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Original Article

Analysis of risk factors associated with incision complications in modified "L" approach for calcaneal fracture

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Abstract: Objective: This study aimed to identify risk factors associated with incision complications following the modified "L" approach for calcaneal fractures. Methods: Data from 100 patients treated with the modified "L" approach for calcaneal fractures between January 2018 and December 2021 were analyzed. These included 52 cases in the poorly healing group and 48 in the well-healing group. Variables such as patient age, sex, body mass index, fracture type (Sanders classification), smoking history, alcohol consumption, diabetes status, timing of surgery, tourniquet use, bone grafting, suture method, and postoperative incision care were evaluated. A nomogram was developed using R software to predict the risk of incision complications, validated through the area under the ROC curve, C-index, and decision curve analysis. Results: Both univariate and multivariate regression analyses identified fracture type, smoking history, diabetes, timing of surgery, and duration of tourniquet application as significant predictors of incision complications. These factors were incorporated into a clinical predictive nomogram. The nomogram's calibration curves demonstrated high accuracy, both internally and externally. The unadjusted concordance indes (C-index) was 0.793 [95% confidence interval (CI), 0.825-0.995], and the area under the curve for the nomogram was 0.7875882. Decision curve analysis confirmed the clinical applicability of the model at a threshold probability of 20-60%. Conclusion: We have developed a reliable clinical nomogram to predict the risk factors for incision complications in the modified "L" approach for calcaneal fractures, enhancing decision-making in clinical settings.

Keywords: Incision complications, modified "L" approach, calcaneal fractures, risk factors

Introduction

Calcaneus fractures, comprising about 2% of all fractures, typically affect young males involved in high-energy trauma, such as motor vehicle collisions or falls from significant heights [1, 2]. These fractures can also occur in older adults following low-energy incidents, like falls from a standing height, and are often complicated by concurrent injuries to the spine, pelvis, or lower extremities. Individuals with osteoporosis are particularly vulnerable due to bone fragility, increasing their risk of calcaneus fractures [3]. Surgical intervention remains the primary treatment strategy, with techniques including open reduction and internal fixation (ORIF), percutaneous fixation, external fixation, and the modified "L" approach, often supplemented by bone grafting [4-6].

The modified "L" approach, a newer option for treating calcaneus fractures, provides several benefits over traditional methods used for similar fractures. This technique allows for improved access to the fracture site, facilitating better bone alignment and reducing the likelihood of malunion or nonunion. Additionally, it offers enhanced visualization of adjacent soft tissues, which helps minimize tissue damage and supports more effective healing [7, 8].

Common complications associated with the modified "L" approach for calcaneal fractures include infection, nerve damage, blood vessel

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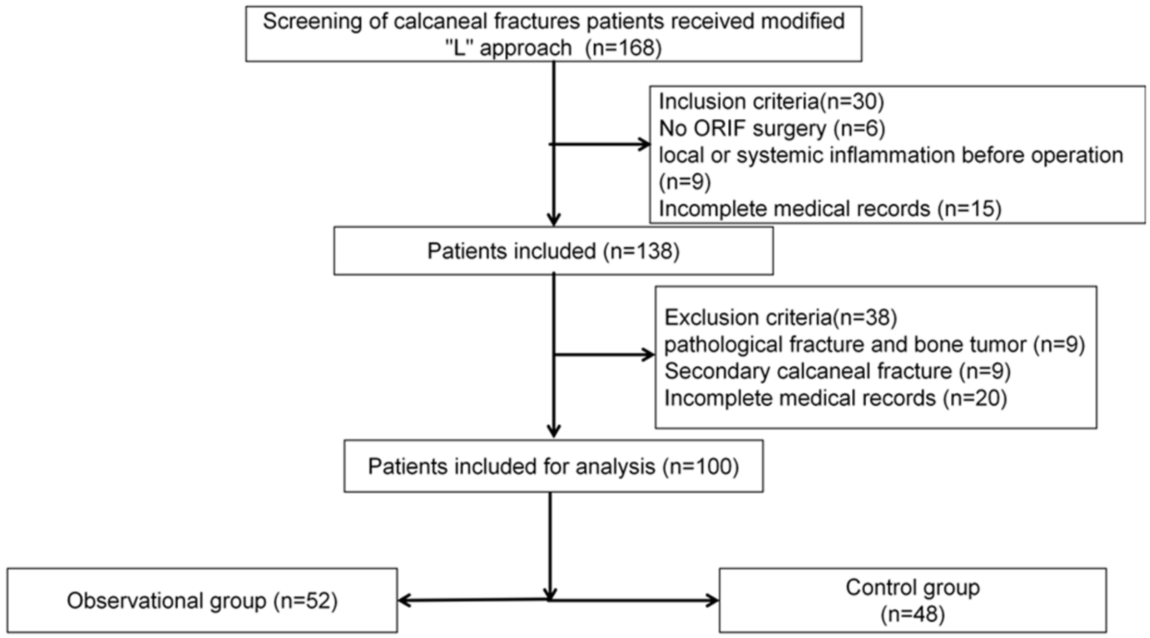

Figure 1. The flow chart. ORIF: open reduction and internal fixation.

injury, delayed healing, and hardware failure [9, 10]. Research suggests that factors such as inadequate surgical exposure, suboptimal surgical technique, and poor post-operative care contribute to incision complications [11, 12]. Despite the frequent use of the "L" approach, which involves an "L"-shaped incision to access and realign the fractured bone, ambiguity remains concerning the specific risk factors for complications in this context.

Therefore, the aim of this study was to investigate the risk factors associated with incision complications following the modified "L" approach for calcaneal fractures, with the goal of providing insight to reduce the incidence of such complications after surgery.

Materials and methods

Study design and ethics

This retrospective analysis was conducted with approval from the ethics committee of General Hospital of Ningxia Medical University. The study classified patients into two groups based on wound healing outcome: the control group (good healing) comprised patients with satisfactory wound healing post-operation, while the observational group (poor healing) consisted of patients experiencing complications related to inadequate wound healing, such as wound nonunion, dehiscence, infection, or necrosis. Criteria for defining poor healing [13] included: discoloration of the incision margin, with a width not exceeding 1 cm, or evident signs of redness, hematoma, or exudate lasting > 7 days; incisional dehiscence or necrosis, with exposure of subcutaneous tissue, calcaneal bone, or fixation hardware; and incisional infection, characterized by persistent inflammation, warmth, pain, and purulent discharge, accompanied by elevated white blood cell count, C-reactive protein, and procalcitonin levels. The study flowchart is depicted in **Figure 1**.

Inclusion criteria

(1) Patients with closed calcaneal fractures classified as Sanders type II/III/IV. (2) Patients who underwent open reduction and internal fixation (ORIF) using the modified "L" approach for calcaneal fracture. (3) Absence of evident local or systemic inflammation prior to surgery. (4) Availability of complete and reliable patient information, including comprehensive demographic data.

Exclusion criteria

(1) History of mental illness. (2) Presence of open fracture. (3) Serious underlying systemic

conditions (e.g., severe hypertension, heart disease, cerebrovascular disease, vascular disease). (4) Patients with congenital or acquired immunodeficiency receive long-term corticosteroid therapy. (5) Pathologic fractures or bone tumors. (6) Secondary calcaneal fractures. (7) Incomplete patient information.

Data collection

Demographic and clinical data were collected from electronic medical records using a standardized methodology. The data included age, sex, body mass index, fracture type (Sanders classification), smoking history, alcohol consumption, diabetes status, timing of surgery, duration of tourniquet use, bone grafting, tourniquet application time, suture technique, and postoperative incision characteristics.

Surgical procedure

The lateral "L" incision started approximately 3-5 cm above the lateral malleolus, extending from the rear between the lateral malleolus and the Achilles tendon. The incision proceeded downward at over 90 degrees between the dorsum of the foot skin and the thicker skin of the sole, curving anteriorly to end about 1 cm near the base of the fifth metatarsal bone, and slightly moving upwards to reach the periosteum. Care was taken to protect the sural nerve and small saphenous vein.

Using "NO Touch" technology, the entire lateral skin flap was lifted, and three 3.0 Kirschner pins were placed transversely from outside to inside through the fibula, talus, and cuboid, bending upwards to aid in exposing the fracture site. Operators must handle the flap gently to preserve its blood supply. Once the lateral aspect was fully exposed, the lateral bone fragment was detached, and any hematoma and blood clots within the calcaneus were thoroughly removed.

The assistant utilized a point type reduction clamp to pull the calcaneal tuberosity distally, while the operator performed prying reduction to restore the height of the displaced fracture blocks and collapsed calcaneus. The procedure was monitored under C-arm fluoroscopy to ensure that the calcaneus height, width, G-angle, and B-angle were satisfactorily restored.

A Kirschner wire was then inserted from the posterior lower part of the calcaneus into the talus for temporary fixation and reduction of the fracture block. The lateral bone block was repositioned and hammered from the outside inward to restore the width of the calcaneus and prevent lateral wall bulging. Bone grafting was considered based on the specific clinical scenario. An appropriate anatomic plate for the calcaneus was selected and secured with screws.

Statistical analysis

Data were analyzed using SPSS version 20.0. Continuous variables were presented as mean ± SD or median, and compared using independent sample t-tests or rank sum tests. Categorical variables were expressed as percentages and analyzed using the chi-square test. A multivariate logistic regression model was employed to identify factors influencing the risk of incision complications associated with the modified "L" approach for calcaneal fractures. A *P*-value < 0.05 was considered significant. The identified risk factors were then used to construct a predictive nomogram in R software (version 3.6.3). This involved determining the variables and their regression coefficients to develop the model, followed by the generation and validation of a ROC curve to assess the model's accuracy.

Results

Clinical characteristics

Statistical analysis revealed significant differences between the two groups in fracture type, smoking history, diabetes, timing of operation, and tourniquet time ($P < 0.05$). However, no significant differences were observed in bleeding volume, suture method, alcohol consumption, bone grafting, gender, age, or body mass index ($P > 0.05$) (**Table 1**).

Univariate and multivariate regression analysis

As indicated in **Table 2**, fracture type, smoking, diabetes, timing of operation, and tourniquet time were significantly associated with incision complications in the modified "L" approach for calcaneal fractures ($P < 0.05$). These factors were confirmed as independent predictors of

Table 1. Comparison of clinical data between the two groups

Clinical data	Observation group (n=52)	Control Group (n=48)	t/χ^2	*P*
Age	36.8±6.1	39.4±3.9	4.847	0.251
Body mass index	25.3±9.8	24.3±5.7	2.078	0.122
Sex			4.49	0.43
Male (n%)	36 (69.2%)	41 (85.4%)		
Female (n%)	16 (30.8%)	7 (14.6%)		
Fracture type			8.533	0.022
I	10 (19.2%)	23 (47.9%)		
II	34 (65.4%)	19 (39.6%)		
III	8 (15.4%)	6 (12.5%)		
Bone grafting	25 (48.0%)	21 (43.8%)	0.093	0.761
Smoking	29 (55.8%)	12 (23.1%)	5.283	0.032
Alcohol use	19 (36.5%)	20 (41.7%)	0.084	0.772
Diabetes	27 (51.9%)	12 (23.1%)	4.831	0.018
Suture mode			7.930	0.221
A-D	20 (38.5%)	12 (23.1%)		
Vertical mattress type	32 (61.5%)	36 (76.9%)		
Operation opportunity	9.26±1.89	7.36±1.87	4.004	0.003
Tourniquet time	93.95±10.04	102.16±10.59	-3.430	0.011
Bleeding volume	124.65±42.74	137.04±40.41	-1.175	0.334

Table 2. Correlations between various variables and incision complications in modified "L" approach for calcaneal fracture

Value	rho	*P*
Age	-0.071	0.454
Body mass index (kg/m^2)	-0.070	0.461
Sex	0.064	0.321
Fracture type	-0.032	0.023
Bone grafting	0.088	0.355
Smoking	-0.070	0.021
Alcohol use	0.088	0.355
Diabetes	0.431	< 0.001
Suture mode	0.338	0.123
Operation opportunity	0.458	< 0.001
Tourniquet time	0.431	< 0.001
Bleeding volume	0.332	0.233

Note: The correlation analysis was used for data with normally distributed data and Spearman correlation analysis was used for data not conforming to a normal distribution.

incision complications through multiple regression analysis, as detailed in **Table 3**.

Development of nomogram model

The nomogram model, developed using R software (version 3.6.3), includes the identified risk factors for incision complications in the modified "L" approach for calcaneal fractures. The predictive probability was calculated by summing the scores assigned to each risk factor, which correlated with the risk of incision complication (**Figure 2**).

Calibration plot and AUC of thenomogram model

The unadjusted concordance index (C-index) for the nomogram was 0.793 with a 95% CI of 0.825-0.995, indicating good model reliability. The calibration plot for the nomogram, illustrated in **Figure 3**, and the area under the curve (AUC) of 0.7875882, shown in **Figure 4**, demonstrate the model's effective discrimination and consistency in predicting risk factors for incision complications in the modified "L" approach for calcaneal fracture.

Decision curve analysis

The decision curve analysis for the model, depicted in **Figure 5**, shows that the model provides clinical utility when the threshold probability of incision complications is between 20% and 60%. This indicates that the nomogram is suitable for clinical application, assisting in the decision-making process for managing patients undergoing the modified "L" approach for calcaneal fractures.

Discussion

We identified fracture type, smoking history, diabetes, timing of surgery, and tourniquet duration as predictive risk factors for incision complication following the modified "L" approach for calcaneal fracture. These factors were incorporated into a clinical predictive nomogram, which has proven suitable for clinical use.

Our findings also highlighted a significant correlation between smoking and poor wound healing. The incidence of poor wound healing

Table 3. Multiple regression analysis

Dependent variable	Independent variable	B	SE	β	*P*
Incision complications	Fracture type	1.288	0.394	0.284	< 0.001
	Smoking	0.593	0.283	0.188	0.038
	Diabetes	2.538	0.940	0.501	0.031
	Operation opportunity	0.095	0.040	0.623	0.018
	Tourniquet time	2.042	0.854	0.712	0.009

Note: B: nonstandard regression coefficient; SE: standard error; β: multiple correlation coefficient adjusted for the degree of freedom.

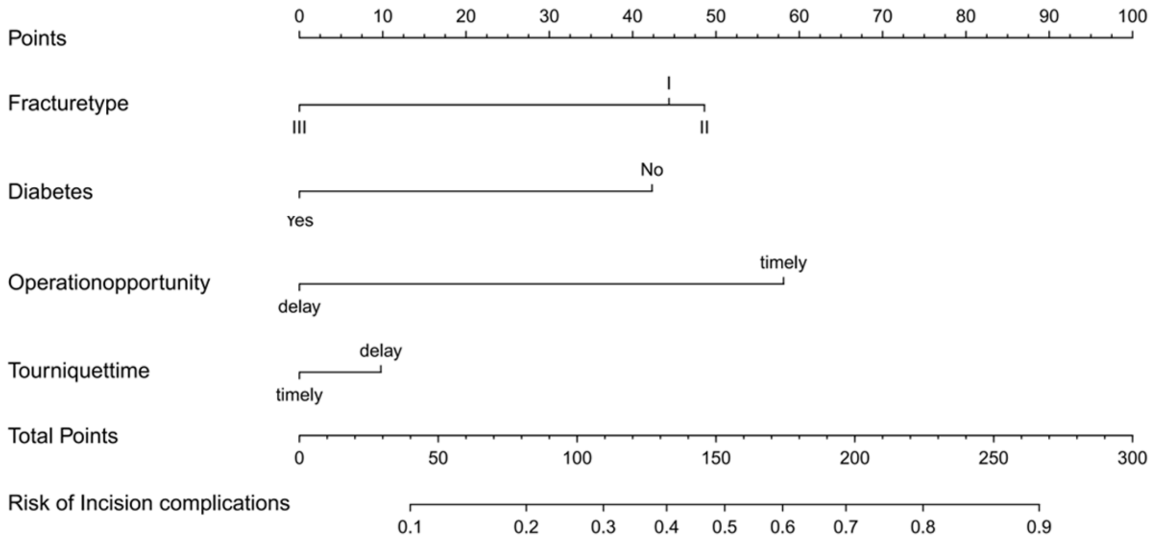

Figure 2. Nomogram for predicting incision complications in modified "L" approach for calcaneal fracture.

among smokers was substantially higher than that in non-smokers. Research suggests that the combustion of tobacco produces large amounts of carbon monoxide, which competes with oxygen for binding to hemoglobin, resulting in decreased oxygen content (pO_2) in arterial blood at the incision site [14, 15]. Additionally, nicotine, another major component of tobacco, alters the collagen structure of the skin, induces vasoconstriction, impairs microcirculation, reduces blood supply to the extremities, and lowers oxygen delivery to end tissues, further exacerbating hypoxia and vasospasm in skin microvessels. Nicotine also diminishes metabolic and immune functions [16]. However, the adverse effects of smoking on post-surgical incisions are not entirely irreversible. Several studies suggest that cessation of smoking one to two months before and one month after surgery can significantly reduce the incidence of incision complications [17]. Although it may be challenging for patients with calcaneal fractures to quit smoking 1-2 months before surgery, it is beneficial for their postoperative wound healing to cease smoking and avoid second-hand smoke exposure as soon as possible after admission. Therefore, it is advisable for patients admitted with calcaneal fracture to quit smoking promptly, and for others in the ward to avoid smoking to reduce passive exposure until wound healing is complete.

Diabetes impairs wound healing by affecting blood vessel walls and coagulation functions [18]. This impact is particularly pronounced in calcaneal surgeries due to the specialized blood supply to the calcaneus and surrounding skin. The blood supply to the tissues below the lateral malleolus primarily originates from the perforating branches, which track alongside the fibula and Achilles tendon, extending towards the junction of the dorsum of the foot and the plantar skin, then curving near the base of the fifth metatarsal bone, forming an

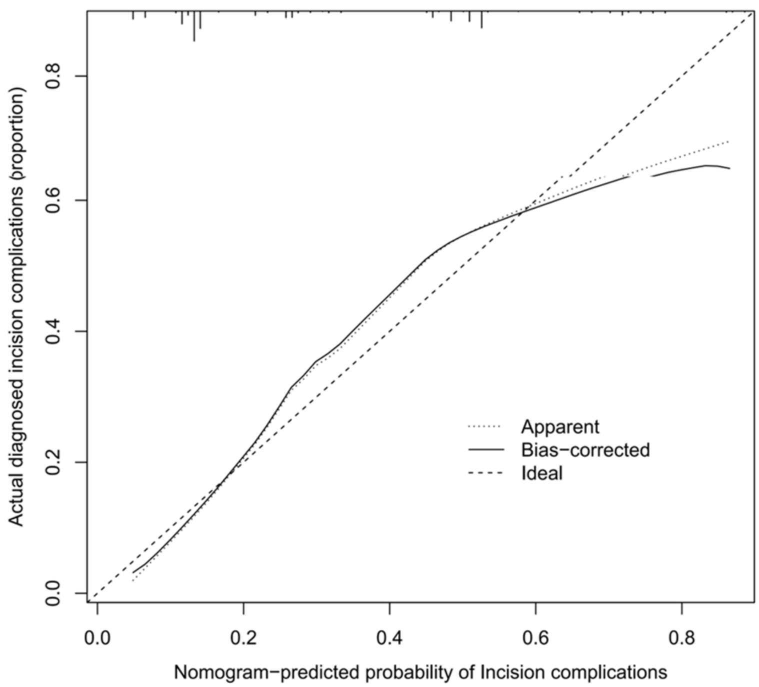

Figure 3. Calibration curves for predicting incision complications in modified "L" approach for calcaneal fracture.

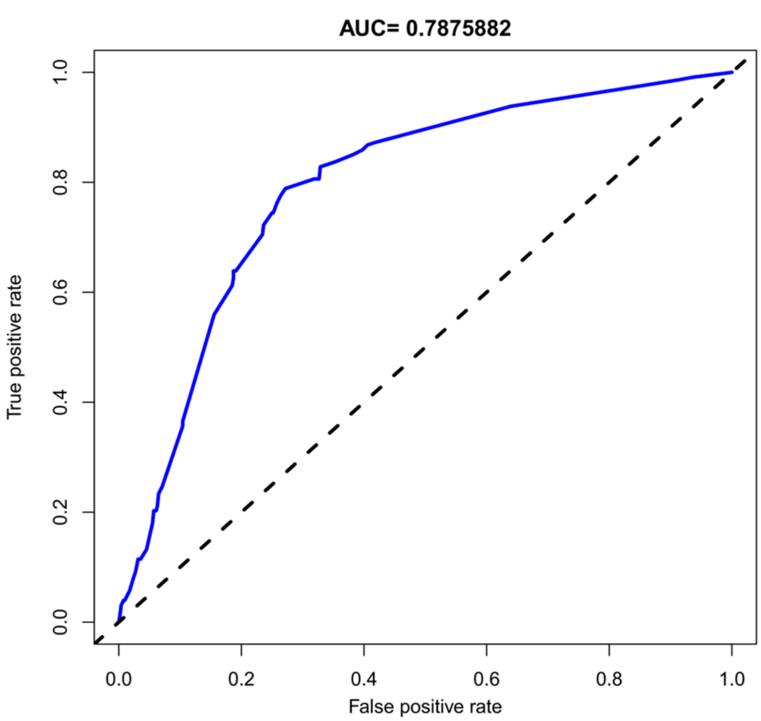

Figure 4. ROC curves for predicting incision complications in modified "L" approach for calcaneal fracture.

"L" shaped route that delineates the intersection of blood supply from the flaps on either side of the incision. The anteroposterior dorsalis pedis flap's blood supply is provided by the anterior tibial artery, forming a local arterial network, while the soft tissue below this division is nourished by the peroneal and plantar arteries [19]. The "L" incision intersects the anterior tibial artery and peroneal artery, with traditional surgical methods potentially damaging the vascular network between the foot's dorsum and sole. The width variation of calcaneal fractures also impacts the lateral skin's blood supply, especially when compounded with diabetes, hindering wound healing. Thus, timely blood glucose monitoring and control are crucial for diabetic patients post-admission.

Our study indicates that Sanders type I fractures are typically managed conservatively. Among surgically treated patients, the incidence of poor wound healing post-type II fracture surgery was 21.7%, escalating to 44.8% and 63.6% post-type III and IV surgeries, respectively. Statistical analysis confirmed the significant correlation between calcaneal fracture type and postoperative incision complications. However, these factors were not independent risk factors. Higher-grade Sanders fractures (II, III, and IV) often result from severe trauma, leading to greater calcaneal deformation [20] and comminution, exacerbating skin necrosis risk post-surgery. Increased calcaneal width, acute lateral calcaneus wall compression on the skin, and continuous post-injury trauma contribute to cause skin flap necrosis. Severe fractures prolong sur-

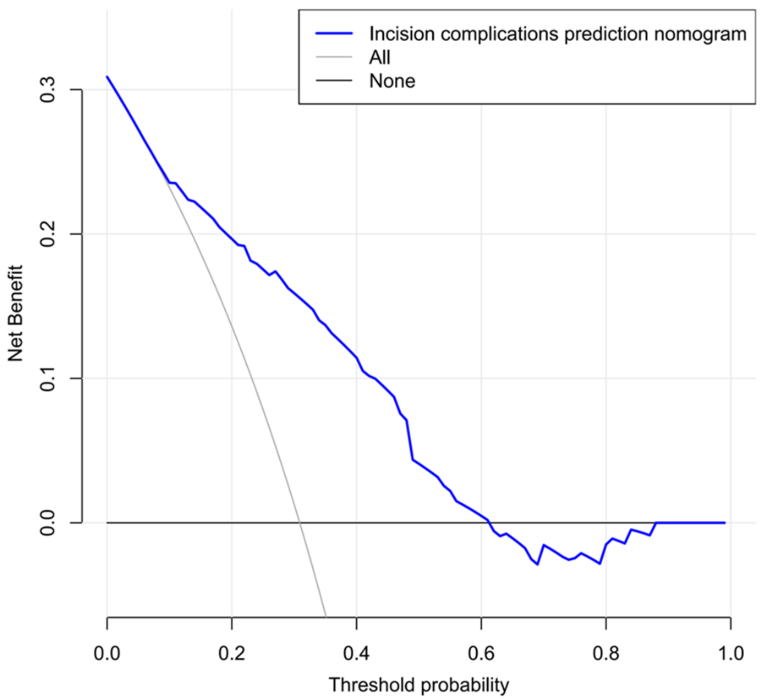

Figure 5. Decision curve analysis for the nomogram.

gery, complicating reductions and increasing postoperative complications [21]. Hence, preoperative CT scans, accurate classification, and comprehensive preoperative planning are vital for reducing surgery time and predicting postoperative outcome.

Prolonged use of a limb tourniquet during surgery can disrupt blood circulation in the affected heel tissue, leading to tissue ischemia, hypoxia, and cellular damage. Additionally, an extended tourniquet duration often correlates with longer operation times, increased incision exposure, and a higher incidence of postoperative wound healing complications [22]. However, strict operation time constraints for calcaneal fracture surgery may prompt surgeons to rush, resulting in inaccurate fracture reduction and compromised fixation, thereby affecting surgical outcome. Research on intraoperative tourniquet use indicates that prolonged tourniquet application heightens the risk of poor wound healing post-surgery [23]. Surgeons must therefore make a balanced assessment and not overlook one aspect at the expense of another. Backes et al. suggest a reasonable tourniquet application time of approximately 90 minutes [24], underscoring the need for surgeons to possess thorough anatomic knowledge, surgical expertise, and a comprehensive surgical plan to prevent intraoperative challenges and minimize operation duration.

Surgical intervention should be promptly conducted following the diagnosis of the fracture to alleviate patient discomfort and facilitate early pain relief. Performing surgery early offers advantages such as clearer fracture lines, incomplete hematoma organization, and relatively easier anatomical reduction. Moreover, early intervention helps alleviate compression damage to soft tissues caused by calcaneal deformation, thereby minimizing soft tissue injury. However, these benefits do not entirely mitigate the drawbacks. Research has indicated that patients often experience rapid local swelling within three days post-trauma, leading to the formation of tension blisters [25]. Additionally, patients may not have psychologically adjusted to their role as a patient, which can exacerbate intraoperative challenges such as increased bleeding and swelling, hindering fracture exposure and reduction. Severe swelling around the heel can complicate incision closure post-steel plate placement, further raising tension on the incision and increasing the risk of complications such as blister formation or rupture infection.

Xu et al. [26] suggested that delaying surgery until three weeks after the injury allows for the organization of hematoma at the fracture site, which begins to form fibrous bone, making orthopedic surgery more challenging. The findings of this case study indicated that the timing of the operation significantly affected wound healing. Therefore, it is recommended that surgery for calcaneal fracture should not be performed too early, but rather, it should be scheduled when local swelling has completely subsided and the wrinkle sign is evident.

In summary, this study developed a clinical nomogram to predict the risk factors associated with incision complications in the modified

"L" approach for calcaneal fractures. We confirmed that diabetes, smoking, fracture type, operation timing, and tourniquet use duration were independent risk predictors for incision complications in the modified "L" approach for calcaneal fractures.

Disclosure of conflict of interest

None.

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References

[1] Allegra PR, Rivera S, Desai SS, Aiyer A, Kaplan J and Gross CE. Intra-articular calcaneus fractures: current concepts review. Foot Ankle Orthop 2020; 5: 2473011420927334.

[2] Anandasivam NS, Bagi P, Ondeck NT, Galivanche AR, Kuzomunhu LS, Samuel AM, Bohl DD and Grauer JN. Demographics, mechanism of injury, and associated injuries of 25,615 patients with talus fractures in the national trauma data bank. J Clin Orthop Trauma 2020; 11: 426-431.

[3] Wallace IJ, Toya C, Peña Muñoz MA, Meyer JV, Busby T, Reynolds AZ, Martinez J, Thompson TT, Miller-Moore M, Harris AR, Rios R, Martinez A, Jashashvili T and Ruff CB. Effects of the energy balance transition on bone mass and strength. Sci Rep 2023; 13: 15204.

[4] Schulz D and Neubert A. Operative vs. conservative treatment for displaced intra-articular calcaneus fractures: a critical appraisal with a systematic review. Unfallchirurgie (Heidelb) 2023; 126: 826-828.

[5] Steelman K, Bolz N, Feria-Arias E and Meehan R. Evaluation of patient outcomes after operative treatment of intra-articular calcaneus fractures. SICOT J 2021; 7: 65.

[6] Wilmsen L, Neubert A, Windolf J, Icks A, Richter B and Thelen S. Screw fixation in the treatment of displaced intra-articular calcaneus fractures: a systematic review protocol. Syst Rev 2022; 11: 199.

[7] Yang X, Pan M, He H and Jiang W. Feasibility of the modified inverted L-shaped approach for posterolateral tibial plateau fracture: a retrospective study. Medicine (Baltimore) 2022; 101: e31057.

[8] Ma C, Zhao J, Zhang Y, Yi N, Zhou J, Zuo Z and Jiang B. Comparison of the modified sinus tarsi approach versus the extensile lateral approach for displaced intra-articular calcaneal fractures. Ann Transl Med 2021; 9: 695.

[9] Joseph NM, Benedick A, McMellen C, Napora J, Wetzel R, Sontich J and Ochenjele G. Acute fixation of displaced intra-articular calcaneus fractures is safe using the sinus tarsi approach. J Orthop Trauma 2021; 35: 289-295.

[10] Wang S, Li B, Li J, Zhang Z, Yang H and Liu L. Comparison of the modified Heuter approach and the Kocher-Langenbeck approach in the treatment of Pipkin type I and type II femoral head fractures. Int Orthop 2019; 43: 2613-2620.

[11] Fan XX, Shen Y and Xie WL. Risk factors analysis on wound complications after closed calcaneal frature operation using lateral extensive L-shaped incision. Zhongguo Gu Shang 2017; 30: 339-344.

[12] Luo L, Chen J, An Z, Sun W, Li M, Ouyang C, Wu W, Gu P, Tao Y, Jiang Z and Zheng X. Efficacy and postoperative complication rates of different surgical approaches for calcaneal fractures: a network meta-analysis. Altern Ther Health Med 2023: 17: AT8437.

[13] Hom DB and Davis ME. Reducing risks for poor surgical wound healing. Facial Plast Surg Clin North Am 2023; 31: 171-181.

[14] Wang J, Qin S, Wang T, Liu J and Wang Z. Comparison of the curative effect of percutaneous reduction with plastic calcaneal forceps combined with medial external fixation in the treatment of intra-articular calcaneal fractures. Orthop Surg 2021; 13: 2344-2354.

[15] Yuan X, Zhang B, Hu J, Lu B and Tang Z. A comparative study on internal fixation of calcaneal fractures assisted by robot and traditional open reduction internal fixation. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi 2021; 35: 729-733.

[16] Cui ST, Liu ZZ, Tang B, Chen GX and Wang ZZ. Closed reduction and internal fixation versus transtarsal sinus small incision internal fixation for Sanders type II calcaneal fractures. Zhongguo Gu Shang 2019; 32: 448-453.

[17] Vicenti G, Carrozzo M, Solarino G, Caizzi G, De Crescenzo A, Portaluri M, Mori CM, Vittore D and Moretti B. Comparison of plate, calcanealplasty and external fixation in the management of calcaneal fractures. Injury 2019; 50 Suppl 4: S39-S46.

[18] Wang H, Pei H, Chen M and Wang H. Incidence and predictors of surgical site infection after ORIF in calcaneus fractures, a retrospective cohort study. J Orthop Surg Res 2018; 13: 293.

[19] Kapil Mani KC, Acharya P, Dirgha Raj RC, Pangeni BR, Sigdel A and Marahatta SB. A modified minimally invasive technique for in-

tra-articular displaced calcaneal fractures fixed by transverse and axial screws. Eur J Orthop Surg Traumatol 2017; 27: 997-1004.
[20] Yang B, Wang DC, Zhang XG and Wang ZW. Improved anatomical locking plate internal fixation through tarsal sinus incision in treating Sanders III-IV calcaneal fractures. Zhongguo Gu Shang 2018; 31: 599-603.
[21] Rodemund C, Krenn R, Kihm C, Leister I, Ortmaier R, Litzlbauer W, Schwarz AM and Mattiassich G. Minimally invasive surgery for intra-articular calcaneus fractures: a 9-year, single-center, retrospective study of a standardized technique using a 2-point distractor. BMC Musculoskelet Disord 2020; 21: 753.
[22] Su J and Cao X. Risk factors of wound infection after open reduction and internal fixation of calcaneal fractures. Medicine (Baltimore) 2017; 96: e8411.
[23] Feng SM, Zhao JJ, Ma C and Xu W. All-inside subtalar arthroscopy through three portals combined with rafting screws technique for the treatment of the calcaneal fractures of Sanders II and III. Zhonghua Wai Ke Za Zhi 2022; 60: 546-551.
[24] Backes M, Spierings KE, Dingemans SA, Goslings JC, Buckley RE and Schepers T. Evaluation and quantification of geographical differences in wound complication rates following the extended lateral approach in displaced intra-articular calcaneal fractures - a systematic review of the literature. Injury 2017; 48: 2329-2335.
[25] Schindler C, Schirm A, Zdravkovic V, Potocnik P, Jost B and Toepfer A. Outcomes of intra-articular calcaneal fractures: surgical treatment of 114 consecutive cases at a maximum care trauma center. BMC Musculoskelet Disord 2021; 22: 234.
[26] Xu H, Hou R, Ju J, Liu Y and Chen L. Articular calcaneal fractures: open or minimally invasive surgery, when the medial wall reduction is obtained percutaneously from the lateral side. Int Orthop 2021; 45: 2365-2373.