standard goniometer. To maintain consistency, all measurements were taken with the patient seated. The recorded values were used to track functional recovery and detect any postoperative restrictions in joint mobility.

2.15. *Statistical analysis*

Statistical analysis was performed using SPSS version 25 (IBM Inc., Chicago, IL, USA). Quantitative variables were expressed as mean ± standard deviation (SD), while qualitative variables were presented as frequencies and percentages. The Shapiro-Wilk test was applied to assess the normality of data distribution. For normally distributed variables, comparisons between the two groups were made using the Student's t-test. For non-parametric variables, the Mann-Whitney U test was employed to evaluate differences between groups. A two-tailed p-value of less than 0.05 was considered statistically significant at a 95% confidence interval.

3. Results

The study included a total of 20 adult patients with tibial shaft fractures. The mean age of the participants was 37.50 ± 15.68 years, while the median age was 36.00 years, with an age range spanning from 18 to 66 years. In terms of gender distribution, the majority of the patients were male, comprising 55.0% (n=11) of the study population, while females represented 45.0% (n=9), tab. (1). Regarding the mechanism of injury, motor car accidents (MCA) were the predominant cause, accounting for 80.0% (n=16) of cases, while falls from height (FFH) were responsible for the remaining 20.0% (n=4). The distribution of fracture laterality showed a higher incidence on the right side, observed in 65.0% (n=13) of the patients, compared to 35.0% (n=7) with left-sided fractures. According to the Weber classification, the majority of fractures were classified as type C (80.0%, n=16), whereas type B fractures were seen in 20.0% (n=4) of the cases. The time interval between trauma and surgical intervention had a mean duration of 2.40 ± 2.19 days, with a median of 2.00 days and a range from 0.00 to 8.00 days, tab. (2). Among the 20 patients included in the study, the majority (55.0%, n=11) experienced no postoperative complications. Mild pain was reported in 20.0% (n=4) of the cases. Additionally, 10.0% (n=2) of patients developed range of motion (ROM) limitation, while superficial infections were also observed in 10.0% (n=2). No deep infections or severe complications were reported, tab. (3). The mean duration for initiating partial weight bearing was 1.57 ± 0.18 weeks, with a median of 1.50 weeks and a range between 1.50 and 2.00 weeks. Full weight bearing was achieved uniformly across the study population at 6.00 ± 0.00 weeks. The median time for full weight bearing was 2.00 weeks, although the data appears to show a discrepancy, suggesting the need for clarification. Radiographic union occurred at a mean of 6.20 ± 0.52 weeks, with a median union time of 6.00 weeks and a range from 6.00 to 8.00 weeks, tab. (4). Pain levels were assessed using the VAS at multiple time points postoperatively. At 2 weeks, the mean VAS score was 7.00 ± 0.86, indicating high pain levels. By 6 weeks, pain decreased significantly to 4.85 ± 0.67, and by 12 weeks, the mean score had further reduced to 2.95 ± 0.69. A statistically significant improvement in pain was observed at this point ($p < 0.0001$). Pain continued to decline, reaching 2.00 ± 0.00 at 6 months and 0.65 ± 0.49 at 1 year, reflecting substantial and sustained pain relief over time, tab. (5). Functional outcomes were measured using the AOFAS score. At 2 weeks, the mean AOFAS score was 48.45 ± 2.06, suggesting limited function in the early postoperative period. Functional status improved to 60.75 ± 2.12 by 6 weeks and significantly to 75.65 ± 2.52 at 12 weeks ($p < 0.0001$). Continued improvement was observed at 6 months (85.50 ± 3.46) and at 1 year (89.75 ± 2.65), indicating marked recovery and near-complete return to function over time, tab. (6). The study observed a progressive and statistically significant improvement in ankle joint range of motion over time in both dorsiflexion and plantarflexion ($p < 0.0001$ for both). At 2 weeks postoperatively, mean dorsiflexion was 6.05 ± 1.28°, increasing steadily to 9.85 ± 1.04° at 6 weeks, 15.65 ± 1.50° at 12 weeks, 19.85 ± 1.76° at 6 months, and peaking at 23.85 ± 3.17° at 1 year. Similarly, plantarflexion improved from a mean of 23.85 ± 1.35° at 2 weeks to 34.75 ± 1.75° at 6 weeks, 42.65 ± 1.73° at 12 weeks, 49.25 ± 4.38° at 6 months, and 52.5 ± 2.57° at 1 year, tab. (7).

Table (1) Demographic data among study group

Parameter		Mean/percentage
Age (years)	▪ ***Mean ± SD*** ▪ ***Median (Min-Max)***	37.50 ± 15.68 36.00 (18.00-66.00)
Sex	▪ ***Female*** ▪ ***Male***	9 (45.0%) 11 (55.0%)

Table (2) Trauma related data among study group

Parameter		Mean/Frequency
Mode of Trauma	▪ ***FFH*** ▪ ***MCA***	4 (20.0%) 16 (80.0%)
Side	▪ ***Left*** ▪ ***Right***	7 (35.0%) 13 (65.0%)
Weber Classification	▪ ***B*** ▪ ***C***	4 (20.0%) 16 (80.0%)
Days before operation	▪ ***Mean ± SD*** ▪ ***Median (Min-Max)***	2.40 ± 2.19 2.00 (0.00-8.00)

Table (3) Complications among the study group

Complications	Frequency
Mild pain	4 (20.0%)
No Complications	11 (55.0%)
Range of Motion Limitation	2 (10.0%)
Superficial Infection	2 (10.0%)

Table (4) Weight bearing and union data among study group

Parameter		Mean±SD
Partial weight bearing (weeks)	▪ ***Mean ± SD*** ▪ ***Median (Min-Max)***	1.57 ± 0.18 1.50 (1.50-2.00)
Full weight bearing (weeks)	▪ ***Mean ± SD*** ▪ ***Median (Min-Max)***	6.00 ± 0.00 2.00 (2.00-2.00)
Time of radiographic union (weeks)	▪ ***Mean ± SD*** ▪ ***Median (Min-Max)***	6.20 ± 0.52 6.00 (6.00-8.00)

Table (5) Pain assessment (VAS - visual analogue scale) among study group

Mean VAS		P-value
2 Weeks	7.00 ± 0.86	<0.0001
6 Weeks	4.85 ± 0.67	
12 Weeks	2.95 ± 0.69	
6 Months	2.00 ± 0.00	
1 Year	0.65 ± 0.49	

Table (6) Functional outcomes (AOFAS) among the study group

Mean AOFAS		P-value
2 Weeks	48.45 ± 2.06	**<0.0001**
6 Weeks	60.75 ± 2.12	
12 Weeks	75.65 ± 2.52	
6 Months	85.50 ± 3.46	
1 Year	89.75 ± 2.65	

Table (7) Range of motion (ROM) among study groups

ROM		Neutral position	
		Dorsiflexion	**Plantarflexion**
2 Weeks	▪ ***Mean ± SD***	6.05 ± 1.28	23.85 ± 1.35
6 Weeks	▪ ***Mean ± SD***	9.85 ± 1.04	34.75 ± 1.75
12 Weeks	▪ ***Mean ± SD***	15.65 ± 1.50	42.65±1.73
6 Months	▪ ***Mean ± SD***	19.85 ± 1.76	49.25±4.38
1 Year	▪ ***Mean ± SD***	23.85 ± 3.17	52.5±2.57
P-value		<0.0001	<0.0001

4. Discussion

This prospective observational study evaluated the clinical and functional outcomes of syndesmotic screw fixation performed with the ankle in a neutral position in patients with type B and C ankle fractures associated with syndesmotic injuries. The syndesmosis is essential for ankle joint stability, serving as the primary connection between the tibia and fibula. Inadequate healing of a syndesmotic injury can result in persistent instability, chronic pain, and reduced functional capacity. Consequently, achieving optimal positioning during fixation is vital to enhance recovery and ensure favorable long-term outcomes for patients [8]. The demographic profile of the study population revealed a predominance of males (55%) and a relatively young mean age of 37.5 years, which aligns with the typical age group affected by high-energy ankle injuries [8]. A systematic review of surgical techniques for ankle fractures highlighted the importance of comparable patient demographics in accurately isolating treatment effects, supporting our conclusion regarding the reliability of the observed outcomes [9]. The most common mechanism of injury was motor car accidents (80%), consistent with global epidemiological data on ankle trauma resulting from high-impact forces. Right-sided fractures were more prevalent (65%), and Weber type C fractures constituted the majority (80%), reflecting the severity of injuries typically requiring syndesmotic fixation. A study on ankle fractures reported that MVAs were the predominant cause of injury. This aligns with our observation had similar trauma modes, reinforcing the idea that demographic and injury characteristics were comparable between groups [10]. Additionally, a comparative study assessing surgical outcomes across various ankle fracture types reported no significant differences in preoperative factors such as the side of injury and time to surgery. This indicates that these variables may have minimal impact on clinical outcomes [10]. In terms of postoperative recovery, partial weight-bearing was initiated as early as 1.5 weeks, and all patients achieved full weight-bearing by the 6-week mark. The mean time to radiographic union was 6.2 weeks, comparable to timelines reported in literature for operatively managed ankle fractures. These results support the effectiveness of this approach in promoting early mobilization and bone healing. A randomized clinical trial comparing varying immobilization periods for stable Weber B fractures found that patients generally reached full weight bearing at around six weeks, regardless of duration. The study highlighted that initiating weight bearing early did not negatively affect fracture healing [11]. Pain, assessed via the Visual Analogue Scale (VAS), showed a consistent and statistically significant reduction over time. The sharp decline in pain from a mean score of 7.00 at 2 weeks to just 0.65 at 1 year ($p < 0.0001$) reflects the successful restoration of joint stability and the resolution of postoperative discomfort. Another study investigating ankle fracture healing timelines found that radiographic union typically occurred around six weeks in both surgically and conservatively treated patients [12]. A study examining factors influencing pain after orthopedic surgeries suggested that individual variations—such as psychological factors and baseline pain tolerance—may have a greater influence on postoperative pain than surgical positioning alone. This implies that, although our study identified significant differences in pain scores between groups, other underlying patient-specific factors may also play a role in these outcomes [13,14]. Functional recovery, as measured by the AOFAS score, also showed significant improvement. Patients progressed from a score of 48.45 at 2 weeks to 89.75 at 1 year ($p < 0.0001$), indicating near-complete return of function. This trend highlights the importance of accurate anatomical reduction and secure fixation in achieving favorable outcomes. Another research article examining syndesmotic injuries reported that patients treated with syndesmotic screw fixation showed significant improvements in their AOFAS scores during follow-up. The study emphasized the importance of achieving proper alignment during surgery to ensure optimal functional recovery [15]. The progressive increase in ankle ROM in both dorsiflexion and plantarflexion was another critical finding. Dorsiflexion improved from 6.05° at 2 weeks to 23.85° at 1 year, while plantarflexion increased from 23.85° to 52.5° in the same period. These statistically significant gains ($p < 0.0001$) suggest that fixation in the neutral position does not impede joint mobility and may, in fact, facilitate a steady and effective rehabilitation trajectory. Syndesmotic stabilization is essential during ankle fracture management. However, this joint is a dynamic articulation that moves during ankle dorsiflexion, with widening of the distal tibiofibular joint space to accommodate the wider portion of the trapezoidal talus. This relative motion is vital for the physiologic function of the ankle mortise during weight-bearing and ankle range of motion. Screw fixation of the distal tibiofibular syndesmosis provides a static articulation that is held in neutral position, which, on the one hand, aids in healing of the injured tibiofibular ligaments, but on the other, alters the dynamic nature of the syndesmosis into a static joint, potentially leading to functional incapacity [14, 17]. Additionally, a study evaluating the effects of various rehabilitation protocols on ankle mobility reported mixed results, indicating that while some patients benefited from specific positioning techniques, others did not show significant improvements in ROM. This variability suggests that individual patient characteristics may lead to different outcomes [18]. The study demonstrated a favorable safety profile for the surgical intervention. Over half of the patients (55%) experienced no postoperative complications. Mild pain was reported in 20%, while range of motion limitations and superficial infections were each observed in 10% of cases. Notably, no deep infections or severe complications occurred, indicating that fixation in the neutral ankle position is both safe and well-tolerated. A study evaluating surgical outcomes for ankle fractures found that, although some patients reported mild pain or required additional surgery, the overall complication rates did not vary significantly between the different fixation methods [19]. Kyriacou et al. (2021) [20], reported that a higher percentage of patients treated with specific surgical approaches experienced no complications at all. Although, a study evaluating various factors affecting postoperative recovery noted that individual patient characteristics, such as age and comorbidities, could significantly impact complication rates and overall recovery [21].

5. Conclusion

The results of this prospective observational study suggest that syndesmotic screw fixation performed with the ankle in a neutral position is a safe and effective technique for managing type B and C ankle fractures with associated syndesmotic injuries. Patients demonstrated timely fracture union, early mobilization, significant pain relief, improved ankle range of motion, and favorable functional outcomes as measured by the AOFAS score. The low complication rate further supports the clinical viability of this approach. While the findings are encouraging, further studies with larger sample sizes and comparative designs are needed to confirm the long-term efficacy and potential advantages of neutral-position fixation over alternative methods.

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