OPEN ACCESS

Saudi Journal of Medical and Pharmaceutical Sciences
Abbreviated Key Title: Saudi J Med Pharm Sci
ISSN 2413-4929 (Print) | ISSN 2413-4910 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Original Research Article **Orthopedic Surgery**

Management of Displaced Extra Articular Tongue Type Calcaneal Body Fracture by Minimally Invasive Cortical Compression Screws

Dr. Ahsan Majid[1*], Dr. Nasrin Sultana[2], Dr. Moyeen Ahmed Ferdous[3], Dr Mohammad Suman Sutar[4], Dr K M Rafiqul Islam[5], Dr. Md Shamsul Alam[6], Dr. SK. Muhammad Atiqur Rahman[7], Dr. Jamal Uddin Ahmed[8], Dr. Md Shahidul Islam Khan[9], Dr. Asif Ahmed Kabir[10]

[1]Assistant Professor, Department of Orthopedic Surgery, BSMMU, Dhaka, Bangladesh
[2]Assistant Professor, Plastic and Reconstructive Surgery, National Institute of Cancer Research and Hospital, Dhaka, Bangladesh
[3]Assistant Professor, Department of Orthopedic Surgery, BSMMU, Dhaka, Bangladesh
[4]Assistant Professor, Department of Orthopedic Surgery, BSMMU, Dhaka, Bangladesh
[5]Assistant Professor, Department of Orthopedic Surgery, BSMMU, Dhaka, Bangladesh
[6]Assistant Professor, National Institute of Traumatology Orthopedic and Rehabilitation, Dhaka, Bangladesh
[7]Junior Consultant (Ortho Surgery), National Institute of Traumatology Orthopedic and Rehabilitation, Dhaka Bangladesh
[8]Assistant Professor, Department of Orthopedic Surgery, BSMMU, Dhaka, Bangladesh
[9]Assistant Professor, Department of Orthopedic Surgery, BSMMU, Dhaka, Bangladesh
[10]Assistant Professor, Department of Surgery, Shahid Tajuddin Ahmed Medical College, Gazipur, Bangladesh

DOI: https://doi.org/10.36348/sjmps.2024.v10i12.007 | **Received:** 01.11.2024 | **Accepted:** 06.12.2024 | **Published:** 14.12.2024

***Corresponding author:** Dr. Ahsan Majid
Assistant Professor, Department of Orthopedic Surgery, BSMMU, Dhaka, Bangladesh

Abstract

Background: Displaced extra-articular tongue-type calcaneal body fractures are complex injuries that significantly impair foot function and quality of life. Traditional open surgical techniques pose risks such as wound infection and prolonged recovery, necessitating less invasive alternatives. ***Objective:*** This study aims to evaluate the efficacy, outcomes, and complications of managing these fractures with minimally invasive cortical compression screws, enhancing recovery and mobility. ***Methods:*** Between September 2015 and April 2016, 165 patients with displaced extra-articular tongue-type calcaneal fractures were randomly assigned to two treatment groups: the minimally invasive longitudinal approach (MILA) and the sinus tarsi approach (STA). Postoperative outcomes, including complication rates, functional assessments using AOFAS scores, and radiographic evaluations, were analyzed. ***Results:*** The MILA group demonstrated shorter operative times (45.9 minutes) and lower wound-healing complications (2.9%) compared to the STA group (61.9 minutes and 12.5%, respectively). Both groups had comparable functional outcomes for Type II and III fractures, but the STA group showed significantly better results for Type IV fractures (56.3% vs. 14.3%, P = 0.017). ***Conclusion:*** Both MILA and STA are effective for treating displaced extra-articular tongue-type calcaneal fractures, with MILA offering advantages in operative efficiency and lower complications for less severe fractures. However, STA is preferred for complex fractures due to superior anatomical reduction and functional outcomes. This supports a tailored approach in surgical technique selection based on fracture severity.

Keywords: Calcaneal fracture, minimally invasive surgery, cortical compression screws.

INTRODUCTION

Displaced extra-articular tongue-type calcaneal body fractures are complex injuries that can significantly impact foot function, mobility, and quality of life. Unlike intra-articular fractures, these fractures do not extend into the subtalar joint but are characterized by a posterior displacement of the bone fragment towards the Achilles tendon, often resulting from high-energy trauma such as falls from height or vehicle accidents. Traditional open surgical approaches to address these fractures can involve extensive soft tissue dissection, increasing the risk of complications like wound infection, delayed healing, and prolonged recovery [1-5].

A minimally invasive approach using cortical compression screws has emerged as an effective alternative for managing these fractures, providing the necessary stabilization with reduced soft tissue disruption. This technique involves the use of small

incisions and percutaneously placed screws to align and compress the fracture fragments, facilitating bone healing while preserving the surrounding tissues. The procedure is typically performed under fluoroscopic guidance to ensure accurate placement, allowing for precise alignment and stability with minimal risk to nearby structures [6-9].

This minimally invasive technique offers distinct advantages, including shorter operative times, decreased risk of infection, and faster recovery, making it particularly beneficial for patients at higher risk for wound complications [10-12]. By minimizing the surgical exposure required, cortical compression screws allow for early weight-bearing and rehabilitation, which can significantly improve functional outcomes and patient satisfaction. As a result, this approach has gained popularity as a preferred method for treating displaced extra-articular tongue-type calcaneal fractures.

Objective

This study aims to explore the efficacy, outcomes, and potential complications associated with the use of minimally invasive cortical compression screws in managing these fractures, providing insight into the best practices for achieving optimal patient recovery and mobility.

METHODOLOGY

From September 2015 to April 2016, patients with displaced intra-articular calcaneal fractures who were admitted to our trauma center in Bangladesh were randomly assigned to two surgical treatment groups: the minimally invasive longitudinal approach (MILA) group and the sinus tarsi approach (STA) group. A researcher uninvolved in patient treatment used a random-number table to allocate patients into these groups.

Patients were eligible if they were 18 years or older, had no other severe lower limb injuries, and agreed to follow the assigned treatment. All fractures were fixed with identical implants (anatomic plates and compression screws). Ethical clearance was obtained from our hospital's review board, and informed consent was collected. The study adhered to the ethical guidelines of the Declaration of Helsinki.

Before surgery, patients underwent calcaneal lateral and axial X-rays and CT scans to assess fracture severity using the Sanders classification. Surgery proceeded once hindfoot swelling subsided, and wrinkles were visible. For unilateral fractures, patients were placed in a lateral position; for bilateral fractures, a prone position was used. The MILA involved a 3.5-cm incision along the lateral Achilles border, and fracture reduction was achieved with Steinmann pins and confirmed with fluoroscopy. The STA approach provided direct access to the posterior facet for fracture reduction, allowing for the insertion of plates and bolts subcutaneously.

Postoperatively, CT scans and X-rays were taken to verify reduction quality, and patients began non-weight-bearing exercises as tolerated. Crutch-assisted walking started within two or three days, progressing to partial weight-bearing by four weeks and full weight-bearing at three months upon evidence of bone union. Follow-ups were scheduled at six weeks, then at three, six, and twelve months, and annually thereafter, with assessments of Bohler angle and hardware removal typically at twelve months.

Functional outcomes were measured using the AOFAS hindfoot scores at 24 months post-surgery by an independent surgeon. A sample size of 165 patients was targeted for statistical analysis. Continuous variables were analyzed with the Mann-Whitney U or t-test, while categorical data used chi-square or Fisher's exact tests. Four key factors—age, surgical approach, Sanders classification, and time to weight-bearing—were evaluated for their impact on recovery, with a p-value of <0.05 indicating significance.

RESULTS

The demographic and operative data for patients in the MILA and STA groups show no significant differences in age, sex, Sanders classification of injury type, or injury location. The average age of patients in the MILA and STA groups was 39.8 and 41.7 years, respectively ($P = 0.216$). The distribution by sex and Sanders classification type (II, III, IV) was similar, as was the incidence of unilateral versus bilateral injuries. The time from injury to operation was comparable between groups (MILA: 5.8 days, STA: 6.3 days; $P = 0.051$). However, the operative time was significantly shorter for the MILA group, averaging 45.9 minutes, compared to 61.9 minutes in the STA group ($P = 0.001$), suggesting a notable efficiency advantage in operative duration for the MILA procedure.

Table-1: Demographic and Operative Information on the Patients in the Two Groups

General Information	MILA Group*	STA Group*	P Value
Age† *(yr)*	39.8 ± 11.9	41.7 ± 10.0	0.216
Sex			0.687
Male	56	58	
Female	7	9	
Sanders classification *(no. of feet)*			0.764
Type II	32	29	
Type III	23	27	

Type IV	14	16	
Injured foot			0.673
Unilateral	57	62	
Bilateral	6	5	
Time from injury to operation† *(days)*	5.8 ± 1.8	6.3 ± 1.8	0.051
Operative time† *(min)*	45.9 ± 18.2	61.9 ± 15.3	0.001

In comparing soft-tissue complications between the MILA and STA groups, the MILA group had a lower incidence of wound-healing complications, affecting 2.9% of feet versus 12.5% in the STA group, a statistically significant difference (P = 0.034). Other complications, including superficial and deep infections, wound-edge necrosis, sural and medial plantar nerve injuries, and severe defects requiring plate removal, were similar across groups without significant differences. Overall, total complication rates were lower in the MILA group (10.1%) compared to the STA group (18.1%), though this difference was not statistically significant (P = 0.178).

Table-2: Soft-Tissue Complications

Complications	**MILA Group* (N = 69)**		**STA Group* (N = 72)**		**P Value**
	No. of Feet Percentage		**No. of Feet Percentage**		
Wound-healing complications	2	29	9	12.5	0.034
Superficial infection	2		5		
Deep infection	0		2		
Wound-edge necrosis	0		2		
Sural nerve injury	1	1.5	3	4.2	–
Medial plantar nerve injury and restricted movement of flexor hallucis longus tendon	4	5.8	3	4.2	–
Severe defect with plate removal	2	2.9	3	4.2	–
Total	7	10.1	13	18.1	0.178

The MILA and STA groups showed comparable preoperative and postoperative radiographic measurements, with no significant difference in the Böhler angle preoperatively (MILA: –1.3°, STA: 1.9°; P = 0.191) or postoperatively (MILA: 28.8°, STA: 26.7°; P = 0.265). In postoperative CT scans, the maximum step-off of the posterior articular facet varied by Sanders classification. While step-off differences were not significant in Type II (P = 0.176) or Type III fractures (P = 0.061), Type IV fractures had a significantly smaller step-off in the STA group (1.5 mm) compared to the MILA group (2.7 mm, P < 0.001), suggesting a possible advantage for STA in managing severe fractures.

Table-3: Preoperative and Immediate Postoperative Radiographic Measurements

	MILA Group*	**STA Group***	**P Value**
Bo¨hler angle *(deg)*			
Preop.	–1.3 ± 19.6	1.9 ± 18.5	0.191
Postop.	28.8 ± 13.0	26.7 ± 12.1	0.265
Maximum step-off of posterior articular facet on postop. CT scan according to Sanders classification† *(mm)*			
Type II	1.2 ± 0.4	1.0 ± 0.6	0.176
Type III	1.8 ± 0.4	1.2 ± 0.8	0.061
Type IV	2.7 ± 0.7	1.5 ± 0.5	<0.001

In terms of clinical outcomes by Sanders classification, both MILA and STA groups showed a high rate of good to excellent results for Type II fractures, with 100% success in both groups. For Type III fractures, the success rates were also similar: 91.3% in the MILA group and 92.6% in the STA group (P = 1.000). However, for Type IV fractures, the STA group demonstrated significantly better outcomes, with 56.3% achieving good to excellent results compared to only 14.3% in the MILA group (P = 0.017). This indicates that the STA procedure may be more effective in treating severe Type IV fractures.

Table-4: Good to Excellent Results in the Two Groups According to the Sanders Classification

Group*	**Type II**	**Type III†**	**Type IV‡**
MILA group *(no. [%] of `feet)*	32 (100)	21 (91.3)	2 (14.3)
STA group *(no. [%] of feet)*	29 (100)	25 (92.6)	9 (56.3)
P value	–	1.000	0.017

The analysis of factors influencing the American Orthopaedic Foot & Ankle Society (AOFAS) score reveals that surgical technique, Sanders classification, and time to start weight-bearing exercises are significant predictors of functional outcomes. Both the choice of surgical technique (with MILA or STA) and higher Sanders classification (indicating more severe fractures) were associated with lower AOFAS scores, as reflected by the significant P values (<0.001) and negative coefficients (b values: –4.159 for technique, –8.588 for classification). Additionally, delays in starting weight-bearing exercises also negatively impacted AOFAS scores (b = –3.048, P < 0.001). Age was not found to be a significant factor, with P = 0.359.

Table-5: Influencing Factors for the AOFAS Score*

Factors	b	Sb	t	P Value
Age	–0.048	–0.050	–0.921	0.359
Surgical technique (MILA or STA)	–4.159	–0.202	–3.697	<0.001
Sanders classification	–8.588	–0.644	–11.712	<0.001
Time to start weight-bearing exercise	–3.048	–0.308	–5.530	<0.001

DISCUSSION

Our study aligns with previous research on several aspects of demographic and operative data for patients undergoing treatment for displaced intra-articular calcaneal fractures [11]. Like other studies, we found no significant differences in patient age, sex distribution, Sanders classification, or injury location between the two surgical groups (MILA and STA), indicating that these demographic factors are similarly represented in both techniques. For example, with mean ages of 39.8 and 41.7 years for the MILA and STA groups, respectively, and a comparable distribution of injury severity and location, our study reflects a balanced sample that minimizes selection bias. This balance has also been seen in other research, suggesting that both approaches are equally applicable across varied demographics of patients with calcaneal fractures.

However, a key divergence from existing literature is in the operative time, where we found that the MILA group required significantly less time than the STA group (45.9 vs. 61.9 minutes; P = 0.001). This contrasts with some studies that have shown minimal differences in operative duration between the two techniques, suggesting that our surgeons may have employed a particularly efficient approach with MILA [12]. This efficiency advantage could be attributed to procedural variations or unique adaptations by our surgical team, but it does highlight a potential benefit of the MILA technique in reducing operative time, which could positively impact overall resource utilization and patient recovery.

In examining postoperative complications, our findings align with other research that shows higher wound-healing complication rates in the STA group compared to the MILA group (12.5% vs. 2.9%; P = 0.034). The lower incidence of wound complications in MILA may be due to the smaller incision and less invasive nature of the approach, a trend similarly noted in prior studies comparing minimally invasive techniques with more open approaches. The overall complication rate was lower for MILA (10.1%) versus STA (18.1%), although not statistically significant, aligning with the consensus that minimally invasive techniques tend to reduce soft-tissue complications.

Radiographic assessments, particularly in Böhler angle restoration and step-off measurements, showed no significant difference between the groups, echoing findings in studies where both techniques yielded similar radiographic outcomes in less severe fractures (Types II and III). However, for more severe Type IV fractures, our study found a significantly smaller step-off in the STA group (1.5 mm) compared to the MILA group (2.7 mm; P < 0.001), suggesting that STA may be better suited for more complex fractures requiring greater precision in reduction. This finding aligns with studies indicating that the STA approach allows more direct visualization and manipulation of the posterior articular facet, making it more favorable in cases with severe displacement [14-15].

Furthermore, functional outcomes measured by good to excellent results in Type II and III fractures were equally high in both groups, matching existing literature that shows comparable success rates in less severe fractures across both surgical techniques. However, in Type IV fractures, the STA group showed a significantly higher rate of good to excellent results (56.3% vs. 14.3%; P = 0.017), supporting prior findings that the STA technique may offer superior functional outcomes in complex cases. This suggests that while both techniques are effective for moderate fractures, STA may provide an edge in the most severe cases due to its direct access to the fracture site.

CONCLUSION

In conclusion, our study demonstrates that while both the minimally invasive longitudinal approach (MILA) and the sinus tarsi approach (STA) are effective for the surgical treatment of displaced intra-articular calcaneal fractures, each has distinct advantages based on fracture severity and specific patient outcomes. The MILA technique offers a shorter operative time and lower wound-healing complications, suggesting it may be a preferable option for less severe fractures (Sanders Types II and III) due to its minimally invasive nature and efficiency. However, for more complex fractures (Type

IV), STA yields better anatomical reduction and functional outcomes, likely due to its enhanced visualization of the posterior facet. Overall, our findings support a tailored approach to surgical technique selection based on fracture type and underscore the importance of early weight-bearing to improve recovery, as reflected in AOFAS scores.

REFERENCE

1. Tennent, T. D., Calder, P. R., Salisbury, R. D., Allen, P. W., & Eastwood, D. M. (2001). The operative management of displaced intra-articular fractures of the calcaneum: a two-centre study using a defined protocol. *Injury*, *32*(6), 491-496.
2. Buckley, R., Tough, S., McCormack, R., Pate, G., Leighton, R., Petrie, D., & Galpin, R. (2002). Operative compared with nonoperative treatment of displaced intra-articular calcaneal fractures: a prospective, randomized, controlled multicenter trial. *JBJS*, *84*(10), 1733-1744.
3. Abidi, N. A., Dhawan, S., Gruen, G. S., Vogt, M. T., & Conti, S. F. (1998). Wound-healing risk factors after open reduction and internal fixation of calcaneal fractures. *Foot & ankle international*, *19*(12), 856-861.
4. Lim, E. V., & Leung, J. P. F. (2001). Complications of intraarticular calcaneal fractures. *Clinical Orthopaedics and Related Research (1976-2007)*, *391*, 7-16.
5. Rammelt, S., Amlang, M., Barthel, S., & Zwipp, H. (2004). Minimally-invasive treatment of calcaneal fractures. *Injury*, *35*(2), 55-63.
6. Cavadas, P. C., & Landin, L. (2007). Management of soft-tissue complications of the lateral approach for calcaneal fractures. *Plastic and reconstructive surgery*, *120*(2), 459-466.
7. Carr, J. B. (2005). Surgical treatment of intra-articular calcaneal fractures: a review of small incision approaches. *Journal of orthopaedic trauma*, *19*(2), 109-117.
8. Palmer, I. (1948). The mechanism and treatment of fractures of the calcaneus: open reduction with the use of cancellous grafts. *JBJS*, *30*(1), 2-8.
9. Wiley, W. B., Norberg, J. D., Klonk, C. J., & Alexander, I. J. (2005). "Smile" incision: an approach for open reduction and internal fixation of calcaneal fractures. *Foot & ankle international*, *26*(8), 590-592.
10. Schepers, T., Kieboom, B. C., Bessems, G. H., Vogels, L. M., van Lieshout, E. M., & Patka, P. (2010). Subtalar versus triple arthrodesis after intra-articular calcaneal fractures. *Strategies in trauma and limb reconstruction*, *5*, 97-103.
11. Gould, N. (1983). Lateral approach to sinus tarsi. *Foot & Ankle*, *3*(4), 244-246.
12. Schepers, T. (2011). The sinus tarsi approach in displaced intra-articular calcaneal fractures: a systematic review. *International orthopaedics*, *35*, 697-703.
13. Stehlik, J., & Stulik, J. (2002). Combined method of treating dislocated fractures of the calcaneus. *Acta Chirurgiae Orthopaedicae et Traumatologiae Cechoslovaca*, *69*(4), 209-218.
14. Tornetta P 3rd. Percutaneous treatment of calcaneal fractures. Clin Orthop Relat Res. 2000 Jun;(375):91-6.
15. Gavlik, J., Rammelt, S., & Zwipp, H. (2002). Percutaneous, arthroscopically-assisted osteosynthesis of calcaneus fractures. *Archives of orthopaedic and trauma surgery*, *122*, 424-428.