MedNEXT
Journal of Medical an Health Sciences

ORIGINAL ARTICLE

DOI: 10.54448/mdnt24403

Comparison of complications and degree of correction between the extensile lateral and sinus tarsi approaches in the treatment of calcaneus fractures: a cross-sectional observational retrospective study

Vanessa Cavazana Takata[1,2*], Carolina Barbosa de Aquino[1,2], João Vitor Oliveira Souto[1,2], Rullya Marson De Melo Oliveira[1,2], Gustavo Cavallari[1,2], Helencar Ignácio[1,2], Marcio Gomes Figueiredo[1,2]

[1] Hospital de Base de São José do Rio Preto (FUNFARME), Orthopedics and Traumatology, São Paulo, Brazil.
[2] FAMERP - Faculty of Medicine of São José do Rio Preto, São Paulo, Brazil.

*Corresponding author: Dr. Vanessa Cavazana Takata.
Hospital de Base de São José do Rio Preto (FUNFARME),
Orthopedics and Traumatology, São Paulo, Brazil, and FAMERP -
Faculty of Medicine of São José do Rio Preto, São Paulo, Brazil.
E-mail: vanessa_takata@hotmail.com
DOI: https://doi.org/10.54448/mdnt24403
Received: 07-11-2024; Revised: 09-12-2024; Accepted: 09-13-2024; Published: 09-14-2024; MedNEXT-id: e24403

Editor: Dr. Vihan Moodi, MD, MHPE, DBA, Post-DBA.

Abstract

Introduction: Calcaneus fractures are a challenge for traumatologists. Their complex anatomy, relative scarcity of surrounding soft tissue, and long learning curve for surgical treatment partly explain the difficulties encountered by surgeons, in addition to contributing to the high rate of complications. **Objective:** This study aimed to identify the differences in complication rates and degree of correction between extensile lateral access (ELA) and sinus tarsi (STA) approaches by reviewing medical records between 2018 and 2023 of patients who underwent open reduction and internal fixation of calcaneus fractures at a hospital in the interior of São Paulo. **Methods:** The present study followed a retrospective observational and cross-sectional model (STROBE). The Kolmogorov Smirnov test, Student-t test, Wilcoxon Rank test, Mann-Whitney test, Pearson Chi-Square test, and binary and predictive logistic regression analysis were used, adopting a confidence risk of 0.05. **Results and Conclusion:** A total of 77 patients were included (52 ELA and 25 STA). It was concluded that no statistical differences were observed after intergroup comparisons (ELA vs. STA). There was also no statistically significant influence of the predictor "age" on the predictors of the responses "Böhler and Gissane angles in degrees" in the final post-procedure phase. In general, STA presented a lower probability of complications with the use of the sinus tarsi route, reaching the same level of joint reduction and control of progression to osteoarthritis. All these results of the present study almost completely confirm the literary findings that appear under discussion.

Keywords: Calcaneus fractures. Extensile lateral access. Sinus tarsi. Böhler angles. Gissane angles. Joint deviation.

Introduction

Calcaneus fractures, especially displaced intra-articular fractures, are a challenge for traumatologists to treat, and several approaches and surgical techniques have been described over the years. As Cotton stated in 1926, "The man that breaks his heel is done" [1,2]. Their complex anatomy, relative scarcity of surrounding soft tissue, and surgical treatment with a long learning curve partly explain the difficulties encountered by surgeons, in addition to contributing to the high rate of complications. From an epidemiological point of view, they represent up to 2% of the total number of all fractures and 60% in the tarsal region. They affect men more frequently, approximately in a ratio of [2-5].

The most common mechanisms of occurrence are high-energy injuries, such as falls from a height or car accidents; as patients age, the amount of energy required decreases. Due to the dominant mechanism of high-energy injuries in working age, associated injuries are also frequent, especially other fractures in the lower limb and lumbar spine. It is believed that the sinus tarsi

approach, due to its lower exposure and injury to soft tissues, leads to a lower rate of complications with the surgical wound such as dehiscence and infection, while maintaining the same level of correction and congruence of the joint anatomy [6-10].

Given this, the present study evaluated the difference in complication rates and the degree of correction of joint deviation after fracture correction between the extensile lateral approach (ELA) and the sinus tarsi approach (STA), as well as analyzed the rates of complications such as dehiscence, superficial and deep infection; need for removal of material and correction of radiographic parameters by the Böhler and Gissane angles.

METHODS

Study Design

The present study followed an observational retrospective and cross-sectional model, following the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) rules. Available at: https://www.strobe-statement.org/checklists/. Accessed on 14/06/2024. This was followed by a retrospective study through analysis of medical records of patients with calcaneal joint fractures who underwent surgical treatment via the extended lateral and sinus tarsi approaches.

Ethical Approval

This study was approved by the Research Ethics Committee of FAMERP-Faculdade de Medicina de São José do Rio Preto, São Paulo, Brazil, under protocol 6.652.177, following the 1964 Declaration of Helsinki.

Sample Size

A minimum of 75 eligible patients was estimated, with 25 undergoing fracture reduction via the sinus tarsi approach and 50 via the extended lateral approach.

Participants and Data Collection

Information was collected from medical records of patients treated at a hospital in the interior of São Paulo between 2018 and 2023 who presented intra-articular fractures of the subtalar calcaneus and underwent surgical corrections. The surgeries during this period were performed by two orthopedic surgeons specializing in foot and ankle at the institution using two main approaches: (1) extended lateral approach, which used calcaneal plates standardized by the same supplier, and (2) sinus tarsi approach, which involved fixation using standardized cortical screws. In the postoperative period, patients continued with immobilization using a plaster cast, later replaced by an immobilizing boot, and zero weight-bearing for 10 to 12 weeks, with stitches removed and passive and active range of motion initiated from the 3rd week. During this period, records were collected over a 6-month follow-up period regarding surgical wound conditions, such as infections, dehiscence, or uneventful evolution; the need for removal of synthetic material; and the degree of surgical correction assessed by Gissane and Bohler angles.

Eligibility

Patients admitted to the Hospital de Base de São José do Rio Preto with displaced calcaneal joint fractures were included: Bhöler and Gissane angles outside the normal parameters (20º to 40º and 120º to 140º respectively); age over 18 years; absence of concomitant fracture; being able to walk before the fracture; minimum follow-up period of 6 months after the surgical procedure; admitted between 2018 and 2023, respecting the minimum follow-up time. Patients under 18 years of age, exposed calcaneal fractures, presence of another fracture in the same traumatic incident, non-ambulatory patients before the same incident, and previous fractures in the same calcaneus were excluded.

Statistical Analysis

After data collection, they were entered into an Excel spreadsheet. Descriptive statistical analysis was performed by calculating measures of central tendency and dispersion and frequency counts. For inferential statistical analysis of quantitative variables, the Kolmogorov-Simirnov test was used to verify data normality, and then appropriate tests were applied to compare quantitative data. Pearson's Chi-Square test was used to compare frequencies, with $p<0.05$ with statistical significance (rejecting H0). Tukey's one-way ANOVA analysis was performed, with a statistically significant difference (rejecting the null hypothesis H0) between quantitative variables. Linear regression analysis was applied between the predictors "age" and responses "Böhler and Gissane angles in degrees" in the final postprocedure phase, for both ELA and STA, with p-value ≤ 0.05 significant. The programs used were Stata 18 and Minitab 21.

Results

A total of 77 patients were included (52 ALS and 25 STA). Regarding qualitative variables, such as extensile lateral approach (ELA) and sinus tarsi approach (STA) for gender, infection, dehiscence, and material removal, Pearson's Chi-Square test (X^2) was applied, finding that there was a significant statistical association between all variables, with $p<0.05$ (rejecting H_0) (Table 1).

Table 1. General clinical data, numerical values, percentage, and p-value. Ntotal_ELA=52 patients, and Ntotal_STA=25 patients.

Gender_ELA*	N	%	Gender_STA*	N	%
Female	4	7.69	Female	2	8.00
Male	48	92.31	Male	23	92.00
Infection_ELA**	**N**	**%**	**Infection_STA****	**N**	**%**
No	49	94.23	No	23	92.00
Yes	3	5.77	Yes	2	8.00
Dehiscence_STA***	**N**	**%**	**Dehiscence_STA*****	**N**	**%**
No	48	92.31	No	23	92.00
Yes	4	7.69	Yes	2	8.00
Material Removal_ELA****	**N**	**%**	**Material Removal_STA******	**N**	**%**
No	44	84.62	No	22	88.00
Yes	8	15.38	Yes	3	12.00

Note:
*Pearson's Chi-Square test shows that the variables are statistically associated, with $p<0.05$ (rejecting H_0). **Pearson's Chi-Square test shows that the variables are statistically associated, with $p<0.05$ (rejecting H_0). ***Pearson's Chi-Square test shows that the variables are statistically associated, with $p<0.05$ (rejecting H_0). ****Pearson's Chi-Square test shows that the variables are statistically associated, with $p<0.05$ (rejecting H_0). Source: Own Authorship.

Table 2 presents the quantitative descriptive statistical results of the age and extensile lateral approach (ELA) and sinus tarsi approach (STA) concerning the Böhler and Gissane angles in degrees.

Table 2. Quantitative descriptive statistical results of the age and extensile lateral approach (ELA) and sinus tarsi approach (STA) concerning the Böhler and Gissane angles in degrees.

Variables	*Mean*	*StDev*	*Minimum*	*Median*	*Maximum*
Age_ELA	41.87	12.53	18.00	43.00	70.00
Age_STA	46.00	10.67	27.00	46.00	65.00
GISSANI PRE_ELA	117.50	11.42	89.40	119.50	139.90
GISSANI PRE_STA	121.95	16.36	98.00	118.10	177.20
GISSANI POS_ELA	120.82	9.79	95.90	120.20	149.90
GISSANI POS_STA	122.44	13.93	105.10	118.70	169.40
BOHLER PRE_ELA	11.66	7.72	1.20	9.05	28.30
BOHLER PRE_STA	3626	12493	3	14	45146
BOHLER POS_ELA	22.31	11.15	1.10	24.20	46.90
BOHLER POS_STA	3629	12476	8	21	45129

Source: Own Authorship.

Table 3 shows the statistical results of Tukey's one-way ANOVA, with $p<0.05$ with a statistically significant difference (rejects the null hypothesis H_0), concerning age and extensile lateral approach (ELA) and sinus tarsi approach (STA), intra and intergroup, concerning the Böhler and Gissane angles in degrees. The results showed that only BOHLER POS_ELA - BOHLER PRE_ELA (intragroup), BOHLER PRE_STA - BOHLER PRE_ELA (intergroup), and BOHLER POS_STA - BOHLER POS_ELA (intergroup) presented a statistically significant difference, with $p<0.05$, as highlighted in red.

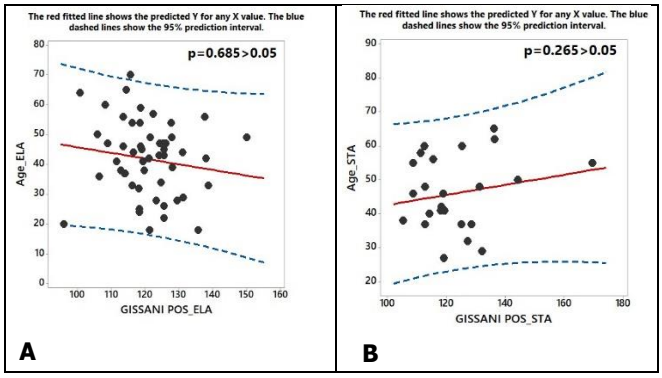
Table 3. Statistical results of Tukey's one-way ANOVA, with $p<0.05$ with a statistically significant difference (rejects the null hypothesis H_0).

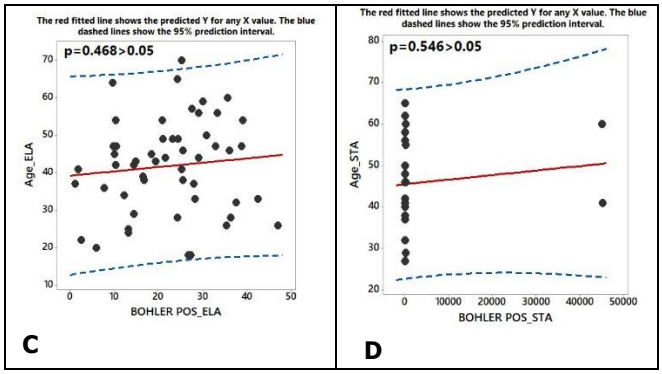
Difference of Levels	Difference of Means	95% CI	T-Value	Adjusted p-Value
Age_STA - Age_ELA	4.13	(-1.67, 9.94)	1.42	0.160
GISSANI POS_ELA - GISSANI PRE_ELA	3.32	(-0.81, 7.46)	1.59	0.114
GISSANI POS_STA - GISSANI PRE_STA	0.49	(-8.15, 9.13)	0.11	0.910
GISSANI PRE_ELA - GISSANI PRE_STA	4.45	(-1.95, 10.85)	1.38	0.170
GISSANI POS_ELA - GISSANI POS_STA	1.61	(-3.85, 7.08)	0.59	0.558
BOHLER POS_ELA - BOHLER PRE_ELA	10.65	(6.92, 14.38)	5.66	0.000
BOHLER POS_STA - BOHLER PRE_ELA	2	(-7097, 7102)	0.00	0.999
BOHLER PRE_STA - BOHLER PRE_ELA	3615	(188, 7041)	2.10	0.039
BOHLER POS_STA - BOHLER POS_ELA	3606	(185, 7028)	2.10	0.039

Source: Own Authorship.

Figure 1 represents the influence through linear regression analysis of the predictor "age" on the response predictors "Böhler and Gissane angles in degrees" in the final postprocedure phase (A, B, C, and D), for both ELA and STA. The results showed that there was no statistically significant influence of the predictor "age" on the response predictors, with $p>0.05$ for all analyses.

Figure 1. Linear regression analysis of the predictor "age" on the response predictors "Böhler and Gissane angles in degrees" in the final post-procedure phase, for both ELA and STA, with $p<0.05$ with statistical significance, at the 95% CI.





Source: Own Authorship.

Discussion

In this study, after evaluating the results of the difference in complication rates and the degree of correction of joint deviation after fracture correction between the extensile lateral approach (ELA) and sinus tarsi approach (STA), as well as the rates of complications such as dehiscence, superficial and deep infection; need for material removal and correction of radiographic parameters by the Böhler and Gissane angles, it was shown that for gender, infection, dehiscence, and removal of material, Pearson's Chi-Square test (X^2) was applied, finding that there was a significant statistical association between all variables, that is, no statistical differences were observed after intergroup comparisons (ELA vs. STA).

Furthermore, the results showed that only Bohler pos_ELA - Bohler pre_ELA (intragroup), Bohler pre_STA - Bohler pre_ELA (intergroup), and Bohler pos_STA - Bohler pos_ELA (intergroup) presented a statistically significant difference. The results also showed that there was no statistically significant influence of the predictor "age" on the predictors of the responses "Böhler and Gissane angles in degrees" in the final post-procedure phase. Thus, STA presented a lower probability of complications with the use of the sinus tarsi approach, achieving the same level of joint reduction and control of progression to osteoarthritis. All these results of the present study almost entirely confirm the literary findings that appear downstream in the discussion.

Based on this, a recent meta-analysis study published this year 2024 compared the clinical results of displaced intra-articular calcaneal fractures (DIACF) treated with open reduction and internal fixation using the lateral extensible approach (ELA) versus the minimally invasive sinus tarsi approach (STA), focusing on wound complications. A total of 21 articles (4 randomized controlled trials, 17 cohort studies) comprising 2086 patients with calcaneal fractures treated with ELA (n = 1129) or STA (n = 957) met the inclusion criteria. The risk of postoperative wound-related complications (RR 2.82, 95% CI: 2.00–3.98, I^2=27%) and the risk of reoperation (RR 1.85, 95% CI: 0.69–5.00, I^2=67%) was higher in ELA patients compared to STA patients. However, the increased risk of postoperative wound-related complications with ELA vs. STA showed a decreasing trend in recent publications. Radiographic measurements at the final follow-up, including the Böhler angle, and Gissane angle, as well as calcaneal height, length, and width, showed no statistically significant differences between the two groups [11].

In addition, a recent retrospective study compared the radiological and functional outcomes of the extended lateral and sinus tarsi approaches for the treatment of displaced intraarticular calcaneal fractures, involving 44 patients with displaced intra-articular calcaneal fractures. There were no significant differences in the American Orthopaedic Foot and Ankle Society ankle-hindfoot score, Foot Function Index, or visual analog scale score between the groups. In both groups, the radiological outcomes (Böhler angle, calcaneal width, and calcaneal height) were better postoperatively than preoperatively. The sinus tarsi approach is a safe and effective alternative to the extended lateral approach for the treatment of displaced intraarticular calcaneal fractures [12].

Also, a retrospective study analyzed the radiographic results and clinical outcomes of patients who underwent extended sinus tarsi approach and extended lateral approach (ELA) for displaced intra-articular calcaneal fractures. The total number of ELA (46 patients, 52 feet) and ELA (56 patients, 64 feet) was evaluated. Neither the postoperative nor the 3-year follow-up Böhler angles nor the calcaneal width differed significantly between the 2 groups (both $p > 0.05$). No significant differences were found between the groups in terms of postoperative translation ($p = 0.232$) or angulation ($p = 0.132$) of the sustentacular fragment on the 3-month follow-up CT scan. During the 3-year follow-up, we found no significant difference between the groups in the mean pain score on the visual analog scale at rest ($p=0.641$) or during weightbearing ($p=0.525$) [13].

Conclusion

It was concluded that no statistical differences were observed after the intergroup comparisons (ELA vs. STA). There was also no statistically significant influence of the predictor "age" on the predictors of the responses "Böhler and Gissane angles in degrees" in the final post-procedure phase. In general, STA presented a lower probability of complications with the use of the sinus tarsi approach, reaching the same level of joint reduction and control of progression to osteoarthritis. All these results of the present study almost completely confirm the literary findings that appear in the discussion.

CRediT

Author contributions: **Conceptualization -** Vanessa Cavazana Takata, Carolina Barbosa de Aquino, João Vitor Oliveira Souto; **Data curation-** Rullya Marson De Melo Oliveira, Gustavo Cavallari, Helencar Ignácio, Marcio Gomes Figueiredo; **Formal Analysis-** Vanessa Cavazana Takata, Carolina Barbosa de Aquino, João Vitor Oliveira Souto, Rullya Marson De Melo Oliveira, Gustavo Cavallari, Helencar Ignácio, Marcio Gomes Figueiredo; **Investigation-** Vanessa Cavazana Takata, Carolina Barbosa de Aquino; **Methodology-**Rullya Marson De Melo Oliveira, Gustavo Cavallari, Helencar Ignácio, Marcio Gomes Figueiredo; **Project administration-** Vanessa Cavazana Takata, Carolina Barbosa de Aquino, João Vitor Oliveira Souto, Rullya Marson De Melo Oliveira, Gustavo Cavallari, Helencar Ignácio, Marcio Gomes Figueiredo; **Supervision-** Vanessa Cavazana Takata; **Writing - original draft-** Vanessa Cavazana Takata, Carolina Barbosa de Aquino, João Vitor Oliveira Souto, Rullya Marson De Melo Oliveira, Gustavo Cavallari, Helencar Ignácio, Marcio Gomes Figueiredo; **Writingreview & editing-** Vanessa Cavazana Takata, Carolina Barbosa de Aquino, João Vitor Oliveira Souto, Rullya Marson De Melo Oliveira, Gustavo Cavallari, Helencar Ignácio, Marcio Gomes Figueiredo.

Acknowledgment

Not applicable.

Ethical Approval

This study was approved by the Research Ethics Committee of FAMERP-Faculdade de Medicina de São José do Rio Preto, São Paulo, Brazil, under protocol 6.652.177, following the 1964 Declaration of Helsinki.

Informed Consent

Not applicable.

Funding

Not applicable.

Data Sharing Statement

No additional data are available.

Conflict of Interest

The authors declare no conflict of interest.

Similarity Check

It was applied by Ithenticate[@].

Peer Review Process

It was performed.

References

1. Rammelt S, Swords MP. Calcaneal Fractures-Which Approach for Which Fracture? Orthop Clin North Am. 2021 Oct;52(4):433-450. doi: 10.1016/j.ocl.2021.05.012.
2. Bába V, Kopp L. Calcaneal fractures - current trends and pitfalls. Rozhl Chir. 2021 Summer;100(8):369-375. English. doi: 10.33699/PIS.2021.100.8.369-375.
3. Wilkinson BG, Marsh JL. Minimally Invasive Treatment of Displaced Intra-Articular Calcaneal Fractures. Orthop Clin North Am. 2020 Jul;51(3):325-338. doi: 10.1016/j.ocl.2020.02.007.
4. Khazen G, Rassi CK. Sinus Tarsi Approach for Calcaneal Fractures: The New Gold Standard? Foot Ankle Clin. 2020 Dec;25(4):667-681. doi: 10.1016/j.fcl.2020.08.003.
5. Landsman A, Melick G, Pundu A. Intra-Articular Calcaneal Fractures: A Literature Review of Atraumatic Incisional Considerations. Clin Podiatr Med Surg. 2019 Apr;36(2):185-195. doi: 10.1016/j.cpm.2018.10.014.
6. Zhang G, Ding S, Ruan Z. Minimally invasive treatment of calcaneal fracture. J Int Med Res. 2019 Aug;47(8):3946-3954. doi: 10.1177/0300060519853402.
7. Liu GT, Vanpelt MD, Lalli T, Raspovic KM, Wukich DK. Surgical Management of Displaced Intra-Articular Calcaneal Fractures: What Matters Most? Clin Podiatr Med Surg. 2019 Apr;36(2):173-184. doi: 10.1016/j.cpm.2018.10.002.
8. Salameh M, Al-Hashki L, Al-Juboori S, Rayyan R, Hantouly A, Blankenhorn B. Management of displaced intra-articular calcaneal fractures; current concept review and treatment algorithm. Eur J Orthop Surg Traumatol. 2023 May;33(4):779-785. doi: 10.1007/s00590-022-03264-5.
9. Russell TG, Byerly DW. Talus Fracture. 2023 May 23. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan–. PMID: 30969509.
10. Rebbert S, Pflüger P, Crönlein M. Operative Versorgung intraartikulärer Kalkaneusfrakturen

mittels Plattenosteosynthese über den Sinus-tarsi-Zugang [Surgical treatment of intra-articular calcaneus fractures with plate osteosynthesis via the sinus tarsi approach]. Oper Orthop Traumatol. 2023 Dec;35(6):370-376. German. doi: 10.1007/s00064-023-00816-8.

11. Attenasio A, Heiman E, Hong IS, Bhalla AP, Jankowski JM, Yoon RS, Liporace FA, Dziadosz D. Postoperative wound complications in extensile lateral approach versus sinus tarsi approach for calcaneal fractures: Are we improving? Updated meta-analysis of recent literature. Injury. 2024 Jun;55(6):111560. doi: 10.1016/j.injury.2024.111560.
12. Mao JT, Chen CM, Lin CW, Lu HL, Kuo CC. Comparison of the Radiographic and Clinical Outcomes between the Sinus Tarsi and Extended Lateral Approaches for IntraArticular Calcaneal Fractures: A Retrospective Study. J Pers Med. 2024 Feb 28;14(3):259. doi: 10.3390/jpm14030259.
13. Song JH, Kang C, Hwang DS, Kang DH, Park JW. Extended Sinus Tarsi Approach for Treatment of Displaced Intraarticular Calcaneal Fractures Compared to Extended Lateral Approach. Foot Ankle Int. 2019 Feb;40(2):167-177. doi: 10.1177/1071100718803333.