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Original Article

Efficacy of deltoid ligament reconstruction on the curative effect, complication and long-term prognosis in ankle fracture-dislocation with deltoid ligament injury

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Abstract: Objective: To investigate the clinical efficacy, complications and long-term prognosis of deltoid ligament reconstruction in the treatment of ankle fracture-dislocation with deltoid ligament injury. Methods: Forty enrolled patients with ankle fracture and deltoid ligament injury were diagnosed and treated in our hospital from May 2010 to June 2014. They were divided into control group and treatment group with 20 cases in each according to the random number table method. The patients in the control group were only treated with fracture open reduction and internal fixation, while the patients in the treatment group were treated with deltoid ligament reconstruction as well as fracture open reduction and internal fixation. After the surgery, all the patients were regularly followed up for 12 to 18 months. Meanwhile, the degree of pain (VAS score) and the incidences of complications were evaluated and recorded 3 months after the operation. At the final follow-up, the Ankle Hindfoot Scale of American Orthopaedic Foot and Ankle Society (AOFAS) was applied to evaluate the ankle recovery of patients. Results: There was no significant differences in the general information between the two groups (P>0.05). All the patients who underwent the surgery under the combined spinal-epidural anesthesia, were followed up for 12-18 months and healed with similarly duration (P>0.05). However, even though the operation time and bleeding loss of the treatment group were longer and greater than those of the control group (P=0.026, P=0.032), its hospital stay was significantly shorter than that of the control group (P=0.041). Moreover, the VAS scores after treatment were evidently decreased in both groups compared with that before the surgery (P=0.012, P=0.020), which was also apparently lower in the treatment group than that in the control group (P=0.025). Additionally, the medial clear space (MCS) of the two groups 1-year after the surgery was significantly lower than that before the surgery (P=0.010, P=0.020), which in the treatment group was obviously smaller than that in the control group (P=0.011). At the final follow-up, the AOFAS Ankle Hindfoot Scale showed that the excellent and good rate (90%) in the treatment group was considerably higher than that in the control group (60%) with significant difference (P=0.001), while the difference in the incidences of complications three months after the operation showed no statistical significance (P>0.05). Conclusion: The deltoid ligament reconstruction can promote the recovery of ankle function and alleviate pain with remarkable curative effect in the treatment of ankle fracture-dislocation with deltoid ligament injury.

Keywords: Ankle fracture, deltoid ligament injury, ligament reconstruction, internal fixation, therapeutic effect

Introduction

Ankle fracture-dislocation is one of the common injuries in orthopedics. The deltoid ligament, which is located on the medial side of the ankle joint, is often associated with ligament rupture in the ankle fracture. In addition, it can divide into shallow and deep layers, while the former includes the tibiocalcanean ligament, tibionavicular ligament and the shallow layer of posterior tibiotalar ligament; the latter includes anterior tibiotalar ligament and posterior tibiotalar ligament [1, 2]. The main function of the deltoid ligament is to control the internal and external rotation of ankle with anterior talofibular ligament, especially, compared with the shallow layer, the deep layer is more significant in maintaining the stability of the ankle joint [3, 4]. In the current study, if the fracture displacement is over 4 mm, it should consider examining the condition of deltoid ligament. Additionally, MRI can be applied as an auxiliary diagnosis

to determine the location and degree of injury [5]. In patients with acute injury, deltoid ligament injury is usually accompanied by ankle fracture ortibiofibular syndesmosis injury, while deltoid ligament injury alone is very rare. Furthermore, Halai et al. found that more than 40% of patients suffered ankle fractures were diagnosed deltoid ligament injury via arthroscopic examination and the injury would cause permanent pain or deformity of pronator muscle, if the lesion was failed to treat [6].

In the currently published study, there is still a great controversy over the need for repair of ligaments in the treatment of ankle joint with deltoid ligament injury [7, 8]. In our previous clinical treatment, we found that some patients, whose deltoid ligament was not repaired, tended to appear pain in the shallow area of medial malleolus which affected the ankle function. Therefore, this article discusses the clinical effects, complications and long-term prognosis of deltoid ligament reconstruction in ankle fracture-dislocation with deltoid ligament injury.

Methods

Patients

This study was approved by the Ethics Committee of our hospital and all patients had already provided the signed informed consent. Forty patients with ipsilateral ankle fracture complicated with deltoid ligament rupture and treated in our hospital from May 2010 to June 2014 were recruited.

Inclusion criteria: The patients who met the diagnostic criteria of deltoid ligament rupture complicated with ipsilateral ankle fracture, especially for acute injury; the patients whose age was between 20 and 60 years old without gender limitation; patients whose preoperative stress X-ray of ankle joint showed a medial clear space (MCS) over 5 mm and their MRI examination confirmed that the rupture of deep and shallow deltoid ligaments was complete.

Exclusion criteria: The patients accompanied with fracture or injuries in other parts of body, or combined with the posterior malleolar fracture involving over 25% of the articular surface; the patients had comorbidities such as severe cardiovascular diseases that could not tolerate surgery; the patients who complicated with vascular injury, nerve injury, or unnormal progress of limb functional rehabilitation; the patients might not be scheduled to review or could not take rehabilitation training on request.

Grouping and surgical method

According to the random number table method, the patients were divided into two groups: treatment group and control group with 20 patients in each. The patients in the control group were routinely taken ankle lateral incision and the restoration of fracture and other injuries, but the deltoid ligament was not repaired, meanwhile, the injured ankle was fixed in plaster in the position of mild varus-internal rotation-dorsal extension after the surgery. In the treatment group, besides the operations in the control group, patients also received deltoid ligament reconstruction. Briefly, a lateral incision was performed on fibular. The lateral malleolus fracture was repaired and fixed, then, an arc incision was made on the medial malleolus to expose the deltoid ligament and its broken ends. Subsequently, MCS was cleaned and anchors were penetrated into the broken ends followed by suturing and knotting tightly to ensure the stability of the ankle.

Follow-up

All the patients were followed up for at least 12 months, once per month. The changes of pain, incision healing condition and the occurrence of complications including tissue infection, nerve injury, motor dysfunction and fixation failure were observed and recorded 3 months after operation. In addition, according to the visual analogue scale (VAS) score, the degree of pain of patients was expressed with numbers from 0 to 10: 0 represents painless while 10 means the most pain. The patients would select a number from the 11 figures on behalf of their pain degree based on their own condition. The MCS was reviewed and recorded via anteroposterior stress X-ray 1 year postoperatively. At the final follow-up, Ankle Hindfoot Scale of American Orthopaedic Foot and Ankle Society (AOFAS) was adopted for the assessment of the postoperative recovery of ankle: excellent, 90-100 points; good, 75-89 points; fair, 50-74 points; poor, less than 50 points.

Observe indicators

The main outcome indicators: The change of AOFAS Ankle Hindfoot Scale score before the

Table 1. Comparison of the General information between two groups ($\bar{x}$±s/n)

Groups	Control group	Treatment group	χ^2/t	*P* value
Cases	20	20		
Gender			1	0.752
Male	11	10		
Female	9	10		
Age (years)	37.53±5.41	40.57±8.72	0.234	0.524
Follow-up duration (months)	13.28±5.96	12.83±5.94	0.265	0.753
Complicating diseases	3	4	0	1
Injured region			1.145	0.227
Left feet	12	11		
Right feet	8	9		
Open injury	2	3	0.000	1
Time from injury to treatment (days)	16.2±5.6	15.8±4.9	0.265	0.753

Table 2. Comparison of the operation parameters between two groups ($\bar{x}$±s)

Groups	Control group	Treatment group	*P* value
Operation time (min)	88.5±6.8	158.5±18.7	0.026
Blood loss (ml)	276.7±58.7	385.5±95.3	0.032
Length of stay (day)	17.6±6.2	10.4±4.1	0.041
Fracture concrescence time (week)	8.13±0.42	7.64±0.28	0.075

Table 3. Comparison of VAS score before and after the surgery between the two groups

Groups	Control group	Treatment group	t	*P* value
Cases	20	20		
Pre-operation	7.19±0.44	7.22±0.67	0.069	0.12
Three months after operation	2.98±0.45	1.14±0.34	6.873	0.025
t	35.312	25.478		
P value	0.003	0.001		

Table 4. Comparison of medial clear space before and after the surgery between two groups

Groups	Control group	Treatment group	t	*P* value
Cases	20	20		
Medial clear space (mm)				
Pre-operation	5.6±0.6	5.7±0.8	1.16	0.21
Post-operation	2.8±0.8	2.1±1.4	5.41	0.011
t	11.48	4.731		
P value	0.01	0.02		

treatment and at the final follow-up; the change of VAS score before the surgery and 3 months postoperatively.

Secondary outcome indicators: fracture healing time, other surgical related indicators and the incidences of complications.

Statistical analysis

SPSS13.0 statistical software was adopted for the data analysis. All the quantitative data were expressed as mean ± standard deviation, and the differences between two independent samples were compared with t test. Categorical data were expressed as percentage and compared by using chi-square test. P<0.05 indicated that the difference was statistically significant.

Results

General information of patients

The differences between the two groups in terms of gender, age, injured region, the time of injury, and whether combining with open injury or others diseases that would affect the recovery or not showed insignificance (P >0.05). In addition, all the patients were followed up for 12 to 18 months of which the duration was also not statistically significant (P>0.05). See **Table 1**.

Comparison of surgical related indicators between two groups

All the patients were received combined spinal and epidural anesthesia and their fractures all recovered with similar duration (P<0.05). The

Table 5. Comparison of AOFAS score between two groups

Groups	Cases (n)	Excellent	Good	Fair	Poor	Excellent and good rate
Control group	20	10	8	1	1	90%
Treatment group	20	8	4	5	3	60%
P value						0.001

Table 6. Comparison of postoperative complications between two groups

Groups	Cases	Pulmonary infection	Incision infection	Incision bleeding	Swelling
Control group	20	5	3	2	1
Treatment group	20	1	1	0	1
χ^2		1.765	0.278	0.526	0
P value		0.184	0.598	0.468	1

operation time and bleeding loss of the treatment group were longer and greater than those of the control group (P=0.026, P=0.032), however its hospital stay was significantly shorter than the control group (P=0.041). See **Table 2**.

Comparison of postoperative pain before and three months after the surgery between two groups

The VAS score in the control group and the treatment group before and after the surgery were (7.19±0.44 vs 2.98±0.45 for control group) and (7.22±0.67 vs 1.14±0.34 for treatment group) respectively, which were significantly lower than those before operation (P= 0.003, P=0.001). Meanwhile, the improvement in the treatment group was greater (P=0.025). See **Table 3**.

Comparison of MCS between two groups

There was no difference in preoperative MCS between the two groups (P=0.21), however, compared with pre-operation, the MCS at one year after the operation was evidently decreased in both control group (P=0.01) and treatment group (P=0.02), which was much lower in the treatment group. See **Table 4**.

Comparison of AOFAS score between two groups

At the final follow-up, results of AOFAS score showed that the rate of excellent and good in treatment group (90%) was obviously higher than that in the control group (65%) with statistical significance (P= 0.001). See **Table 5**.

Comparison of postoperative complications between two groups

Three months after the surgery, the incidences of complications in the two were similar without statistical significance (All P>0.05). See **Table 6**.

Discussion

Deltoid ligament located in the medial ankle and its main function is to limit the anteroposterior translation of the talus which plays a key role in the maintenance of stability of the ankle and its medial structure. Meanwhile, the deltoid ligament had greater effects on the plantar flexion than dorsiflexion as both the lateral and medial ligaments work on keeping the inside and outside balance of joints in the glenoid fossa [9]. The main stress loaded by the ankle joint is weight-bearing and twist, so the stability of ankle joint is crucial for the maintenance of its weight-bearing and motor function. Tian et al. have confirmed that separating the shallow layer of the deltoid ligament would change the position of the tibiotalar ligament [10]. Moreover, deltoid ligament injury could result in oblique displacement of joints, thus lead to the change of joint mechanics, causing joint stability decreased.

In clinic, on the one hand, there are many patients who suffered deltoid ligament injury did not received ligament reconstruction, however, their ankle function is no obvious obstacles. Therefore, some scholars argue that there is no need to repair the damaged deltoid ligament [11]. On the other hand, McCollum et al. also found that the patients without deltoid ligaments reconstruction in the surgery would suffer ligament laxity and chronic pain. Besides, result of some long-term follow-up studies also indicated that deltoid ligaments injured patients without ligament reconstruction had a symptom of chronic pain [12-17]. Therefore, we suggest performing reconstruction of damaged deltoid ligament to patients. In addition, Van et al. proposed several specific indications for deltoid ligament repair, including: 1) X-ray film of

ankle mortise showed the MCS was bigger than the contralateral clear space over 5 mm, and the talus was lateral dislocation or subluxation; 2) after ankle fracture reduction and fixation, Valgus stress test showed that the medial ankle was instable; 3) after joint reduction and fixation, MCS is still widened more than 1 mm, which may be caused by an embedded tissue such as fractured deltoid ligaments or other tissues [18].

The research of Henari et al. showed that it was easy to be missed diagnosis or misdiagnose for most of the ankle fractures which combined with deltoid ligament injury, thus leading to ankle instability, ankle chronic pain and traumatic arthritis [19]. In this study, no patient appears complications that affected the stability of the ankle joint, possibly because the time from the patients were injured to they received treatment was short and they were treated in a timely manner. Similarly, Schuberth et al. believe that the lateral malleolus fracture combined with deltoid ligament rupture should be considered as bimalleolar fracture, which should be surgical repaired [20]. In addition, Stufkens et al. and another study evaluated the clinical therapeutic efficacy of suture anchor in ankle fractures combined with deltoid ligament injury, and their results confirmed that the use of suture anchor in the repair of deltoid ligament injury can achieve better recovery of the stability of the ankle [21, 22]. The results of our study are similar to those of the above studies. Compared with the control group, the MCS in the treatment group at 1-year post-surgery was significantly reduced ($P<0.05$) while the AOFAS Ankle Hindfoot Scale in the treatment group was obviously increased ($P<0.05$), suggesting that performing deltoid ligaments reconstruction could improve the stability of ankle joint in the treatment of ankle fracture combined with deltoid ligament injury.

Three months after the surgery, the pain scores of both the control group and the treatment group were dramatically lower than that before the surgery (all $P<0.05$), and the improvement of the pain condition was more evident in the treatment group, which indicated that the deltoid ligaments reconstruction could significantly inhibit the postoperative chronic pain ($P< 0.05$), thus improve the life quality of the patients.

The results of this study also proved that even though the deltoid ligaments reconstruction would significantly increase the operation time and the intraoperative blood loss, the hospitalization time was reduced in a certain degree, manifesting that deltoid ligaments reconstruction might be beneficial to the healing and prognosis of ankle fracture-dislocation.

However, as the sample size is relatively small, the follow-up time is short, and patient physique and other factors may lead to biased results, more studies with large sample volume are needed to validate the conclusions in this study in the future.

In conclusion, this controlled study confirmed that deltoid ligaments reconstruction plays a positive role in the restoring of MCS, healing fracture, restoring impaired ankle function and reducing chronic pain, so it is worth a popularization and application in clinic.

Disclosure of conflict of interest

None.

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