META-ANALYSIS

Efficacy and Postoperative Complication Rates of Different Surgical Approaches for Calcaneal Fractures: A Network Meta-analysis

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ABSTRACT

Context • Calcaneal fractures (CFs) are the most common kind of tarsal fracture. The choice of surgical approach is a key element in the management of CFs, but the best method remains in dispute. Also, no single approach is appropriate for all kinds of CFs.

Objective • The study intended to evaluate the relationship between six surgical approaches for clinical treatment of CFs and prevention of postoperative complications, to provide an evidence-based approach for treatment.

Design • The research team performed a meta-analysis using the data from a previously published review and updating that data through a new narrative review. The team performed a systematic search in PubMed, Embase, the Cochrane Library, and the Chinese National Knowledge Internet (CNKI) from inception until January 2022, with no language restrictions. The search used the following keywords for the search: calcaneus, heel bone, surgical wounds, surgical incisions, prospective trials, prospective trials, and randomized controlled trials.

Outcome Measures • The research team compared the complication rates, American Orthopedic Foot and Ankle Society (AOFAS) scores, and Bohler's angles for the six surgical approaches, which were: (1) the extensive lateral approach (ELA), (2) the sinus tarsi approach (STA), (3) the horizontal arc approach (HAA), (4) the longitudinal approach (LA), (5) the oblique lateral incision (OLI), and (6) the modified incision (MI)). The team summarized the results using a random effects model.

Results • The research team analyzed the data from 19 RCTs with 1521 participants. They all were randomized controlled trials (RCTs). The complication rates were available for 18 studies, which included 1474 participants. The rates were significantly lower: (1) for HAA compared to ELA, [OR=-2.03; 95% CrI: [-3.63, -0.43)]; (2) for LA compared to ELA (OR=-1.83; 95% CrI: [-2.83, -0.84]); and (3) for STA compared to ELA (OR=- 1.22; 95% CrI: [-1.67, -0.78]). Of the 19 studies, 11 RCTs, with 942 participants, used the AOFAS scale. The probabilities for the surface under the cumulative ranking curve (SUCRA) indicated that OLI (0.694) >LA (0.596) >HAA (0.51) >STA (0.477) >ELA (0.224). In addition, ELA had the worst SUCRA (0.224). Of the 19 studies, 15 RCTs, with 1376 participants, used the Bohler angle as an outcome measure. The probability of SUCRA for the surgical approaches indicated that LA (0.723) >ELA (0.667) >STA (0.468) >HAA (0.373) >MI (0.27).

Conclusions • The meta-analysis provides an evidence-based approach to the clinical treatment of CFs for six surgical approaches. HAA had the best outcomes, and ELA had the worst. (*Altern Ther Health Med.* 2024;30(7):207-213).

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Calcaneal fractures (CFs) are the most common kind of tarsal fracture, accounting for 60%-78% of fractures that occur in tarsal bones, for 30% in the foot, and for 2%-3.1% of all fractures.[1,2] Physicians mainly see these fractures in young adult men in their fourth decade of life. Displaced intraarticular CFs that involve the subtalar joint are the most common type.[3]

Most CFs occur as isolated fractures, but they can also occur together with spinal and lower-limb injuries.[4] CFs often have negative socioeconomic consequences for patients, being frequently associated with long-term morbidity and disability in complex fracture patterns.[5]

Patients with CFs show symptoms such as pain and deformity and rapid swelling of the foot. The management of CFs remains in dispute, especially regarding the surgical methods for it.[6] For Sanders II and III, displaced intraarticular CFS, most surgeons choose open reduction and internal fixation (ORIF) because it can show remarkable outcomes for most patients.[7,8]

The goal of surgical management for CFs is achievement of anatomical reduction and stable fixation, to help patients gain better function and avoid complications. Due to patients' anatomical features and pre-existing co-morbidities, such as diabetes and smoking, and to surgical techniques, soft-tissue complications are common in CFs, including infections, hematomas, dehiscence, and skin-flap necrosis.[1]

Surgical Approaches

The choice of surgical approach is a key element in the management of CFs. For the years, medical practitioners have created multiple surgical approaches for CFs, including the extensive lateral approach (ELA), sinus tarsi approach (STA), longitudinal approach (LA), oblique lateral incision (OLI), modified incision (MI), and horizontal arc approach (HAA). Figure 1 provides a schematic diagram of the six kinds of surgical incisions.

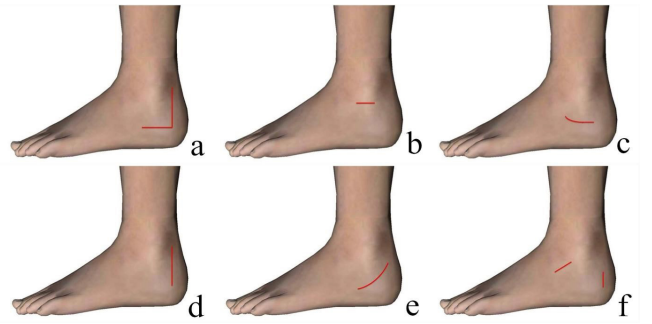
ELA. The skin incision for ELA is L-shaped and occurs on the outside of the heel, between the lateral malleolus and the posterior and inferior margin of the heel.[9] The early lateral approach for CFs, such as the standard Kocher approach, often led to sural-nerve injury due to postoperative adhesion of the peroneal tendon. To avoid that issue, medical practitioners introduced ELA into the management of CFs. Since the 1990s, ELA has gradually become the gold standard for displaced intra-articular CFs.[15-17]

The ELA method can fully expose the lateral wall, subtalar joint, and calcaneal cubic joint so that surgeons can get a good reduction. However, the incidence of wound healing complications in ELA is very high, ranging from 19% to 30% in different studies.[18-22] The wall of the lateral soft tissue of the hind foot is thin and fragile, which can bring a high risk of wound complications.[23,24] Under the guidance of the minimally invasive percutaneous osteosynthesis many orthopedic experts have been developing minimal invasion approaches and alternatives to ELA.

STA. The incision for STA begins above the fibula tendon at the top of the fibula and extends 2 to 3 cm to the distal protrusion. The incision must point to the fourth metatarsal. The STA approach is a new fashion in ORIF of CFs. It limits the dissection of soft tissue while allowing efficient reduction and internal fixation of the fracture.

Basile et al performed a multicenter, prospective study to compare STA and ELA and found that STA showed clinical and radiographic outcomes similar to those of ELA, with a lower incidence of wound complications, a faster surgical procedure, and a shorter waiting time for surgery. That study also found that the STA approach can sufficiently expose Sanders II and III CFs.[4]

Figure 1. Schematic Diagram of Six Kinds of Surgical Incisions. Figure 1a shows the extensive lateral approach (ELA); Figure 1b shows the sinus tarsi approach (STA); Figure 1c shows the horizontal arc approach (HAA); Figure 1d shows the longitudinal approach (LA); Figure 1e shows the oblique lateral incision (OLI); and Figure 1f shows the modified incision (MI).



Springs et al conducted a prospective cohort study with a minimum of one year of follow-up and confirmed that STA has a low risk of surgical site infections (SSI).[30] That study also found that the significant predictors for good outcomes for SSI were: (1) surgery within one week of the injury, (2) an American Society of Anesthesiologists (ASA) score of 2 or higher, and (3) blood loss of >150 cc.

At the same time, some scholars have studied the use of a modified incision on the basis of the STA approach. Wang et al's clinical study confirmed that STA's surgical effects were good and that the incidence of complications was low due to the restoration of the anatomical morphology of the calcaneus through two limited, small incisions.[14] Cottom and Baker found that all X-ray parameters, including the Bohler angle, calcaneal width, and calcaneal height, significantly improved during the follow-up period.[15]

HAA. The incision measures 3 cm horizontally and forward at 0.5 cm below the tip of the lateral ankle, exposing the area layer by layer and pulling the sural nerve downward. Then the surgeon pulls the long and short tendon of the fibula down, cuts the joint capsule, and exposes the posterior articular surface of the calcaneus.[10]

LA. The incision occurs at the midpoint between the posterior edge of the lateral malleolus and the Achilles tendon, at 1-2 cm above the tip of the lateral malleolus, and goes down the Achilles tendon to the junction of the foot's dorsum and the plantar skin.[11,12] The LA approach uses a minimally invasive incision on the posterior part of the lateral hindfoot between the fibula and Achilles tendon.[21] The LA approach has shown favorable outcomes in clinical research.[25-29]

OLI. Geel et al introduced this incision in 2001.[13] This curved, linear incision moves backward, parallel to the sural nerve, and allows the same amount of fracture and soft tissue

visualization as an L-shaped incision, such as ELA. It shows reliable results and can reduce wound and neurological complications.[14]

MI. The incision cuts 3-4 cm obliquely from the lateral malleolus' tip to the anterior process of the calcaneus. Then, the surgeon makes a vertical incision of 4 cm at 5-10 mm in front of the lateral edge of the Achilles tendon of the posterior tubercle of the calcaneus.[14]

Previous Analyses of Approaches

Despite the variety of surgical approaches, most previous studies of them have been comparisons between ELA and minimally invasive approaches. Zeng et al conducted a meta-analysis to compare the modified incision (MI) and ELA for Sanders type II and III CFs and found that the MI could significantly improve the American Orthopedic Foot and Ankle Society (AOFAS) score and lower the rate of wound complications as well as provide the advantages of shortening the length of the surgery and of the hospital stay.[31]

Seat et al performed another meta-analysis in 2020 to determine if the minimum incision approach (MIA) was superior to ELA, with 2179 patients.[32] Those researchers found that MIA was superior to traditional ELA in reducing the incidence of complications and the operation time. The calcaneus was high. The study's outcome measures include the AOAFS and a VAS for pain. The study found no significant differences in the anatomical reduction between the two methods, including the Bohler and Gissane angles, calcaneal width, and calcaneal length.

Several studies have focused on a comparison of ELA and STA. The results of these meta-analyses seem to indicate that STA can be an ideal choice for CFs due to its low wound-complication rates, shorter surgery times, and reliable anatomical reduction, as compared to ELA.[33-37]

Even though many meta-analyses have evaluated the surgical approaches for CFs, the final answer to each approach's benefits remains unknown. Several original studies ignored inconsistencies in the fractures' severity or the surgeons' experience.[22,23] Apart from those faults, most previous works have been pair-wise comparisons between approaches.[18,33-37]

Current Study

However, no single approach is appropriate for all kinds of CFs. Displaced intraarticular CFs remains a surgical challenge, and the ideal choice for these fractures is still under debate.

The current study intended to evaluate the relationship between six surgical approaches for clinical treatment of CFs and prevention of postoperative complications, to provide an evidence-based approach for treatment.

METHODS

Procedures

The research team performed a meta-analysis, using the data from a previously published review and updating that data through a new narrative review.

Search and selection strategy. The team performed a systematic search in PubMed, Embase, Cochrane Library, Web of Science, and Chinese National Knowledge Internet (CNKI) databases from inception until January 2022, with no language restrictions.

The team chose these databases because of their open access and widespread use in biomedicine. The search used the following keywords for the search: calcaneus, heel bone, surgical wounds, surgical incisions, prospective trials, prospective trials, and randomized controlled trials.

The review included studies if they: (1) included a CFs diagnosis based on an imaging examination, and the patients' Sanders classifications were type II, III, or IV; (2) included at least two of the studied surgical approaches—ELA, STA, LA, OLI, MI, and HAA; and (3) were retrospective trials or randomized controlled trials (RCTs).

The review excluded studies if they: (1) were republished literature,(2) didn't provide data or include any outcomes that the current review used; or (3) had an unclear description of the treatment plan.

Literature screening. Two members of the research team, strictly following the inclusion and exclusion criteria, independently sorted the literature, eliminated duplicate documents, browsed the literatures' titles and abstracts, eliminated irrelevant studies, and finally read the full text to determine the studies' final inclusion.

Quality assessment. Using the Cochrane system's assessment handbook which provides the standards for an assessment, and Revman5.3, the research team evaluated the methodological quality of the literature. The risk items included random sequence, allocation hiding, blinding, integrity of outcome data, risk of selective reporting bias, and other biases. If the team assessed each of the seven items as having low risk, a study's bias risk was low. If the team assessed one or more items as having a high risk, a study's bias risk was high.

Outcome measures. The research team compared the complication rates, American Orthopedic Foot and Ankle Society (AOFAS) scores, and Bohler's angles for the six surgical approaches: ELA, STA, HAA, LA, OLI, and MI. The team summarized the results using a random effects model.

Statistical Analyses

Using Stata15.1, the research team analyzed the data and drew forest maps and evidence relationship charts, SUCRA sorting charts, and other graphics. The team used: (1) the relative odds ratio (OR) and its 95% credible interval (CrI) to express the results of the mesh meta-analysis about the incidence of complications; and (2) the mean difference (MD) with corresponding 95% credible intervals (CrIs) to evaluate the AOFAS scores and Bohler's angles. If the CrI didn't include a value of zero, the team considered a comparison to be statistically significant.

To rank the efficacy of the interventions for CFs, the team used the surface under the cumulative ranking curve (SUCRA). High probabilities in SUCRA signified favorable

Table 1. Characteristics at Baseline. All studies were randomized controlled trials (RCTs)

Author, y	Interv Group n	Cntrl Group n	Mean age		Gender		Intervention		Mean Operation Time min		Outcome	Sanders Classification
			Interv Group Mean ± SD Median (Q1-Q4)	Cntrl Group Mean ± SD Median (Q1-Q4)	M	F	Interv Group	Cntrl Group	Interv Group Mean ± SD	Cntrl Group Mean ± SD		
Cong, 2017	29	35	40.1 ± 12.1	43.6 ± 12.4	31	33	LA	ELA	52.5 ± 11.1	82.8 ± 16.2	1,2,3	II, III
Li, 2016	32	32	40 ± 9	41 ± 9	47	17	STA	ELA	NA	NA	1,2,3	II, III, IV
Zhang, 2014[27,34]	63	67	39.8 ± 11.9	41.7 ± 10.0	114	16	LA	STA	45.9 ± 18.2	61.9 ± 15.3	1,2,3	II, III, IV
Xia, 2014	59	49	38 (20-67)	37 (19-67)	104	4	STA	ELA	62	93	1,3	II, III
Samani, 2018	20	20	35.11 ± 7.6	38.11 ± 5.7	31	9	STA	ELA	65.6 ± 6	72.8 ± 3.3	1,2,3	II, III
Khurana, 2017	12	9	30.6	34.3	NA	NA	LA	ELA	NA	NA	1,3	II, III
Sampath, 2014	22	23	31.5 ± 11.7	30.7 ± 10.07	35	10	STA	ELA	NA	NA	1,3	II, III, IV
Chen, 2011	40	38	31.1	32.7	44	34	STA	ELA	NA	NA	1,2,3	II, III
Basile, 2016[4]	18	20	41.89 ± 11.59	39.55 ± 13.19	28	10	STA	ELA	NA	NA	1,2	II, III
Xin, 2019	12	15	19-56	19-56	23	4	OLI	ELA	NA	NA	1,2	II, III, IV
Xie, 2012	15	15	20-50	20-50	22	8	OLI	ELA	NA	NA	1	II, III
Zhou, 2017	40	35	46.21 ± 7.26	47.05 ± 7.12	20	15	HAA	ELA	NA	NA	1,2,3	II, III
Fan, 2017	28	28	32.78 ± 16.57	33.53 ± 18.18	49	7	MI	ELA	NA	NA	1,3	II, III
Wu, 2012[26]	181	148	39.42 ± 10.50	41.49 ± 11.42	307	22	STA	ELA	101.31	73.64	1,2,3	II, III, IV
Takasaka, 2016	27	20	NA	NA	NA	NA	STA	ELA	NA	NA	2,3	II, III
Wang, 2015	54	53	39 (19-66)	41 (22-58)	100	7	STA	ELA	NA	NA	1,3	II
Weber, 2008	24	26	42.67 (16 ± 65)	40.04 (15 ± 64)	NA	NA	STA	ELA	108	160	1,2	II, III
Kline, 2013[18]	79	33	42.2 (18-65)	46.4 (21-66)	93	19	STA	ELA	NA	NA	1,3	II, III
Yeo, 2015	40	60	20-65	17-64	25	15	STA	ELA	40~75	65~ 95	1,3	II, III

Abbreviations: ELA, extensive lateral approach; HAA, horizontal arc approach; LA, longitudinal approach; MI, modified incision; OLI, oblique lateral incision; STA, sinus tarsi approach.

Figure 2. Literature Screening Flowchart

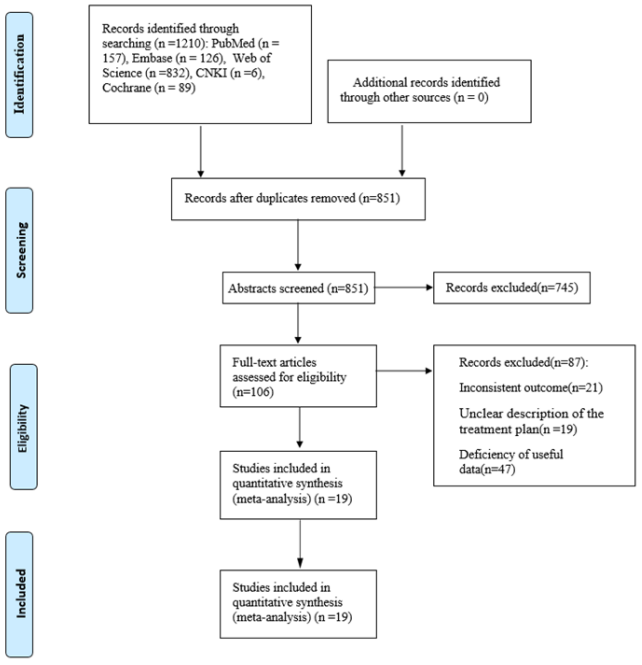
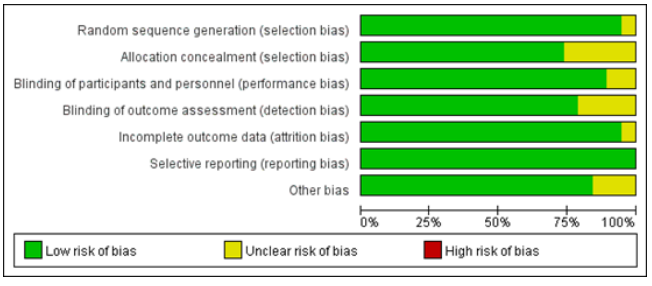


Figure 3. Assessment of Risk of Bias in the Included Studies



interventions. In addition, the team assessed publication bias by evaluating funnel plots.

The team also compared scatterplots, for which the team plotted effect sizes for each treatment (x-axis), to determine their resemblance to the standard error shown on the y-axis. In addition, the team assessed any inconsistency between direct and indirect evidence using node-splitting.

RESULTS

Literature Search

Initially, the research team found 1210 studies in the search and then eliminated 359 duplicates, with 851 studies remaining (Figure 2). After reading the titles and abstracts, the team removed 745 studies that didn't involve non-calcaneal fractures, weren't RCTs, or were conference papers or reviews, with 106 studies remaining. After reading the full text, the team excluded 21 studies that had inconsistent outcomes, 19 that had unclear descriptions of the treatment plan, and 47 that had missing data. Finally, the team analyzed the data of 19 studies, all RCTs with 1521 participants.

Characteristics of Studies

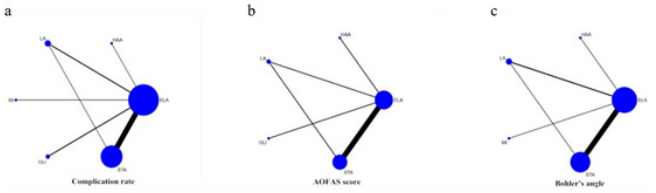
Table 1 shows the baseline characteristics of the included literature. All were RCTs. All of the included studies compared two interventions and had an intervention group and a control group.

Quality Assessment

The 19 included studies involved two-arm designs, and all 19 reported proper generation methods with a low risk of bias (Figures 3). Of the 19 RCTs, 13 reported proper allocation concealment with a low risk of bias, but six didn't report allocation concealment.

All of the RCTs reported the blinding of participants and personnel. Of the 19 included studies, 14 reported the blinding of the outcome assessments, and 17 reported the complete outcome data, with a low risk of bias. All of the

Figure 4. Network Diagram of Trials Included in the Quantitative Analysis. Figure 4a shows the complication rate; Figure 4b shows the AOFAS score; and Figure 4c shows Bohler's angle. Each node represents a treatment type. The numbers in the circles represent the number of people involved in all of the included studies and the widths of lines with numbers on them between two nodes represent the number of studies involved in the head-to-head comparison.



Abbreviations: AOFAS, American Orthopedic Foot and Ankle Society; ELA, extensive lateral approach; HAA, horizontal arc approach; LA, longitudinal approach; MI, modified incision; OLI, oblique lateral incision; STA, sinus tarsi approach.

included studies had a low risk of bias. The other bias of 16 trials with a low risk of bias.

Network Comparison

Figure 4 shows the network comparison for each outcome measure. The participants in all studies had received a diagnosis of a Sanders type II or III CF. Among them, the surgeries of 694 participants used ELA, of 104 participants used LA, of 596 participants used STA, of 27 participants used OLI, of 40 participants used HAA, and of 28 participants used MI.

Each node represents a treatment type. The numbers in the circles represent the number of people involved in all of the included studies and the widths of lines with numbers on them between two nodes represent the number of studies involved in the head-to-head comparison.

For the outcome measures: (1) 18 RCTs with 1474 participants examined the complication rate, comparing ELA, STA, LA, OLI, MI, and HAA (Figure 4a); (2) 11 RCTs with 942 participants used the AOFAS ankle-hindfoot scale, comparing ELA, HAA, LA, OLI, and STA (Figure 4b); and (3) 15 RCTs with 1376 participants used Bohler's angle, comparing ELA, HAA, LA, MI, and STA (Figure 4c).

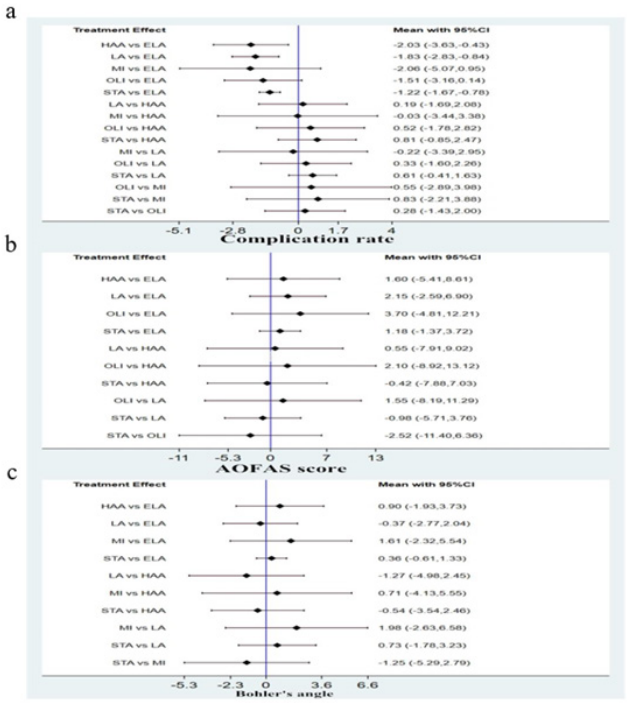
Forest Plots of Outcomes

Figure 5 shows the forest plots of outcomes, and Table 2 shows the comparisons of the surgical approaches.

Complication rates. The complication rates were significantly lower (Figure 5a): (1) for HAA compared to ELA [OR=-2.03; 95% CrI: (-3.63, -0.43)], (2) for LA compared to ELA [OR=-1.83; 95% CrI: (-2.83, -0.84)]), and (3) for STA compared to ELA [OR=-1.22; 95% CrI: (-1.67, -0.78)]. The other comparisons of surgical approaches found no significant differences.

AOFAS scores. Figure 5b and Table 2 demonstrate that no significant differences existed among the surgical approaches.

Figure 5. Forest Plots of Outcomes for ELA, STA, HAA, LA, OLI, and MI. Figure 5a shows the complication rate; Figure 5b shows the AOFAS score; and Figure 5c shows Bohler's angle.



Abbreviations: ELA, extensive lateral approach; HAA, horizontal arc approach; LA, longitudinal approach; MI, modified incision; OLI, oblique lateral incision; STA, sinus tarsi approach

Table 2. Comparisons of Surgical Approaches for Calcaneal Fractures

Complication rate		AOFAS score		Bohler's angle	
Treatment Effect	Mean with 95% CI	Treatment Effect	Mean with 95% CI	Treatment Effect	Mean with 95% CI
LA vs HAA	0.19 (-1.69, 2.08)	OLI vs LA	1.55 (-8.19, 11.29)	LA vs ELA	-0.37 (-2.77, 2.04)
MI vs HAA	-0.03 (-3.44, 3.38)	OLI vs HAA	2.10 (-8.92, 13.12)	STA vs LA	0.73 (-1.78, 3.23)
OLI vs HAA	0.52 (-1.78, 2.82)	STA vs OLI	-2.52 (-11.40, 6.36)	LA vs HAA	-1.27 (-4.98, 2.45)
STA vs HAA	0.81 (-0.85, 2.47)	OLI vs ELA	3.70 (-4.81, 12.21)	MI vs LA	1.98 (-2.63, 6.58)
HAA vs ELA	-2.03 (-3.63, -0.43)	LA vs HAA	0.55 (-7.91, 9.02)	STA vs ELA	0.36 (-0.61, 1.33)
MI vs LA	-0.22 (-3.39, 2.95)	STA vs LA	-0.98 (-5.71, 3.76)	HAA vs ELA	0.90 (-1.93, 3.73)
OLI vs LA	0.33 (-1.60, 2.26)	LA vs ELA	2.15 (-2.59, 6.90)	MI vs ELA	1.61 (-2.32, 5.54)
STA vs LA	0.61 (-0.41, 1.63)	STA vs HAA	-0.42 (-7.88, 7.03)	STA vs HAA	-0.54 (-3.54, 2.46)
LA vs ELA	-1.83 (-2.83, -0.84)	HAA vs ELA	1.60 (-5.41, 8.61)	STA vs MI	-1.25 (-5.29, 2.79)
OLI vs MI	-0.55 (-2.89, 3.98)	STA vs ELA	1.18 (-1.37, 3.72)	MI vs HAA	0.71 (-4.13, 5.55)
STA vs MI	0.83 (-2.21, 3.88)				
MI vs ELA	-2.06 (-5.07, 0.95)				
STA vs OLI	0.28 (-1.43, 2.00)				
OLI vs ELA	-1.51 (-3.16, 0.14)				
STA vs ELA	-1.22 (-1.67, -0.78)				

Abbreviations: AOFAS, American Orthopedic Foot and Ankle Society; ELA, extensive lateral approach; HAA, horizontal arc approach; LA, longitudinal approach; MI, modified incision; OLI, oblique lateral incision; STA, sinus tarsi approach

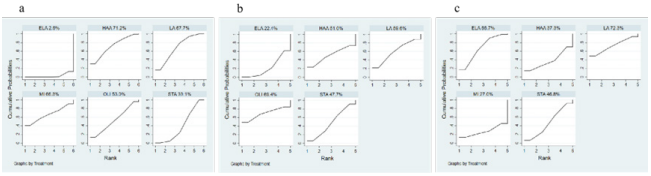
Bohler's angles. Figure 5c and Table 2 demonstrate that no significant differences existed among the surgical approaches.

SUCRA Probabilities

Figure 6 shows the SUCRA probabilities.

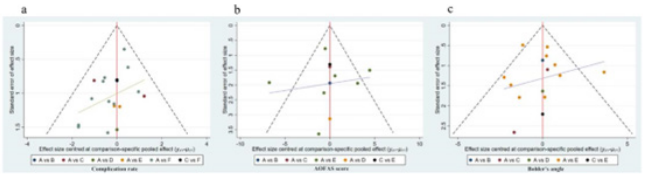
Complication rates. SUCRA demonstrated significant superiority for HAA (Figure 6a). The SUCRA probabilities for the surgical approaches were: HAA (0.712) >LA (0.677) >MI (0.663) >OLI (0.53) >STA (0.391) >ELA (0.026).

Figure 6. SUCRA Probabilities for Various Interventions. Figure 6a shows the probabilities for the ELA, HAA, LA, MI, OLI, and STA surgical approaches related to complication rates; Figure 6b shows the probabilities for the ELA, HAA, LA, OLI, and STA interventions; and Figure 6c shows the probabilities for the ELA, HAA, LA, MI, and STA interventions.



Abbreviations: ELA, extensive lateral approach; HAA, horizontal arc approach; LA, longitudinal approach; MI, modified incision; OLI, oblique lateral incision; STA, sinus tarsi approach; SUCRA, surface under the cumulative ranking curve

Figure 7. The Funnel Plots Identifying Publication Bias for ELA, STA, HAA, LA, OLI, and MI. Figure 7a: shows the funnel plots for the complication rate; Figure 7b shows the funnel plots for the AOFAS score; and Figure 7c shows the funnel plots for Bohler's angle.



Abbreviations: AOFAS, American Orthopedic Foot and Ankle Society; ELA, extensive lateral approach; HAA, horizontal arc approach; LA, longitudinal approach; MI, modified incision; OLI, oblique lateral incision; STA, sinus tarsi approach

Table 3. Complications of Surgical Approaches for Calcaneal Fractures

Study, y	Superficial Infections		Deep Infections		Wound Necrosis	
Cong, 2017	ELA	LA	ELA	LA	ELA	LA
	2	0	4	1	7	1
Li, 2016	ELA	STA	ELA	STA	ELA	STA
	5	2	1	0	4	0
Zhang, 2014[27,34]	STA	LA	STA	LA	STA	LA
	5	2	2	0	2	0
Samani, 2018	ELA	STA	ELA	STA	ELA	STA
	1	0	1	0	0	0
Khurana, 2017	ELA	LA	ELA	LA	ELA	LA
	1	0	0	0	0	0
Sampath, 2014	ELA	STA	ELA	STA	ELA	STA
	1	0	3	0	0	0
Chen, 2011	ELA	STA	ELA	STA	ELA	STA
	3	0	2	1	0	0
Wu, 2012[26]	ELA	STA	ELA	STA	ELA	STA
	12	4	2	0	0	0
Wang, 2015	ELA	STA	ELA	STA	ELA	STA
	0	0	2	0	6	0
Weber, 2008	ELA	STA	ELA	STA	ELA	STA
	0	0	0	0	4	1
Yeo, 2015	ELA	STA	ELA	STA	ELA	STA
	0	0	0	0	8	2

Abbreviations: ELA, extensive lateral approach; HAA, horizontal arc approach; LA, longitudinal approach; MI, modified incision; OLI, oblique lateral incision; STA, sinus tarsi approach.

AOFAS scores. SUCRA demonstrated significant superiority for OLI (Figure 6b). The SUCRA probabilities for the surgical approaches were: OLI (0.694) >LA (0.596) >HAA (0.51) >STA (0.477) >ELA (0.224). In addition, ELA was the worst therapy in terms of SUCRA (SUCRA=0.224).

Bohler's angles. SUCRA demonstrated significant superiority for LA (Figure 6c). [The SUCRA probabilities for the interventions were: LA (0.723) >ELA (0.667) >STA (0.468) >HAA (0.373) >MI (0.27).

Publication Bias and Consistency

Figure 7 shows the funnel plots of publication bias for each outcome. Only a small number of points were outside the inverse funnels, which suggests that the conclusions were highly consistent and trustworthy. Therefore, the team concludes that no significant publication bias existed in the included studies. In addition, the node-splitting indicated that no inconsistency existed between the direct and indirect evidence because all had $P > .05$.

Complications

Overall, the incidence of wound-healing complications in the intervention groups of the included studies was significantly lower than that of the control groups in those studies. The main complications were superficial infections, deep infections, and wound necrosis. Table 3 shows that 11 studies found these three main complications. Other studies also mentioned relatively rare complications, such as dehiscence, wound-edge necrosis, sural nerve injury, bilateral fracture, and heel broadening.

DISCUSSION

The current meta-analysis showed that HAA was the best and ELA the worst surgical approach methods.

CONCLUSIONS

The meta-analysis provides an evidence-based approach to the clinical treatment of CFs for six surgical approaches. HAA had the best outcomes, and ELA had the worst.

DATA AVAILABILITY

The simulation experiment data used to support the findings of this study are available from the corresponding author upon request.

AUTHORS' DISCLOSURE STATEMENT

The authors declare that they have no competing interests related to the study.

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