

Original Article

Comparison of the efficacy of surgeries on intra-articular calcaneal fracture via tarsal sinus approach and lateral extended approach

Kai Zhang¹, Ruiqing Liu¹, Zonggeng Wang²

¹Department of Orthopedics, Linyi Central Hospital, Linyi 276400, Shandong Province, China; ²Department of Orthopedics, Caoxian County Hospital, Linyi 274400, Shandong Province, China

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Abstract: The surgical approaches for intra-articular calcaneal fracture are still controversial. The purpose of this study was to compare the efficacy of the tarsal sinus approach and the lateral extended approach on intra-articular calcaneal fracture. One hundred and six patients with intra-articular calcaneal fracture were divided into Group A and Group B randomly, with 53 patients in each group. Group A received surgery via the tarsal sinus approach. Group B received surgery via the lateral extended approach. The results showed that intraoperative blood loss, getting out-of-bed time and length of stay of Group A were all lower than those of Group B (all $P < 0.001$). Total incidence of postoperative complications in Group A was lower than that in Group B ($P = 0.014$). In conclusion, compared with the lateral extended approach, the tarsal sinus approach has less intraoperative blood loss, shorter getting out-of-bed time, shorter length of stay and fewer postoperative complications.

Keywords: Tarsal sinus approach, lateral extended approach, calcaneal fracture, complications

Introduction

Calcaneal fracture is the most common tarsal fracture and is generally divided into extra-articular and intra-articular fractures [1]. Intra-articular calcaneal fracture is a common type of calcaneal fracture. The traditional conservative regimen may leave some sequelae, and the feet are prone to pain after being stressed, so currently, the main effective regimen for displaced calcaneal fracture is surgical treatment [2, 3]. However, the surgical treatment of calcaneal fractures also has some drawbacks, which are mainly characterized by a high incidence of postoperative complications which many affect the patients' recovery and overall functions [4, 5]. Meanwhile, the surgical approach is also controversial. As pointed out by Schepers, patients who received surgeries via the tarsal sinus approach and the lateral extended approach for intra-articular calcaneal fracture had similar functional outcomes and incidences of complications [6]. Park et al. argued that the tarsal sinus approach can be a good choice for treating intra-articular calcaneal fracture and can prevent main soft tissue complications induced by the lateral extended approach [7].

The purpose of this study was to compare the efficacy of the tarsal sinus approach and the lateral extended approach on intra-articular calcaneal fracture.

Materials and methods

Study subjects

Approval was obtained from the Ethics Committee of Linyi Central Hospital, China. This experimental study was conducted from March 2017 to March 2019. A total of 106 patients with intra-articular calcaneal fracture were selected as research subjects. The inclusion criteria were patients with Sanders types II and III; those who were diagnosed with intra-articular calcaneal fracture by X-ray imaging; patients with closed fresh fractures in a single foot; no surgical contraindications; no foot deformities, no congenital diseases nor abnormal foot functions before fracture. The exclusion criteria were patients with extra-articular calcaneal fracture; patients with Sanders type IV; patients with an old calcaneal fracture; patients complicated by serious cardio-and cerebro-vascular diseases, diabetes, liver disease and kidney disease, etc.; patients complicated by serious

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Table 1. Comparison of surgical indicators between the two groups

Parameters	Group A (Mean ± SD) n=53	Group B (Mean ± SD) n=53	p-value
Operation time (min)	61.47±3.44	60.95±3.16	0.415
Intraoperative blood loss (mL)	42.65±2.13	62.35±2.30	<0.001
Getting out-of-bed time (d)	5.92±0.32	7.36±0.65	<0.001
Length of stay (d)	8.17±0.95	12.89±1.41	<0.001

fractures in other sites and those whose 6-month (on average) postoperative follow-up data were unavailable.

Grouping and curative treatment

The 106 patients with intra-articular calcaneal fracture were divided into Group A and Group B randomly, with 53 patients in each group.

Group A received surgery via the tarsal sinus approach; that is, an incision about 3 cm long was cut along the long axis of fibula, 1-2 cm below the ankle in order to expose the tarsal sinus, and then the fracture site was adjusted using a Steinmann pin. After that, the fracture site was fixed temporarily using 2-3 Kirschner wires. The calcaneus was repositioned by manipulation, and after the reposition standard was met, a hollow screw was inserted into the tarsal sinus for fixation.

Group B received surgery via the lateral extended approach; that is, the standard surgical method of lateral incision was used, the skin of the foot was cut open to the heel, about 1 cm above the junction between the instep and sole, the periosteum was stripped, the fractured end of calcaneus was opened and repositioned using a medical stripper. The articular surface was observed using X-ray. When the reposition standard was met, the fracture site was fixed with a medical screw and a medical steel plate.

Observed indicators

The operative time, intraoperative blood loss, getting out-of-bed time and length of stay of two groups were compared. The VAS pain scores of the affected feet before surgery and 7 d after surgery between the two groups were compared. The Bohler's angle and Gissane angle before surgery and 6 months after surgery were compared between two groups (for the follow-up, patients were measured through

X-ray when being admitted to hospital and receiving re-examination). The AOFAS scores of hind foot function before surgery and 6 months after surgery were compared between two groups. The full mark of AOFAS was 100, and the higher score, the better the hind foot function. The incidences of postoperative complications were also compared between two groups.

Statistical analysis

The data were processed by SPSS 25 (Chicago, USA) statistical software. Measurement data were expressed as (Mean ± SD), and independent-sample t test was carried out for intergroup comparison. Enumeration data were expressed as n (%), and chi-square test was carried out for intergroup comparison. P<0.05 indicated that the difference was statistically significant.

Results

General data

Among 106 patients, there were 59 (55.66%) males and 47 (44.34%) females, aged 24-58 (41.57±2.63). All had unilateral fractures. There were 64 (60.38%) cases with left foot fractures and 42 (39.62%) cases with right foot fractures; 70 (66.04%) cases were injured by falling from a height and 36 (33.96%) cases were injured in traffic accidents; 55 (51.89%) cases were Sanders type II and 51 (48.11%) cases were Sanders type III. The duration from injury to surgery was 1-4 (2.05±0.38) days.

Variation of surgical indicators

There was no difference between two groups in terms of operative time (P=0.415). The intraoperative blood loss, getting out-of-bed time and length of stay of Group A were all significantly lower than those of Group B (all P<0.001), as shown in **Table 1**.

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Table 2. Comparison of VAS score, AOFAS score, Bohler's angle and Gissane angle between the two groups

Parameters	Group A (Mean ± SD) n=53	Group B (Mean ± SD) n=53	p-value
VAS scores before surgery (score)	6.79±0.90	6.82±1.07	0.875
VAS scores 7 d after surgery (score)	6.68±0.80	6.72±0.78	0.810
AOFAS scores of hind foot functions before surgery (score)	53.72±2.64	54.21±1.11	0.216
AOFAS scores of hind foot functions 6 months after surgery (score)	85.67±3.89	84.33±4.56	0.108
Bohler's angle before surgery (°)	-1.71±2.92	-1.68±2.96	0.955
Bohler's angle 6 months after surgery (°)	26.77±2.22	26.33±2.29	0.316
Gissane angle before surgery (°)	172.09±6.63	171.15±5.47	0.426
Gissane angle 6 months after surgery (°)	109.64±6.71	108.95±7.54	0.623

Table 3. Comparison of postoperative complications between the two groups

Postoperative complications	Group A [n (%)] n=53	Group B [n (%)] n=53	p-value
Wound infection	1 (1.89)	4 (7.55)	0.169
Delayed union	1 (1.89)	2 (3.77)	0.558
Skin flap necrosis	0 (0)	3 (5.66)	0.079
Nerve injury	0 (0)	1 (1.89)	0.315
Total complications	2 (3.77)	10 (18.87)	0.014

Variation of VAS score, AOFAS score, Bohler's angle and Gissane angle

The comparison between two groups in terms of VAS scores before surgery and 7 d after surgery showed no statistically significant difference ($P=0.875$, 0.810). The comparison between the two groups in terms of AOFAS scores of hind foot function before surgery and 6 months after surgery showed no statistically significant difference ($P=0.216$, 0.108). The comparison between the two groups in Bohler's angle before surgery and 6 months after surgery showed no statistically significant difference ($P=0.955$, 0.316). The comparison between two groups in Gissane angle before surgery and 6 months after surgery showed no statistically significant difference ($P=0.426$, 0.623). See **Table 2**.

Variation of postoperative complications

The total incidence of postoperative complications in Group A was 3.77% (2 cases), significantly lower than that in Group B (18.87%, 10 cases) ($P=0.014$), as shown in **Table 3**.

Example of a typical case

A typical case associated with a high fall in Group A; male, 50 years old, received surgery

via the tarsal sinus approach after detumescence, and was released after 5 days postoperative (see **Figure 1A-C**).

Discussion

The present study showed that Group A was superior to the control group in intraoperative blood loss, getting out-of-bed time and length of stay. This

was likely due to the fact that Group A had smaller incisions and thus less intraoperative blood loss. Group A had less harm to the skin and soft tissues, so the patients could get out of bed and be discharged earlier. This suggested that the tarsal sinus approach had the advantage of minimal invasion and can facilitate postoperative rehabilitation of patients [8, 9]. Both groups did not differ significantly in operative time, which was inconsistent with Zhang's findings [10], they believed that the tarsal sinus approach can reduce the separation time and exposure time of skin flaps, so the operative time of the tarsal sinus approach was clearly shorter than that of the lateral extended approach. The author believed that the tarsal sinus approach had a high technical requirement for the operators, and the surgical operations were somewhat difficult, so the operative time was associated with the proficiency of surgeons. The more proficient a surgeon was at the tarsal sinus approach, the shorter operative time [11, 12].

In the present study, there were no significant differences between the two groups in terms of AOFAS score, Bohler's angle and Gissane angle. This was basically consistent with previous reports [13]. The author also found no significant differences between the two groups in



Figure 1. The operation chart of a typical case. A: Preoperative after debridement. B: Intraoperative injection of Kirschner wire to close and open. C: Postoperative incision suture.

terms of VAS scores before surgery and 7 d after surgery, which indicated that surgeries via the tarsal sinus approach and lateral extended approach had similar effects on the postoperative pain of patients. Our results showed that the total incidence of postoperative complications (e.g. wound infection, delayed union, flap necrosis and neurotrosis) in Group A was lower than that in Group B, illustrating that compared with the lateral extended approach, the tarsal sinus approach had fewer complications for the treatment of intra-articular calcaneal fracture. This was basically consistent with the findings of Basile et al. and may have had something to do with greater trauma in the lateral extended approach [14]. Large area stripping was prone to flap necrosis [15]. At the same time, due to the large contact area between patient's surgical site and the air, the lateral extended approach had an increased risk of wound infection and higher union difficulty [16]. Additionally, the heel is abundant in skin blood supply and nerves, so the lateral extended approach can easily lead to neurological impairment and other complications if one operates carelessly [17].

It should be noted that although the tarsal sinus approach can effectively expose the posterior subtalar joint, because of the small incision, the surgical field was limited, and the posterolateral treatment of calcaneus must be

conducted under direct vision [18, 19]. Therefore, the tarsal sinus approach had a certain requirement for indications. It was generally suitable for treating patients with Sanders types II and III [20]. However, for patients with Sanders type IV, due to the serious comminution of articular surface, it was hard to reposition the articular surface under a limited surgical field. An arthroscope and other auxiliary measures were needed.

Due to the limitations of this study, such as sample size, type of patients included and follow-up time, etc., more multi-center, large-sample and high-quality randomized controlled trials are required in

order to further validate the experimental results.

Conclusion

In summary, both surgeries via the tarsal sinus approach and the lateral extended approach have a good efficacy on intra-articular calcaneal fracture. However, compared with the lateral extended approach, the tarsal sinus approach has less intraoperative blood loss, shorter getting out-of-bed time, shorter length of stay and fewer postoperative complications.

Disclosure of conflict of interest

None.

Address correspondence to: Zonggeng Wang, Department of Orthopedics, Caoxian County Hospital, No. 17, Jiankang Road, Yishui County, Linyi 274400, China. Tel: +86-0539-2251731; E-mail: pfdov5@163.com

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