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Analysis of preoperative and postoperative depression and anxiety in patients with calcaneal fractures

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Abstract

Purpose The aim of this study is to investigate the preoperative and postoperative psychological health status of patients with calcaneal fractures, and to explore the impact of preoperative psychological health status on the prognosis of surgical treatment for calcaneal fracture patients.

Methods This study included 67 patients with calcaneal fractures who underwent surgical treatment in the Foot and Ankle Surgery Department of Honghui Hospital in Xi'an from November 2019 to September 2022. Patients were divided into two groups based on the presence of preoperative anxiety/depression symptoms, with patients exhibiting preoperative anxiety/depression symptoms assigned to Group A and those without such symptoms assigned to Group B. Preoperative and final follow-up assessments were conducted using the Hospital Anxiety and Depression Scale (HADS), Visual Analogue Scale (VAS), and the American Orthopaedic Foot and Ankle Society (AOFAS) Score to evaluate patients.

Results Among the 67 patients with complete follow-up for calcaneal fractures, 33 patients exhibited preoperative anxiety/depression symptoms (49.25%). Both Group A and Group B patients showed significant improvements in various evaluation indicators after calcaneal fracture surgery compared to preoperative assessments, but the overall prognosis of Group A was worse than that of Group B.

Conclusions The preoperative psychological health status of patients is related to postoperative clinical outcomes, and patients with poorer psychological health have a worse prognosis.

Keywords Calcaneal fracture, Surgical treatment, Psychological factors, Prognosis, Anxiety, Depression

Introduction

Calcaneal fractures are the most common fractures of the tarsal bones, accounting for approximately 2% of all skeletal fractures in the human body [1], with about 70% of adult calcaneal fractures being intra-articular fractures with displacement [2–5]. Calcaneal fractures are typically caused by high-energy injuries such as falls from height or motor vehicle accidents [6]. Additionally, as the largest bone in the foot, the calcaneus plays a crucial role in walking and standing. However, calcaneal fractures often lead to foot deformities, chronic foot pain, stiffness, and decreased mobility [7]. These factors may have a significant impact on people's quality of life and psychological well-being.

There is currently no standardized treatment protocol for calcaneal fractures; clinically, treatment is typically based on patient preference, the severity of the fracture,

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and underlying physical health conditions [8, 9]. For fractures without displacement or with slight displacement, partial articular fractures, and cases where surgery is not recommended due to specific contraindications, non-surgical treatment is generally recommended [8]. However, for calcaneal fractures with significant displacement or severe articular surface damage, open reduction and internal fixation surgery is currently advocated for treatment [10, 11].

Psychological health not only affects the patient's sensitivity to pain and symptoms but is also closely related to postoperative recovery outcomes and patient satisfaction [12–14]. In recent years, there has been an increasing amount of research on the correlation between patients' psychological health and orthopedic surgery. Research has found that patients with preoperative symptoms of anxiety/depression experience poorer postoperative recovery in total shoulder arthroplasty [15, 16]. Similar reports have been made in hip and knee arthroplasty, where patients with preoperative anxiety and depression symptoms have poorer prognosis and satisfaction [17–19]. Furthermore, a long-term follow-up study has shown that the preoperative psychological health status of patients with tibial plateau fractures significantly affects postoperative recovery [20]. However, studies have found that patients with calcaneal fractures have psychological and emotional disorders at twice the rate of the general population [21]. However, there is currently a lack of research on the impact of psychological health on the surgical outcomes of patients with calcaneal fractures, highlighting an important gap in the research. Meanwhile, studies have further emphasized the key role of psychological health in the overall rehabilitation of orthopedic patients. Jiang, L. et al. explored the relationship between pain intensity and depressive symptoms in patients with hip fractures, finding that depressive symptoms significantly affect postoperative pain management and recovery [22]. Gunduz, E.S. et al. emphasized the positive role of psychological resilience in postoperative recovery and discharge preparation in orthopedic surgery patients [23]. These studies provide a solid theoretical foundation for this research and further validate the impact of psychological health on fracture prognosis.

This study aims to investigate the psychological health status of patients with calcaneal fractures to analyze the impact of preoperative anxiety and depression symptoms on prognosis, as well as to examine postoperative psychological changes in these patients. The findings will assist clinicians in more comprehensively considering patients' psychological factors when developing treatment plans for calcaneal fractures, thereby optimizing postoperative clinical outcomes through personalized psychological interventions, reducing the incidence of postoperative complications, and improving overall rehabilitation.

Materials and methods

General information

This study obtained approval from the Ethics Review Committee of Xi'an Honghui Hospital. (No:202407011). We retrospectively analyzed patients with calcaneal fractures who underwent surgical treatment in the Foot and Ankle Surgery Department of Honghui Hospital in Xi'an from November 2019 to September 2022, and all patients provided informed consent.

Inclusion criteria: (1) Fresh calcaneal fractures with closed epiphyseal lines; (2) Patients treated with open reduction and internal fixation surgery for calcaneal fractures; (3) SandersII and above unilateral closed calcaneal fractures. Exclusion criteria: (1) Multiple fractures of the foot; (2) Patients with rheumatoid arthritis, talonavicular arthritis, hypertension, diabetes, and other internal medical conditions affecting surgical prognosis; (3) Severe neurovascular injuries in the affected lower limb; (4) Patients with mental illnesses other than anxiety/depression.

Methods

This study utilized the Visual Analogue Scale (VAS), the American Orthopaedic Foot and Ankle Society Ankle and Hindfoot Scale (AOFAS), and the Hospital Anxiety and Depression Scale (HADS) to assess the patients. The VAS and HADS scales are standard assessment tools in the Department of Foot and Ankle Surgery at this institution. Due to the limited preoperative activity caused by calcaneal fractures, only the VAS and HADS scales were employed to evaluate the patients' pain and psychological health prior to surgery. At the final follow-up, in addition to continuing the use of the VAS and HADS scales, the AOFAS scale was also employed to assess the patients' functional recovery and activity levels post-surgery. The VAS score is a 100-mm line on which patients mark their level of pain based on their own perception, ranging from 0 (no pain) to 100 (worst pain), providing a precise assessment of pain intensity [24]. The AOFAS scoring system includes evaluations of pain, function, and appearance, with scores for each category summed to obtain a composite score up to 100 points. The higher the composite score, the better the patient's foot health and functional status, as assessed by the evaluations of pain, function, and appearance. Higher composite scores generally indicate better patient health and are widely used in pre- and post-operative functional evaluations of ankle joint diseases [25]. For mental health assessment, we utilized the HADS score, which consists of two subscales: the Anxiety (HADS-A) score and the Depression (HADS-D) score. Each subscale comprises 7 items, rated from 0 to 3, with a total score range of 0 to 21. A cut-off value of 8 is used, where scores equal to or greater than 8 indicating the presence of some level of anxiety or

Fig. 1 Preoperative and postoperative X-ray comparisons of the patients. (**a**) Preoperative lateral and axial X-ray images of the patient's calcaneus show evident fracture lines and mild varus deformity. (**b**) Postoperative lateral and axial X-ray images of the patient's calcaneus show excellent fracture reduction, stable internal fixation, and well-corrected calcaneal alignment

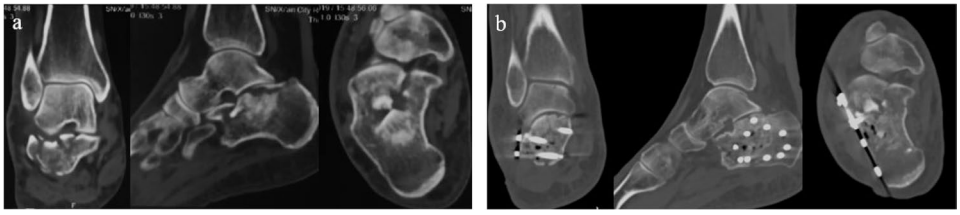

Fig. 2 Preoperative and postoperative CT image comparisons of the patient. (**a**) Preoperative coronal, sagittal, and transverse CT images of the patient's calcaneus show fragmentation of the subtalar joint surface, poor smoothness, significant compression of the calcaneus height, lateral bulging of the calcaneal outer wall, and widened calcaneus. (**b**) Postoperative coronal, sagittal, and transverse CT images of the patient's calcaneus show a well-aligned subtalar joint surface post-reduction, with good anatomical matching and restored calcaneal width

depression symptoms. This scale is widely employed in clinical research [26].

Based on patients' preoperative mental health conditions, we categorized them into two groups: Group A included patients with preoperative anxiety/depression symptoms, while Group B included patients without such symptoms. All surgeries were performed by the same group of senior orthopedic surgeons, and all patients received specific rehabilitation training guidance postoperatively to ensure consistency in postoperative management.

Surgical and rehabilitation plan

Under general anesthesia, a lateral "L"-shaped surgical incision was made over the lateral aspect of the calcaneus, followed by sequential dissection through the skin and subcutaneous tissues, and release of the soft tissues surrounding the fracture. Evidence of posterior facet collapse and comminution was observed. Hematoma, impinged soft tissues, and detached loose cartilage at the fracture ends were cleared, followed by irrigation with saline solution. The distal tibiofibular joint surface was reduced under direct visualization, showing a smooth articular surface. Intraoperatively, C-arm fluoroscopy was used to obtain lateral and axial views of the calcaneus to assess the reduction of the calcaneus. If satisfactory, the calcaneus was fixed using locking plates and screws. The joint cavity was irrigated, and the surgical incision was closed layer by layer. Sterile gauze and bandages were applied with compression to minimize the occurrence of postoperative complications such as joint swelling and infection.

Postoperatively, a brace was applied to immobilize the affected ankle joint, with elevation of the limb and appropriate ice application to control swelling, avoiding weight-bearing or dependent positioning of the limb. Following the recommendations of Schepers et al. [27], non-weight-bearing was maintained for the first 8 weeks postoperatively, followed by partial weight-bearing at 8 weeks, gradually transitioning to full weight-bearing. All patients underwent regular follow-up assessments at 1, 2, and 3 months postoperatively, as well as annually, and received specific rehabilitation guidance to closely monitor their postoperative recovery (Figs. 1 and 2).

Statistical analysis

Statistical analysis of the data was performed using SPSS 27.0 software (IBM, New York, United States). First, the normality of each continuous variable in the data was assessed using the Shapiro-Wilk test ($\alpha = 0.05$), and the homogeneity of variances was evaluated using Levene's test ($\alpha = 0.10$). For data that followed a normal distribution, the mean ± standard deviation ($x \pm s$) was used. Comparisons between two groups were conducted using independent t-tests or paired t-tests, with the 95% confidence interval and Cohen's d effect size for the mean difference (MD) reported. For data that did not follow a normal distribution, the median (P25, P75) was used,

Table 1 Basic characteristics of the patients. [mean ± SD/M(Q_1, Q_3)]

Variables	GroupA(*n* = 33)		GroupB(*n* = 34)		*P*	Group Difference (95% CI)	Effect Size (95% CI)
	Male	Female	Male	Female			
Sex	30(90.91)	3(9.09)	30(88.24)	4(11.76)	0.72	RD: 0.03(−0.12, 0.17)	OR: 1.33 (0.21,9.60)
Age	46.64 ± 12.40		42.26 ± 13.21		0.17	MD: 4.38(−1.88, 10.63)	*d*: 0.34(−0.14,0.82)
Follow-uptime	35.00(26.50, 49.00)		36.00(26.75, 45.00)		0.83	Med diff: 0.00(−5.00, 7.00)	*r*: 0.04 (−0.20, 0.28)

Abbreviations: *RD* Risk Difference, *MD* Mean Difference, *Med diff* Median difference (Hodges-Lehmann estimator), *OR* Odds Ratio, *d* Cohen's d, *r* Rank-biserial correlation

Data presentation: *n* (%) for Sex, mean ± SD for Age, median (IQR) for Follow-up time

Table 2 Changes in evaluation indicators of group A patients before surgery and at the final follow-up. (mean ± SD)

Variables	Preoperative	Last follow-up	*P*	Group Difference (95% CI)	Effect Size (95% CI)
VAS	79.61 ± 5.71	25.27 ± 9.76	<0.001	MD: 54.33(50.78, 57.89)	*d*: 5.42(4.05, 6.78)
HADS-A	10.85 ± 2.27	6.24 ± 1.44	<0.001	MD: 4.61(4.07, 5.15)	*d*: 3.03(2.21, 3.84)
HADS-D	10.30 ± 1.86	4.58 ± 2.21	<0.001	MD: 5.73(4.85, 6.61)	*d*: 2.31(1.65, 2.97)

Abbreviations: *MD* Mean Difference; d: Cohen's d

Data presentation: mean ± SD for all variables

Table 3 Changes in evaluation indicators of group B patients before surgery and at the final follow-up. [mean ± SD/M(Q_1, Q_3)]

Variables	Preoperative	Last follow-up	*P*	Group Difference (95% CI)	Effect Size (95% CI)
VAS	63.79 ± 6.52	14.82 ± 6.45	<0.001	MD: 48.97(46.68, 51.25)	*d*: 7.48(5.65, 9.30)
HADS-A	4.50(3.75, 5.00)	3.00(2.00, 4.00)	<0.001	Med diff: −1.00(−1.50, −1.00)	*r*: −0.83(−0.91, −0.75)
HADS-D	4.50(4.00, 6.00)	3.00(2.00, 4.00)	<0.001	Med diff: −1.00(−1.50, −1.00)	*r*: −0.91(−0.96, −0.87)

Abbreviations: *MD* Mean Difference, *Med diff* Median difference (Hodges-Lehmann estimator), *d* Cohen's d, *r* Rank-biserial correlation

Data presentation: mean ± SD for VAS; median (IQR) for HADS

and analysis was performed using the Mann-Whitney U test or paired Wilcoxon signed-rank test. The Hodges-Lehmann median difference (Med-diff), 95% confidence interval, and rank-biserial correlation (r) effect size were reported. Comparisons among multiple groups were conducted using the Kruskal-Wallis H test, with the corresponding effect size reported. Categorical data were presented as *n* (%), and comparisons between two or more groups were conducted using the χ^2 test or Fisher's exact test. The risk difference (RD) or odds ratio (OR) with 95% confidence intervals was reported. All p-values were two-tailed, with $p < 0.05$ considered statistically significant. All statistical analyses were performed using standard statistical methods to ensure the reliability and accuracy of the results.

Results

General condition of the patient

A total of 105 patients with calcaneal fractures were included in this study, of which 67 patients completed the follow-up, consisting of 60 males and 7 females. The average age was 44.42 ± 12.91 years, and the average follow-up duration was 35.58 ± 12.07 months. Thirty-three patients presented with preoperative anxiety/depressive symptoms, accounting for 49.25%, including 30 males and 3 females. Thirty-four patients had no preoperative anxiety/depressive symptoms, accounting for 50.75%, including 30 males and 4 females. No significant statistical differences were observed between the two groups in terms of gender, age, and follow-up duration ($P > 0.05$, Table 1).

Analysis of therapeutic efficacy

The average follow-up duration for the 67 patients was 35.58 ± 12.07 months, and during the follow-up period, no complications such as infection, malunion, delayed union, or nonunion were observed in any patient.

Both groups of patients showed significant improvement in all evaluation indicators at the last follow-up compared to preoperatively ($P < 0.05$, Tables 2 and 3). There were significant differences in the evaluation indicators between the two groups of patients at both preoperative and last follow-up, with Group A showing inferior preoperative indicators compared to Group B ($P < 0.05$, Table 4). At the last follow-up, Group B exhibited better therapeutic effects than Group A ($P < 0.05$, Table 5; Fig. 3). Furthermore, our study revealed that the improvement in evaluation indicators was greater in Group A compared to Group B ($P < 0.05$, Table 6; Fig. 4).

Discussion

In the process of orthopedic surgical treatment, clinicians often focus more on restoring the injured area of the patient, thereby overlooking the potential impact of psychological factors on prognosis. However, an increasing number of researchers have found that the mental health condition of patients plays an indispensable role in disease treatment [28–31]. In daily life, anxiety or

Table 4 Comparison of preoperative evaluation indicators between the two groups of patients. (mean ± SD)

Variables	GroupA(*n* = 33)	GroupB(*n* = 34)	*P*	Group Difference (95% CI)	Effect Size (95% CI)
VAS	79.61 ± 5.71	63.79 ± 6.52	<0.001	MD: 15.81(12.82, 18.81)	*d*: 2.58(1.92, 3.22)
HADS-A	10.85 ± 2.27	4.44 ± 1.26	<0.001	MD: 6.41(5.52, 7.30)	*d*: 3.51(2.74, 4.27)
HADS-D	10.30 ± 1.86	4.62 ± 1.37	<0.001	MD: 5.69(4.89, 6.48)	*d*: 3.49(2.71, 4.25)

Abbreviations: *MD* Mean Difference, *d* Cohen's d

Data presentation: mean ± SD for all variables

Table 5 Comparison of evaluation indicators at last Follow-up between the two groups of Patients(mean ± SD)

Variables	GroupA(*n* = 33)	GroupB(*n* = 34)	*P*	Group Difference (95% CI)	Effect Size (95% CI)
VAS	25.27 ± 9.76	14.82 ± 6.45	<0.001	MD: 10.45(6.39, 14.51)	*d*: 1.27(0.74, 1.79)
HADS-A	6.24 ± 1.44	3.35 ± 1.23	<0.001	MD: 2.89(2.24, 3.54)	*d*: 2.17(1.55, 2.77)
HADS-D	4.58 ± 2.21	3.24 ± 1.26	0.004	MD: 1.34(0.46, 2.23)	*d*: 0.75(0.25, 1.24)
AOFAS	78.91 ± 13.59	89.74 ± 7.51	<0.001	MD: −10.83(−16.24, −5.41)	*d*: −0.99(−1.50, −0.48)

Abbreviations: *MD* Mean Difference *d* Cohen's d

Data presentation: mean ± SD for all variables

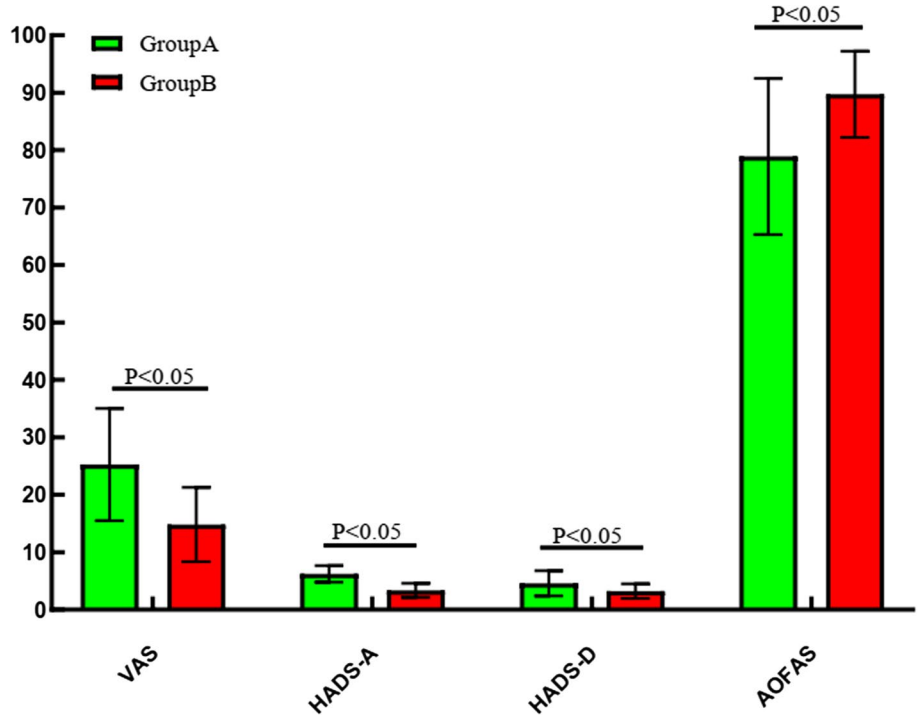

Fig. 3 Comparison of Evaluation Indicators at Last Follow-up Between the Two Groups of Patients

Table 6 Comparison of changes in various indicators between the two groups of patients at preoperative and last Follow-up visits. [mean ± SD/M(Q_1, Q_3)]

Variables	GroupA(*n* = 33)	GroupB(*n* = 34)	*P*	Mean Difference (95% CI)	Effect Size (95% CI)
VAS Difference	54.33 ± 10.03	48.97 ± 6.54	0.012	MD: 5.36(1.20, 9.52)	*d*: 0.64(0.14, 1.12)
HADS-A Difference	4.00 (3.50, 6.00)	1.00 (1.00, 1.25)	<0.001	Med diff: 3.00(3.00, 4.00)	*r*: −0.86(−0.91, −0.78)
HADS-D Difference	6.00 (4.00, 7.50)	1.00 (1.00, 2.00)	<0.001	Med diff: 5.00(4.00, 5.00)	*r*: −0.79(−0.86, −0.68)

Abbreviations: *MD* Mean Difference, *Med diff* Median difference (Hodges-Lehmann estimator), *d* Cohen's d, *r* Rank-biserial correlation

Data presentation: mean ± SD for VAS Difference; median (IQR) for HADS Difference

depression emotional disorders are commonly present. Research reports that approximately one-third of individuals experience severe anxiety and depression in daily life, with a higher prevalence among orthopedic disease patients [32, 33]. Furthermore, relevant studies have found a correlation between the severity of depression and anxiety in patients undergoing foot and ankle surgery and their postoperative clinical outcomes [34, 35].

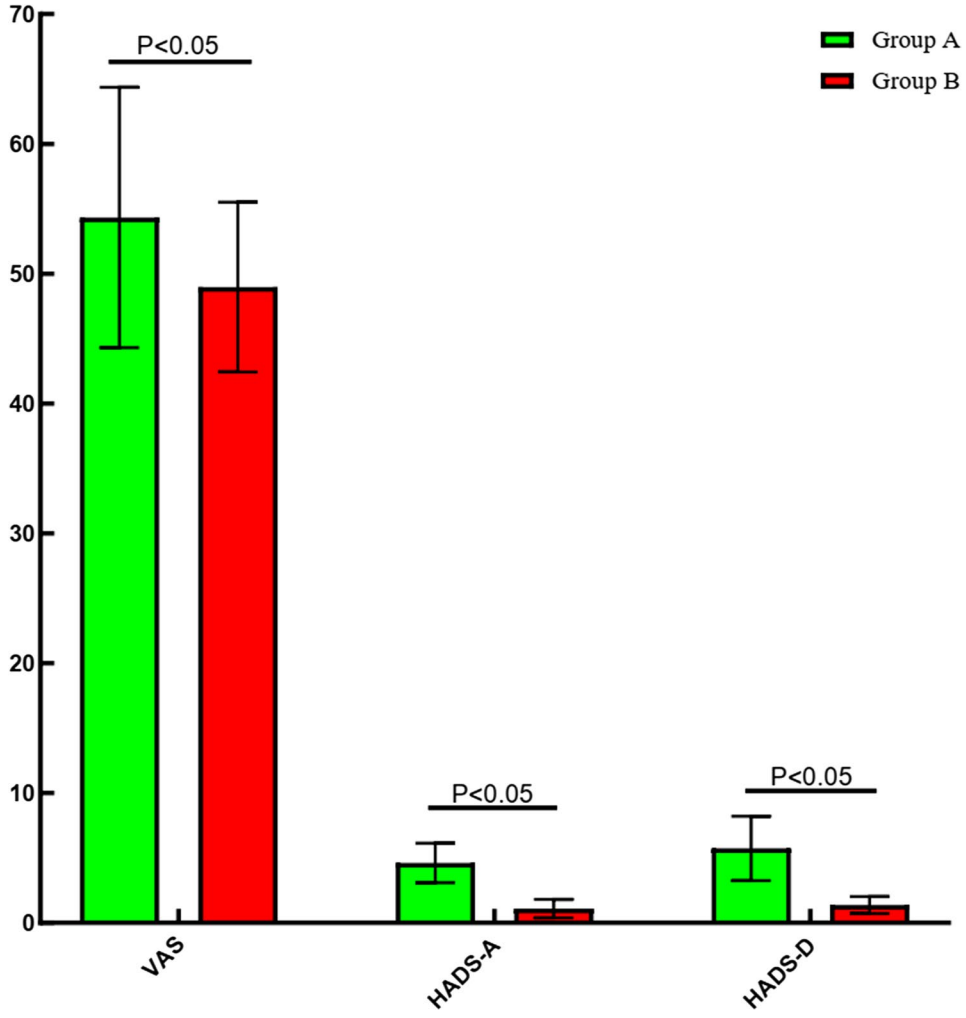

Fig. 4 Comparison of Changes in Various Indicators between the Two Groups of Patients at Preoperative and Last Follow-up Visits

However, healthcare providers often overlook the influence of psychological factors on patients during the surgical treatment process.

Our study found that regardless of whether patients had anxiety/depressive symptoms preoperatively, both groups of patients showed significant improvement in pain and related clinical symptoms at the last follow-up. Lewis et al. also pointed out in their study that surgical treatment significantly improves pain, functional activities, and quality of life in patients with calcaneal fractures [36]. However, the current research on the correlation between surgical treatment and the psychological well-being of patients with calcaneal fractures is limited. Therefore, we conducted a study on this aspect and found that both groups of patients showed significant improvement in psychological well-being at the last follow-up compared to preoperatively. Cao et al. found in their study that preoperative anxiety/depressive symptoms in patients improved significantly after surgical treatment [28], which is consistent with the results of our study.

Our study demonstrated that patients with preoperative anxiety/depressive symptoms reported significantly worse pain compared to those without such symptoms prior to surgery. Studies have shown that patients with depression exhibit higher pain sensitivity [37]. Moreover, James identified in a pain tolerance experiment that participants with elevated anxiety levels exhibited significantly reduced pain tolerance [38]. These findings align with the results of our study. Furthermore, we evaluated postoperative outcomes between the two groups and found that patients with preoperative anxiety or depressive symptoms had worse outcomes in pain, functional activity, and psychological well-being at the final follow-up compared to those without such symptoms. As early as 2000, Trief reported that poor outcomes following lumbar spine surgery were linked to preoperative psychological distress [39]. Subsequent studies revealed that total hip arthroplasty patients with preoperative anxiety or depressive symptoms exhibited significantly lower preoperative and postoperative VAS scores and Harris

Hip Scores compared to patients without such symptoms [40], further corroborating the findings of our study.

Additionally, patients with preoperative anxiety or depressive symptoms exhibited more substantial improvements in pain and psychological health after surgery compared to asymptomatic patients. Data revealed that patients with anxiety or depressive symptoms had a preoperative VAS score of 79.61 ± 5.71, which decreased to 25.27 ± 9.76 postoperatively. In contrast, asymptomatic patients had a preoperative VAS score of 63.79 ± 6.52, decreasing to 14.82 ± 6.45 postoperatively. These findings suggest that while both groups experienced postoperative pain relief, patients with preoperative anxiety or depressive symptoms demonstrated greater improvement. This phenomenon may be attributed to the influence of negative emotions on central nervous system pain modulation mechanisms. The reduction of anxiety/depressive symptoms after surgery may contribute to the recovery of central pain modulation, thereby promoting significant alleviation of pain experiences. However, further research is needed to verify this [34, 37, 41].

Similarly, patients with preoperative anxiety or depressive symptoms demonstrated greater improvements in psychological health after surgery. While asymptomatic patients exhibited some postoperative improvement in psychological state, the reduction in psychological distress was more pronounced among patients with anxiety or depressive symptoms. This difference may be attributed to the fact that surgical treatment not only alleviates physical symptoms but also enhances physical function and quality of life, thereby reducing psychological distress and resulting in more substantial relief from symptoms such as anxiety and depression [28].

This study has the following limitations: First, the sample size is relatively small. Although it meets statistical requirements, it may limit the generalizability of the conclusions, particularly in specific populations. Future studies should aim to increase the sample size to improve the reliability of the results. Second, this is a single-center study, with the sample drawn from a specific region, which introduces selection bias and may affect the generalizability of the results. Thus, it is recommended that future research be conducted at multiple centers to enhance the representativeness of the data. Third, the pain and psychological status reported by patients during the pre-operative and final follow-ups may be influenced by subjective bias, which could compromise the objectivity of the data. To minimize such bias, future studies should employ objective physiological indicators or multidimensional assessment tools for cross-validation. Finally, in addition to pain and anxiety/depression symptoms, factors such as individual differences, education level, socio-economic status, occupation type, and family support may influence post-operative recovery. However, this study did not adequately control for these factors, which could affect the accuracy of the findings. Future research should focus on larger sample sizes and multi-center data, and further explore these potential factors. Additionally, establishing a systematic preoperative psychological assessment and intervention mechanism will be beneficial in optimizing the clinical prognosis of orthopedic surgery patients.

Conclusion

Preoperative anxiety/depressive symptoms can adversely affect the prognosis of patients with calcaneal fractures, and individuals exhibiting such symptoms generally have a poorer outcome. However, regardless of the presence of preoperative anxiety/depressive symptoms, surgical treatment can improve pain relief, functional activities, and other relevant clinical outcomes. Notably, patients with preoperative anxiety/depressive symptoms tend to show greater improvement postoperatively. This suggests that mental health may significantly influence postoperative recovery. In clinical practice, emphasizing preoperative mental health screening and intervention may enhance patient outcomes, particularly in terms of pain reduction and functional recovery.

Abbreviations

VAS	Visual Analogue Scale
AOFAS	American Orthopaedic Foot and Ankle Society Ankle and Hindfoot Scale
HADS	Hospital Anxiety and Depression Scale

Conflicts of interest

We declare that we have no conflicts of interest.

Authors' contributions

Zhao Tian designed the study idea for this clinical trial. ShiHang Cao and Dong Hu to collect relevant data. Jun Lu and Yi Li to organise and manage data. JunKui Xu and HongXing Zhang to analyse data. JunKui Xu wrote the paper. Zhao Tian to review and revise the first draft of the paper.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

This study strictly adhered to the ethical principles of the Helsinki Declaration and obtained approval from the Ethics Committee of Xi'an Honghui Hospital. (NO.202407011).

Informed consent was obtained from all individual participants included in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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