Outcome Comparison of Arthroscopic versus Mini-open Technique for Ankle Arthrodesis

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Abstract

Background

Ankle arthrodesis is considered to be the gold standard for the treatment of end-stage ankle diseases. At present, the commonly used methods of ankle arthrodesis include open ankle arthrodesis, arthroscopic ankle arthrodesis and mini-open ankle arthrodesis. The authors analyze and compare the clinical efficacy and related complications of arthroscopic ankle arthrodesis and mini-open ankle arthrodesis in the treatment of end-stage ankle disease.

Methods

From January 2007 to June 2018, 56 patents with end-stage ankle joint pathology were treated with arthroscopic ankle arthrodesis and mini-open ankle arthrodesis. There were 30 cases in arthroscopy group, including 19 males and 11 females with an average age of 49.6 years old (ranged, 32 to 71); while 26 cases in mini-open group, including 18 males and 8 females with an average age of 48.3 years old (ranged, 43 to 65). The operative time was calculated with use of computerized operative and anesthetic records. The pain visual analogue score (VAS), American Orthopedic Foot Ankle Society ankle and hind foot score (AOFAS), fusion rate, complications rate, length of hospital stay, operation time, and tourniquet time were compared between the two groups of patients.

Results

51 patients were followed up for 15–35 months (mean, 22.5 ± 1.5) months. The bony fusion was achieved in all patients. The average time to fusion was 12.4 weeks (range, 10–16 weeks). The VAS score 3 days post-operation was (6.37 ± 0.69) points in the arthroscopy group and (7.61 ± 1.05) points in the mini-open group, there was significant difference between the two groups ($P < 0.05$). The VAS score and AOFAS score between the two groups pre- and post-operation have statistically significant differences ($P < 0.05$). At the last follow-up, VAS score was (1.55 ± 0.57) in the arthroscopy group and (1.43 ± 0.73) in the mini-open group, and there was no significant difference between the two groups ($P > 0.05$). The AOFAS score was (85.32 ± 2.96) points in the arthroscopy group and (86.72 ± 3.05) points in the mini-open group, and there was no significant difference between the two groups ($P > 0.05$). Arthroscopic ankle fusion was associated with a shorter tourniquet time and shorter length of hospital stay compared to mini-open ankle fusion ($P < 0.05$); however, there was no significant difference between two groups in terms of operation time ($P > 0.05$). Wounds healing was satisfying during the follow-up in the arthroscopy group. But the wounds healing was delayed in two patients of the small incision group. All patients were satisfied with the surgery.

Conclusion

Arthroscopic ankle arthrodesis and mini-open ankle arthrodesis have satisfactory curative effect and fusion rate. Arthroscopic assisted ankle arthrodesis has more advantages, including small incision, less injury, and low morbidity.

Background

Ankle arthrodesis is an effective method for the treatment of end-stage ankle diseases. At present, many different surgical procedures have been described[1]. The commonly used methods of ankle arthrodesis include open ankle arthrodesis, arthroscopic ankle arthrodesis and mini-open ankle arthrodesis. Open ankle arthrodesis surgery is mainly used for patients with obvious malalignment of ankle joint, which has the advantage of better correction of force line, but the recovery period of open surgery is longer, and extensive peeling during operation is easy to cause poor wound healing after operation.

In recent years, with the continuous popularization of minimally invasive concept and the continuous development of arthroscopic technology, arthroscopic ankle arthrodesis and mini-open ankle arthrodesis have been widely used because of their high fusion rate and low incidence of complications [2, 3]. Nonetheless, to our knowledge, comparison between arthroscopic and mini-open technique for ankle arthrodesis has not been reported in a series of patients.

The purpose of the study was to evaluate and compare the clinical efficacy of arthroscopic ankle arthrodesis and mini-open ankle arthrodesis. A series of 56 cases of end-stage ankle diseases treated with arthroscopic ankle fusion and mini-open ankle fusion from January 2007 to June 2018 were retrospectively analyzed.

Materials And Methods

Patients

The inclusion criteria of this study were end stage of ankle osteoarthritis, Kaschin-Beck disease and traumatic arthritis, which were ineffective after conservative treatment, and were not accompanied with severe ankle valgus and rotation deformity. A total of 56 patients were divided into two groups according to the surgical methods, including arthroscopy group (n = 30) and mini-open group (n = 26). There were 19 males and 11 females with an average age of 49.6 years old in arthroscopy group and 26 patients in mini-open group (18 males and 8 females with an average age of 48.3 years old). Baseline demographic and clinical information of the study populations (age, gender, clinical presentation of the study participants) were showed in Tab.1. There was no significant difference in gender, age, VAS score and AOFAS score between the two groups ($P > 0.05$).

Surgical procedure and postoperative care

The operation was performed under general anesthesia or epidural anesthesia. Patients were taken supine position, and bony markers, blood vessels and nerves of ankle joint were routinely marked before

operation. Pneumatic tourniquet was prepared on the root of affected thigh, and tourniquet was pressurized to 280mmHg before operation.

In the arthroscopic fusion group, sterile saline was injected into the ankle cavity, anterior-lateral and anterior-medial portals were established. Attention was paid to avoid injury to anterior tibial vessels, nerves and tendons. 4.0 mm 30^0 arthroscopy was routinely used. The imaging system and water inlet and outlet pipes were connected and epinephrine saline was maintained continuous infusion during the operation. First, ankle arthroscopy was performed and evaluation was performed to clean the loose body in the joint cavity. Shaver and radio frequency probe were used to clean the synovial in the joint cavity and enlarge the visual field of operation. After the ankle joint cavity was fully exposed, the articular cartilage surface of distal tibia and talus dome was cleaned with grinding drill, curette. The cartilage surface of medial and lateral malleolus was removed thoroughly by the same method.

In the small incision fusion group, two 4cm longitudinal incisions were made on the anterolateral and anteromedial sides of the ankle joint, and the skin and subcutaneous tissue were dissected in turn. The tendons and neurovascular bundles on the anterior side of the ankle joint were protected, the joint capsule was cut longitudinally to expose the ankle joint. The retractor was used to increase the exposure, and the articular cartilage surfaces of the lateral malleolus, the lateral talus and the lateral half of the tibiotalar articular cartilage were cleared with curettes and bone knives under direct vision through the anterolateral incision. The same method was used to clean the cartilage surface of the medial half, medial malleolus and medial talus through the anterior medial incision.

Under the C-arm monitoring, we keep ankle in the neutral position of flexion and extension, 5^0 of valgus and external rotation, then two cross guide pins was drilled. Confirming the ideal fixed position under C-arm, two 6.5mm cannulated screws were screwed in along the guide pins. After placing the drainage tube, the incisions were closed routinely.

After operation, short leg plaster or brace was fixed. The affected limb was raised up to reduce limb swelling. Weight-bearing was allowed gradually after 4 weeks. X-ray films were reviewed regularly to evaluate fusion. Plaster or brace could be removed to participate in daily activities after complete bony fusion.

Outcome assessment

Ankle pain, incision healing, ankle X-ray, complications and ankle function were evaluated during the follow-up period; pain score was evaluated by pain visual analogue scale (VAS). The pain scores of 3 days post-operation and the last follow-up were recorded respectively. Length of hospital stay, operative time, and tourniquet time were compared. The operative time was calculated with use of computerized operative and anesthetic records. At the last follow-up, according to ankle function score (AOFAS score), pain, spontaneous activity, walking distance, ground walking, range of motion, and stability and joint alignment were evaluated.

Statistical analysis

SPSS17.0 statistical software package was used for statistical analysis. The quantitative data were expressed by mean ± standard deviation. Comparison of preoperative to postoperative VAS scores and AOFAS scores were performed by use of an independent t test. Two independent samples t-test was used to determine statistical significance between groups. $P < 0.05$ was considered statistically significant.

Results

28 patients in the arthroscopy group and 23 patients in the mini-open group were followed up for 35 months with an average of (22.5 ± 1.5) months, and the ankle pain and function of all patients were relieved and bony fusion was obtained. The average time to fusion was 12.4 weeks (range, 10–16 weeks).

The VAS score 3 days post-operation was (6.37 ± 0.69) points in the arthroscopy group and (7.61 ± 1.05) points in the mini-open group, there was significant difference between the two groups ($P < 0.05$). The VAS score and AOFAS score between the two groups pre- and the last follow-up have statistically significant differences ($P < 0.05$). At the last follow-up, VAS score was (1.55 ± 0.57) in the arthroscopy group and (1.43 ± 0.73) in the mini-open group, there was no significant difference between the two groups ($P > 0.05$). The AOFAS score was (85.32 ± 2.96) points in the arthroscopy group and (86.72 ± 3.05) points in the mini-open group, there was no significant difference between the two groups ($P > 0.05$) (Table 2). Arthroscopic ankle fusion was associated with a shorter tourniquet time and shorter length of hospital stay compared to mini-open ankle fusion ($P < 0.05$); however, there was no significant difference between two groups in terms of operation time ($P > 0.05$) (Table 3). Wounds healing was satisfying during the follow-up in the arthroscopy group. But the wounds healing was delayed in two patients of the mini-open group.

Discussion

If various ankle diseases are not treated effectively in the early stage, they will gradually cause severe ankle pain, deformity and dysfunction. Surgical treatment must be considered, if conservative treatment is ineffective. In recent years, joint replacement technology has been developed rapidly, hip and knee replacement surgery has been very mature, and the surgical effect is excellent. Ankle replacement has also been applied in clinic [4–6].But because of the special anatomical and physiological characteristics of ankle joint, the long-term effect is far inferior to knee joint and hip replacement [7, 8]. So for advanced ankle diseases, ankle arthrodesis is still the "gold standard" of end-stage ankle disease[9], and it is also the mainstream treatment in clinic[10]. Open ankle arthrodesis is a predictable, time-tested procedure with consistent results when performed in appropriate patients [11]. The traditional open ankle fusion surgery has large incision, extensive peeling, large amount of bleeding and large trauma, and often needs to amputate the fibula, so the duration of postoperative pain is long. There are many incision complications, and the incidence of infection is high, also the recovery period is longer. With the popularization of the

concept of rapid rehabilitation and the development of minimally invasive technology represented by arthroscopy, small incision and arthroscopic arthrodesis have been gradually carried out in clinic, showing more obvious advantages than traditional open surgery [12–15]. Arthroscopic ankle arthrodesis has gained increasing popularity, with reports of shorter hospital stays, shorter time to solid fusion, and equivalent union rates when compared with open arthrodesis. Townshend et al evaluated the results of open and arthroscopic ankle arthrodesis in a comparative case series of patients and proved arthroscopic arthrodesis resulted in a shorter hospital stay and showed better outcomes at one and two years[16]. Nielsen et al evaluated the results of arthroscopic guided ankle arthrodesis with open surgery arthrodesis. They found the patients in the arthroscopic group were discharged on average 2.27 days earlier than the patients operated by open technique. Ninety percent of the patients in the arthroscopic group and 57% in the open group showed bony union after 12 weeks. The rate of union after 1 year was 95% in the arthroscopic group and 84% in the open group[17]. Yasui et al showed that although open ankle arthrodesis is more commonly performed, it is associated with a greater incidence of subsequent adjacent joint arthrodesis specifically in the hindfoot[18]. O'Brien et al achieved comparable fusion rates with arthroscopic ankle arthrodesis compared to open ankle arthrodesis, with significantly less morbidity, shorter operative times, shorter tourniquet times, less blood loss, and shorter hospital stays, and concluded arthroscopic ankle arthrodesis is a valid alternative to traditional open arthrodesis of the ankle for selected patients with ankle arthritis[19].

Compared arthroscopic fusion with small incision, the surgical trauma is further reduced, and the visual field of arthroscopic surgery is clear, which can produce almost "bloodless" visual field, so the removal of cartilage is more thorough. It is beneficial to create good conditions for bone fusion. Honnenahalli et al demonstrates that arthroscopic ankle fusion may be associated with a higher fusion rate, shorter tourniquet time, and shorter length of stay compared to open ankle fusion[20]. Duan et al used arthroscopic ankle arthrodesis without bone graft. On average, all patients achieved bony fusion at an average of 12.1 weeks, and the AOFAS score was significantly improved [21]. DeLeeuw et al also achieved a 100% fusion rate in 40 patients using posterior ankle arthroscopic arthrodesis [22]. Woo et al conclude that the arthroscopic group displayed better clinical outcomes compared to the open group at the 24months follow-up. The advantages of arthroscopic ankle arthrodesis include significantly less perioperative pain, higher AOFAS Ankle-hindfoot scores at 24months, shorter length of stay, fewer postoperative complications[23]. In our study, it was also found that the incidence of complications of arthroscopic joint fusion was lower, and the postoperative recovery was faster. Cottino and others also found similar findings in their studies[24]. Arthroscopic ankle arthrodesis requires the operator to master arthroscopic technology[25], high surgical equipment and high technical threshold. Mini-open ankle arthrodesis is only the minimally invasive operation of routine surgery, and the operator can be carried out on the basis of foot and ankle surgery, and the operation cost is obviously lower than arthroscopy fusion.

No matter arthroscopic ankle arthrodesis or mini-open ankle arthrodesis, it has the disadvantage of insufficient exposure and cannot correct severe ankle deformities, so we routinely perform imaging examination to evaluate the ankle force line before operation. The ankle valgus and valgus of the selected patients were no more than 20 degrees, and there was no serious rotation deformity. For patients

with valgus deformity more than 20 degrees, severe rotation deformity and severe bone defect, we recommend routine open ankle arthrodesis.

Conclusions

To sum up, arthroscopic ankle arthrodesis and mini-open ankle arthrodesis have satisfactory curative effect and fusion rate, and were effective methods for the treatment of end-stage ankle disease. Arthroscopy ankle arthrodesis has more advantages, including small incision, shorter tourniquet time and length of hospital stay, quick recovery and low incidence of complications, but arthroscopy ankle arthrodesis has a certain technical threshold. It is suggested that arthroscopy ankle arthrodesis can be used after mastering conventional ankle arthroscopy.

Declarations

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Availability of supporting data

All data and materials were in full compliance with the journal’s policy.

Authors' contributions

WJL and GWP contributed equally to this work and should be considered co-first authors. WJL, GWP and HWS enrolled patients in the study and participated in the interpretation of the data, drafting and editing the manuscript. LYJ and LF is the lead surgeon of the study that he conceived and designed. All authors read and approved the final manuscript.

Ethics approval and consent to participate

This study was approved by the Ethics Committee of the Chinese PLA General Hospital and was performed in accordance with the ethical standards of the Declaration of Helsinki of 1964. Consent to participate was obtained from the participants.

Consent for publication

Signed consent for publishing patient identifiable information, data, figures, and video was obtained.

Competing interests

The authors declare that they have no competing interests.

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Tables

Tab.1 Comparison of baseline demographic and clinical information of patients

ıp	cases	age	gender（cases）		VAS score	AOFAS score
		（X±s）	male	female		
roscopy group	30	49.6 ± 7.05	19	11	7.63±0.44	35.53±4.07
-open group	26	48.3± 6.53	18	8	7.76±0.53	36.73±5.15
value	-	t=0.712	χ^2=3.704		t=1.003	t=0.973
lue	-	0.479	0.054		0.320	0.335

Tab.2 Comparison of postoperative effect of patients with ankle joint arthrodesis

ıps	Pre-operation		Last follow-up	
	VAS	AOFAS	VAS	AOFAS
roscopy group	7.63±0.44	35.53±4.07	1.55±0.57▼	85.32±2.96▽
-open group	7.76±0.53	36.73±5.15	1.43±0.73	86.72±3.05
lue	t=1.003	t=0.973	t=0.690	t=1.740
lue	0.320	0.335	0.493	0.086

* The VAS score between the two groups pre- and post-operation have statistically significant differences. ▼t=46.248P<0.05t=54.190P<0.05

The AOFAS score between the two groups pre- and post-operation have statistically significant differences. ▽t=35.779P<0.05t=42.587P<0.05

Tab.3 Comparison of clinical operation data of two groups

ıps	tourniquet time (min)	operation time (min)	VAS score 3 days post-operation	length of hospital stay (day)
roscopy group	78.42±6.21	147.52±13.82	6.37±0.78	5.38±0.72
-open group	95.83±8.54	153.81±15.27	7.61±0.93	7.23±0.84
lue	t=8.419	t=1.543	t=5.180	t=8.470
lue	0.000	0.129	0.000	0.000