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PŮVODNÍ PRÁCE

Clinical Effect of Screw Internal Fixation on Fracture Healing and Ankle Alignment in Patients with Posterior Malleolar Fracture

Klinický výsledek vnitřní fixace šrouby na hojení zlomeniny a postavení hlezna u pacientů se zadní malleolární zlomeninou

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ABSTRACT

PURPOSE OF THE STUDY

To examine the clinical impact of screw internal fixation on the process of fracture healing and ankle alignment in individuals diagnosed with posterior malleolar (PM) fracture, specifically those with a fracture involving less than 25% of the articular surface (ASR) area.

MATERIAL AND METHODS

A total of 120 patients diagnosed and treated for PM fracture, encompassing less than 25% of the distal tibial ASR area, were selected from our hospital's records spanning from September 2021 to June 2023. These people were subsequently divided into two groups, namely the control group (group A) and the observation group (group B), based on the distinct treatment methods employed, with each group consisting of 60 patients. The people in the group A were treated with posterior malleolus non internal fixation, while the patients in the group B were treated with posterior malleolus screw internal fixation. The visual analog scores, peak plantar pressure and AOFAS scores of the two groups were subjected to comparison.

RESULTS

The visual analog scores in the observation group at 6 months and 12 months after operation were reduced than the group A. Three months after operation, the peak plantar pressure of the affected foot (full foot, hind foot) in the group B was reduced than that of the healthy foot; There was a lack of statistically significant variation observed in the peak plantar pressure (full foot, hind foot) between the affected foot and the healthy foot 12 months after operation in the group B, and the plantar pressure tended to be balanced. Three months after operation, the peak plantar pressure of the affected foot (full foot, hind foot) in the group A was reduced than that of the healthy foot; After a period of 12 months following the surgical procedure, no notable disparity in the maximum pressure exerted on the sole of the foot was observed between the foot that underwent the operation and the unaffected foot in the group A, but the peak plantar pressure of the whole foot was reduced than that of the healthy foot, and the plantar pressure did not tend to be balanced. At the intervals of 6 months and 12 months following the surgical procedure, AOFAS ankle hind foot score in the group B was increased than the group A.

CONCLUSIONS

The utilization of screw internal fixation demonstrates favorable clinical outcomes in patients presenting with PM fracture encompassing less than 25% of the articular surface area, which is conducive to promoting fracture healing, maintaining good ankle alignment, and promoting patient rehabilitation.

Key words: screw internal fixation, posterior ankle fracture, articular surface of distal tibia, fracture healing, ankle joint alignment.

INTRODUCTION

The occurrence of ankle fracture ranks among the most prevalent types of intra-articular fractures, which is mostly caused by indirect torsion violence. the patients are mainly manifested by obvious local swelling, pain, deformity, dysfunction, ankle movement and other clinical symptoms (19). Posterior malleolar (PM) fractures frequently coexist with severe ankle fractures, constituting 14% of the total cases of ankle fractures. The study found that individuals who experience ankle fractures that encompass the posterior malleolus exhibit a notably heightened susceptibility to traumatic arthritis (13). Manual reduction and anatomical reduction and internal fixation are the two primarytreatment methods for posterior malleolus fracture at present. At present, it is still controversial whether in patients presenting with a posterior malleolus fracture encompassing an articular surface area of less than 25%, it is recommended that surgical anatomical reduction and internal fixation be undertaken. It was previously considered that fracture displacement < 2 mm in patients with posterior malleolus fracture encompassing an articular surface area less than 25% will not affect the

functional results, and smaller fragments will not change joint biomechanics. Therefore, manual reduction is often used for this kind of patients, and anatomical reduction and internal fixation is usually performed only when the fracture fragment of the posterior malleolus exceeds 25% of the ASR (5, 20). However, there is a tendency to expand surgical indications. According to recent studies, improper reduction may change the tibiotalar contact area and joint biomechanics of patients with PM fracture, leading to the occurrence of traumatic ankle osteoarthritis (6, 8). Therefore, in order to explore the best treatment for patients with PM fracture encompassing an ASR area less than 25%, 120 patients with PM fracture involving distal tibial ASR area less than 25% were selected in this study. Peoplein group A were treated with non-internal fixation of PM, and peoplein the group B were treated with PM screw internal fixation. To exam the clinical impct of screw internal fixation on fracture healing and ankle alignment in peoplewith PM fracture involving articular surface area less than 25%.

MATERIAL AND METHODS

General information

Between September 2021 and June 2023, a total of 120 patients diagnosed with a PM fracture encompassing less than 25% of the ASR area of the distal tibia were allocated into two groups: a control group (group A) consisting of 60 patients, and an observation group (group B) also comprising 60 patients. The present study haveunderwent examination and approval, and all participantsexpressed their informed consent by signing appropriate documentation. Inclusion criteria: 1 according to clinical symptoms, signs, X-ray imaging, ankle CT examination, etc., diagnosed as PM fracture involving distal tibial ASR area less than 25% (15); 2 without any treatment after fracture; 3 simple trimalleolar fracture; 4 course of disease less than 3 weeks. Exclusion criteria:

(1) less than 18 years old,
(2) with cognitive impairment,
(3) with severe heart, liver and renal insufficiency,
(4) ankle CT examination of PMfracture involving less than 10% of the ASR area of distal tibia.

Methods

The patients comprising group A underwent non-internal fixation of the PM as their treatment, and the patients were admitted to the operating room. The epidural block of the medial malleolus was fixed with screw andthe external malleolus was stabilized using a steel plate. The bone mass of the posterior ankle was reduced under the direct vision of C-arm X-ray machine. Andthe C-arm X-ray machine revealed successful restoration of the fracture and the incision was meticulously sutured in a layered manner. Broad-spectrum antibiotics were given after operation.

The patients comprising group B underwent treatment involving posterior malleolus screw fixation.Following the patient's admission into the surgical suite, the anesthesiologist proceeded to administer the epidural block, a longitudinal incision was used at the distal end of the lateral malleolus, peeling the soft tissue from the posterior side of the lateral malleolus to the upper medial malleolus, taking the incision of the medial malleolus, the fracture was reduced under direct visualization, followed by fixation using steel plates and screws. Additionally, the posterior aspect of the tibia was exposed and the posterior malleolus was stabilized using screws. Broad-spectrum antibiotics were given after operation.

Observation index

Visual analogy score (9)

The visual analogy score was employed as a means of assessing the level of foot pain experienced by the patients. The two ends of the 10cm were marked with "painless" and "the most severe pain" respectively, and the patients chose the corresponding score according to their own pain. The numerical scale spans from 0 to 10, with an increasing score indicating a greater degree of perceptible pain.

Peak plantar pressure

The plantar pressure distribution was analyzed by using the plantar scanner FootScan produced by Techstorm Company in South Korea. Perform three iterations and calculate the mean value.

AOFAS ankle-hindfoot score (18)

The assessment of foot and ankle function in patients was conducted using the AOFAS score, which has a maximum score of 100. A higher score on this scale indicates superior foot and ankle function.

Statistical method

Analysis and processing of data were carried out using the SPSS 22.0 statistical software, and the measurement information was expressed by ($x \pm s$).When the $P < 0.05$, the observed difference was deemed to have statistical significance.

RESULTS

Compare the baseline data

There was a lack of statistically significant disparity in the baseline data observed between the two groups (see Table 1).

Comparison of visual analogy scores in postoperative follow-up between the two groups

The visual analogy score at 6 months and 12 months in the group B was reduced than the group A, but there was no discernible distinction observed between the two groups at 3 months after operation (Table 2).

Table 1. Compare the baseline data of two groups

Group	N	Gender(N)		Age (y)	BMI (kg/m²)	Height (m)
		Male	Female			
Observation	60	35	25	38.46±6.58	24.74±2.63	1.74±0.16
control	60	34	26	39.20±6.84	24.60±2.74	1.73±0.17
χ^2/t		0.034		–0.604	0.286	0.332
P		0.854		0.547	0.776	0.741

Table 2. Compare the visual analogy scores obtained during postoperative follow-up for both groups

Group	N	3 months after operation	6 months after operation	12 months after operation
A	60	3.74±1.22	2.21±0.82	1.67±0.61
B	60	3.52±0.81	1.83±0.80	1.04±0.38
t		1.164	2.569	6.790
P		0.247	0.011	0.000

Table 3. Comparison of postoperative peak plantar pressure in observation group

Group	N	Full foot		Hind foot	
		6 months after operation	12 months after operation	3 months after operation	12 months after operation
Affected side	60	575.53±87.64*	1181.26±106.56	358.48±85.97*	438.02±55.32
Healthy side	60	1574.94±217.55	1191.24±96.29	658.11±115.85	435.28±58.29
t		–33.007	–0.538	16.088	0.264
P		0.000	0.591	0.000	0.792

Note: Comparison with healthy side:* $P < 0.05$

Table 4. Comparison of postoperative peak plantar pressure in the group A

Group	N	Full foot		Hind foot	
		3 months after operation	12 months after operation	3 months after operation	12 months after operation
Affected side	60	584.62±98.72*	1060.55±78.24*	315.72±51.68*	430.58±70.20
Healthy side	60	1585.77±209.30	1168.32±87.73	615.94±101.79	425.54±68.18
t		–33.511	–7.102	–20.371	0.399
P		0.000	0.000	0.000	0.691

Note: Comparison with healthy side:* $P < 0.05$

Table 5. Comparison of postoperative follow-up AOFAS ankle-hindfoot score

Group	N	3 months after operation	6 months after operation	12 months after operation
A	60	57.24±6.10	74.58±8.13	83.62±7.34
B	60	57.68±6.21	81.64±7.28	92.52±8.58
t		–0.392	–5.011	–6.106
P		0.696	0.000	0.000

Compare the postoperative peak plantar pressure in observation group

Three months after operation, the peak plantar pressure in the group B (whole foot, hindfoot) was reduced than the healthy side, and after a 12-month period following the operation, no significant disparity was observed between the group under observation and the healthy side. The plantar pressure tends to be balanced (Table 3).

Comparison of postoperative peak plantar pressure in the group A

Three months after operation, the peak plantar pressure of the group A was reduced than the healthy foot, but there was a lack of statistically significant disparity observed between the group A and the healthy foot at the 12-month postoperative period. However, the peak plantar pressure of the whole foot was reduced than the healthy foot, and the plantar pressure did not tend to balance (Table 4).

Comparison of postoperative follow-up AOFAS ankle-hindfoot score

At the three-month postoperative mark, no discernible disparity in AOFAS ankle-hindfoot score was observed, but the AOFAS ankle-hindfoot score at 6 and 12 months after operation in the group B was increased than the group A (Table 5).

DISCUSSION

The ankle joint consists of peri-articular ligaments (medial triangular ligament, lateral ankle ligament, inferior tibiofibular syndesmosis ligament, etc.), talus and distal tibiofibula (11). The ligament complex forms the ankle joint with the bony structure and maintains the force line and the ankle joint (16). The PM is the lateral part of the Volkman triangle. The presence of the PM has the potential to augment the contact surface area of the tibiotalar joint, consequently mitigating the pressure exerted per unit area. Furthermore, the termination of the posterior tibiofibular ligament at the distal extremity of the fibula, in conjunction with the PM (10). When the fracture of the ankle involves the PM, the displacement of the fracture block of the PM causes the posterior dislocation of the talus, which destroys the stability of the posterior joint and the geometry of the ASR, and changes the stress distribution of the ASR, and the ankle joint is in an unstable state. the risk of traumatic arthritis is significantly increased, accelerating the degeneration of articular cartilage, resulting in the recovery of foot function and relatively poor prognosis (7). According to the investigation of clinical epidemiology, the incidence of ankle fracture is on the rise. The risk of post-traumatic arthropathy in patients with double malleolus fracture is 4%, while the risk of trimalleolar fracture involving posterior malleolus fracture is as high as 34% (4). Therefore, effective treatment of trimalleolar fracture patients involving posterior malleolus fracture has important clinical significance to improve the prognosis of peopleand reduce the risk of post-traumatic arthropathy. Currently, the primary objective of clinical intervention for fractures of the PM is to achieve the restoration of anatomical structure and joint stability. However, there remains a contentious debate surrounding the surgical indication for posterior malleolus fractures.

The utilization of surgical intervention is a crucial approach in the management of fractures involving the posterior malleolus. a good surgical method can achieve good mechanical transmission of the ankle joint, maintain posterior stability, and restore the anatomical structure and flatness of the posterior ankle articular surface (12). Traditionally, most scholars believe that the displacement of the bone mass of the PM on the lateral X-ray film of the ankle joint exceeds 2 mm and the articular surface involved is more than 25%. However, there is no need for surgical reduction when the displacement of the PM fracture measures less than 2 mm, or the involvement of the ASR of the PM is less than 25%. However, in recent years, there has been a growing skepticism towards this perspective, prompting a tendency to broaden the surgical indications within clinical settings. Some scholars even think that all PM fractures need surgical fixation (2). Some studies have suggested that anatomical reduction should be performed when the displacement of the posterior malleolus exceeds 1 mm's expectation that the posterior malleolus exceeds a mere 5% of the ASR of the distal tibia., because this kind of patients have a higher probability of traumatic arthritis (14). Some scholars also believe that whenever the PM fracture occurs, regardless of the displacement of the posterior malleolus and how much it exceeds the articular surface located on the distal tibia, surgical anatomical reconstruction should be carried out to minimize the likelihood of developing traumatic arthritis (17). At present, the debate on surgical anatomical reduction of PM fractures with articular surface area less than 25% is still going on. With the improvement of medical level, the author tends to avoid non-operative treatment when the displacement of PM bone exceeds 5% of the ASR of distal tibia. Surgical anatomical reduction treatment should be completed as far as possible in order to enhance the efficacy of recovery and mitigate the potential occurrence of traumatic arthritis. Therefore, people with PM fractures encompassing less than 25% of the ASR of the distal tibia were subjected to non-internal fixation of the PM and internal fixation of PM screws, based on their economic circumstances and medical requirements. Subsequently, the therapeutic outcomes of these two approaches were juxtaposed for comparative analysis.

The study revealed that the visual analogy score of the group B was reduced than the group A at both the 6-month and 12-month post-operation intervals. Three months after operation, the peak plantar pressure in the group B (whole foot, hindfoot) was reduced than the healthy side, but there was a lack of statistically significant variationbetween the group B and the healthy side 12 months after operation. the plantar pressure tends to be balanced. Three months after operation, the peak plantar pressure in the group A was reduced than that in the contralateral foot, but there was a lack of statistically significant variation between the group A and the contralateral foot 12 months after operation. however, the peak plantar pressure of the whole foot was reduced than the healthy foot, and the plantar pressure did not tend to be balanced. At 6 months and 12 months after operation, the AOFAS ankle-hindfoot score in the group B was increased than the group A. It is recommended that screw internal fixation for patients with posterior malleolus fracture involving articular surface area less than 25% has a good clinical effect and keeps fracture reduction, and no changes of ankle arthritis and displacement of posterior malleolus fracture are found in short-term follow-up. And can significantly improve the ankle function of patients. Early ankle range of motion exercises and weight-bearing training are beneficial to improve ankle function. Non-operative patients need to prevent rotation force during early healing, so it

does not promote favorable conditions for early ankle range of motion exercises and weight-bearing training (1, 3). The results show that screw fixation is found to be advantageous for facilitating early ankle range of motion exercises and weight-bearing training in patients with PM fractures encompassing less than 25% of the articular surface area, thereby promoting late-stage recovery.

CONCLUSIONS

To sum up, screw internal fixation has a great clinical treatment impact on people with posterior malleolus fracture involving articular surface area less than 25%, which is beneficial to promote fracture healing, maintain good ankle alignment and promote patient recovery. Therefore, the author suggests that patients presenting with a PM fracture that involves less than 25% of the distal tibial ASR should be treated with surgical anatomical reduction as far as possible.

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