



## **A new approach for surgical treatment of acute closed Achilles tendon rupture -- a retrospective clinical study**

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### **Abstract**

**Background** To introduce a new surgical approach for Achilles tendon repair and analyze its clinical effect and postoperative complications compared with the traditional long incision approach.

**Methods** A retrospective control study of 43 patients treated with Achilles tendon rupture using two different approaches carried out. The conventional approach: one continuous longitudinal incision, 1cm medial from the central posterior ankle joint. The modified approach: one short S shape incision across the posterior part of the ankle and 2 pairs of tiny incisions at the proximal edges of Achilles tendon. The Arner-Lindholm score was used for ankle function evaluation and complications were summarized.

**Results** In the conventional group (25 patients), there were 4 cases with local skin necrosis. Achilles tendon rupture occurred again in one patient 2 month after surgery. No cutaneous nerve injury occurred. The total incidence rate of complication was 20%. In the modified group (19 patients), one patient had sural nerve injury. No wound dehiscence and re-rupture

of Achilles tendon occurred in all the cases. The total incidence rate of complication was 5.3%. There were significant differences between the two groups in the incidence of postoperative complications ( $P < 0.05$ ). The excellent and good rates of the ankle joint function in the modified group were statistically higher than those in the conventional group ( $P < 0.05$ ).

**Conclusion** The modified surgical approach for Achilles tendon repair was recommended. With this approach fewer complications and better functional recovery could be achieved.

**Level of Evidence: III**

**Keywords** operative approach; Achilles tendon rupture; postoperative complication; curative effect

## INTRODUCTION

Acute Achilles tendon rupture(AATR) is a common clinical disease with a lack of consensus on appropriate treatment.<sup>22,23</sup> The traditional approach is one 10cm-15cm long longitudinal incision posterior to ankle joint, which is widely used in clinical practice for its clear vision and fast suture. There are several disadvantages for this approach, such as its large trauma, tendon re-rupture, wound non-healing and tendon adhesion,<sup>13,28,31</sup> which result in a variety of minimally invasive surgeries emerging, such as Achillon repair method. The superiorities of the minimally invasive surgeries are still in discussion.<sup>5,17,20</sup> Some drawbacks of current minimally invasive surgeries exist, such as cutaneous nerve injury after a blind percutaneous puncture, the suture slippage by the force point shift which induce tendon re-rupture and so on. Based on the above reasons, we designed a new surgical approach: one 3cm long "S" shape oblique incision posterior to the ankle combined with two pairs of tiny incisions at proximal edges of the Achilles tendon, which had not been reported before. This method can reduce trauma, as well as get a clear vision, prevent the suture slippage by controlling the suture position in Achilles tendon precisely, and avoid injuring cutaneous nerve.

## **METHODS**

A retrospective control study of 43 patients treated with Achilles tendon rupture repair using two different approaches was carried out. The injury was all closed. All the patients examined by preoperative physical examination and Doppler ultrasound(three suspected cases were diagnosed by magnetic resonance imaging) before operation. In this study, there were 43 patients, 35 males and 9 females. There were 25 patients in the conventional group and 18 patients in the modified group. The mean age at the time of injury was 41.9 years (range: 31–63 years). 11 patients suffered diabetes mellitus. 4 patients had hyperuricemia. 9 patients had been injected with drug. 26 cases of Achilles tendon ruptures occurred in running or jumping. 17 patients slipped. There was no significant difference between the two groups in sex, age, time from injury to operation. The mean follow-up period was 3.4 years (range: 9 months–5 years). Inclusion criteria: the site of Achilles tendon rupture was 2cm or more from the insertion; the injury was closed; the time from injury to surgery was less than 1 month. Exclusion criteria: age (more than 70 years old); patients with Achilles tendon avulsion or too little tendinous tissue remain(the length from the insertion to the site of Achilles tendon rupture was less than 2cm) ; patients with severe visceral disease; psychiatric patients; pregnant women; open injury; chronic injuries (the time from injury to surgery was more than 1 month); case lost within 6 months after operation.

### **Surgical methods**

The conventional approach: one continuous longitudinal incision, 1cm medial from the central posterior ankle joint. (10-15cm long)

The modified approach: one short S shape incision across the posterior part of the ankle (about 3cm long) and 2 pairs of tiny incisions (less than 1cm long) at the proximal edges of the Achilles tendon.

All the Achilles tendons were sewed with 1-0 PDS in stress and 4-0 Vicryl sparse suture at the end anastomosis continuously for closure. The postoperative fixation: knee flexion 30 degrees and ankle plantar flexion 20 degree in a long leg plaster. All the operations were done by the same group of doctors and the time of suture removal were 2 weeks postoperatively.

### **Rehabilitation therapy**

Deep venous thrombosis prevention was carried out after the operation. Since the first day postoperatively, the foot flexion and extension movement and the isometric exercise of toes

started on the bed. The patients were advised to study walking with crutches. Attention was paid to avoid falling down. 4 weeks later, a short leg cast was used to fix the knee joint in external position and the ankle joint in neutral position. External fixator was removed 6 weeks after operation. Wear special high heel shoes with 10-12 layers oblique insoles and walk for practice. Remove one layer of insoles every week. 3 months later postoperatively patients were advised to wear normal shoes and do normal walking, jogging and other soothing movement. 6 months after the operation, moderate intensity sports could be carried out.

### **Evaluation method**

Arner-Lindholm standard was commonly used to evaluate ankle function.<sup>4</sup> Excellent: the patient without any discomfort, heel lift strongly with normal muscle strength, calf circumference reduction does not exceed 1 cm, dorsiflexion and plantar flexion angle decrease less than 5 degrees; Good: mild discomfort, walk slightly abnormal, muscle strength decreases compared with that in the contralateral calf, circumference decreases by 1-3 cm, dorsiflexion angle reduces by 5-10 degrees; Poor: obvious discomfort, obvious limp, muscle strength decreases significantly, calf circumference decreases by more than 3 cm, dorsiflexion angle decreases more than 10 degrees, the plantar flexion angle decreases more than 15 degrees.

### **Statistical analysis**

SPSS17.0 statistical software was used for analysis. Comparisons between the two groups were performed using Chi-square test. P values were two-tailed, and P values less than 0.05 were considered significant.

## **RESULTS**

The mean follow-up period was 3.4 years (range: 9 months–5 years). In the conventional group, there were 4 cases with local skin necrosis in the middle and lower part of the Achilles tendon after the operation, the wounds dehiscence and infected. After debridement, direct suture or skin flap transfer was carried out. The 4 cases recovered within 3 months. Achilles tendon rupture occurred again in one patient 2 month after surgery. The Achilles tendon was repaired using modified Lindholm form for reinforcement, with one sural neurovascular flap transfer for covering. No cutaneous nerve injury occurred. The total incidence rate of complication

was 20%. (Table1).After following-up for 9 months since operation ,according to Arner-Lindholm grading standard, 14 cases were excellent, 8 cases were good and 3 cases were poor. The excellent and good rates were 88%.

In the modified group, one patient had partial injury of the sural nerve with the numbness of lateral foot after operation. 3 months later, the sensory function recovered. In another case, the incision on the back of the ankle joint became red and swollen 5 days later operatively. After anti infection treatment, the skin returned to normal and no skin necrosis occurred. There's no skin necrosis and deep infection in all cases. No wound dehiscence and re-rupture of Achilles tendon occurred in all the cases. No cases needed to be repaired. The total incidence rate of complication was 5.3%. (Table1). After following-up for 9 months since operation ,the ankle joint function was evaluated according to the evaluation criteria of Arner-Lindholm. 13 cases were excellent, 4 cases were good and one case was poor. The excellent and good rates were 94.7%.The bad symptoms mainly contained skin adhesion, sense of tensile in local area when moving ,pain,lameness,ankle joint movement limited and triceps surae muscle atrophy, decrease of force in the lower limb when walking , and so on.The ankle joint function of 1 patient was evaluated as poor 9 months after the operation for the dorsiflexion angle decreased more than 12 degrees, the calf circumference decreased by 3.5 cm, while the plantar flexion muscle strength was grade 4 ,the plantar flexion angle was normal.The main cause was considered as the insufficiency of functional training.After the further standardized training,The ankle joint function of the patient was evaluated as good 12 months after the operation .

There were significant differences between the two groups in the incidence of postoperative complications ( $P < 0.05$ ). The excellent and good rates of the ankle joint function in the modified group were statistically higher than those in the conventional group ( $P < 0.05$ ).There was no significant difference between the two groups of Achilles tendon rupture and cutaneous nerve injury ( $P > 0.05$ ).

**Tab.1 Postoperative complications and Comparison of two approaches for Achilles Tendon Repairation**

Group	Case	rupture again	wound dehiscence	nerve injury	total incidence
Conventional group	25	1	4	0	20.0
Modified group	18	0	0	1	5.6*

\*: Comparison between conventional group and modified group,  $P < 0.05$

**Tab.2 Postoperative Curative Effect Comparison of two approaches (According to Arner-indholm grading standard)**

Group	Case	Excellent	Good	Poor	Exercellent-good rate
Conventional group	25	13	9	3	88.0
Modified group	18	13	4	1	94.4*

\*: Comparison between conventional group and modified group,  $P < 0.05$

### Typical case

A 32 years-old male got sudden pain and weakness in the left ankle after a collision to the metal railings when running hurdles. The left Achilles tendon rupture was confirmed by physical examination and color Doppler ultrasonography. The patient had have local block injection therapy in the left Achilles tendon to relieve the pain in the insertion 2 years ago. The repairing operation was performed 8 days after injury. The approach design was one S shape short incision in the posterior ankle joint and two pairs of small incision on the edge of the proximal part of Achilles tendon (Figure 1). In the S shape short incision of the posterior ankle joint, Achilles tendon end could be shown completely (Figure 2). The sural nerve and saphenous nerve could be seen clearly in pairs of small incisions (Figure 3). After the Achilles tendon suture, the broken ends became neat and closed tightly (Figure 4). The wound was sutured without tension. 2 weeks after operation, the wound healed well without necrosis (Figure 5). 6 weeks later, the plaster of ankle joint was removed. The ankle joint function recovered well 3 months after operation (Figure 7-9). Figure 6 showed a clear sketch line of suture during operation. In addition, anatomical study has prove there is fewer blood vessel in the posterior ankle joint, wound dehiscence and re-rupture of Achilles tendon were prone to occur (Figure 10).



**Figure 1: the short cut of the ankle joint and the small incision position in the proximal part of The ankle joint**



**Figure 2: In the S shape short incision of the posterior ankle joint, Achilles tendon end could be shown completely**



**Figure 3: the sural nerve and the saphenous nerve**



**Figure 4: The ends of Achilles tendon were neat and close after suture.**



**Figure 5: Two weeks after operation, the wound healed well.**



**Figure 6: a clear sketch line of suture during operation**



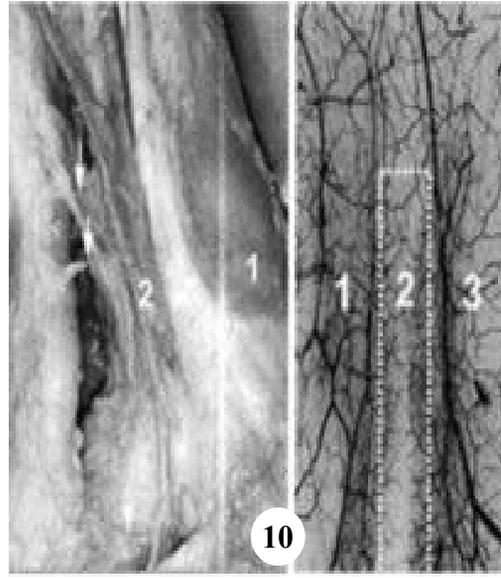
**Figure 7: Six weeks after operation, the wound healed well.**



**Figure 8: Six weeks after operation, the ankle joint plantar flexion function recovered well.**



**Figure 9:Six weeks after operation,the ankle joint dorsiflexion function recovered well.**



**Figure 10:The distribution of blood vessel around the Achilles tendon.**



**Figure 11:The blood supply of the wound was poor on the back of the ankle joint by adopting the traditional longitudinal continuous long incision,despite it was convenient to operate.**

## **DISCUSSION**

The traditional Achilles tendon repair operation is characterized by one long longitudinal incision on the back of the ankle joint.<sup>9,19</sup> The upper part and the insertion point of Achilles tendon have better blood supply, while the lower part is poor. Its blood supply is from the

gastrocnemius muscle and surrounding soft tissue. The advantage of traditional longitudinal continuous long incision is for one clear operation field, including full exposure, convenient observation and operation, accurate and reliable location of Achilles tendon suture. The disadvantages of traditional incision included the big destruction of blood supply, swelling tissue and high tension for the skin, which would result in non-healing wound, secondary infection and Achilles tendon nonunion and re-rupture.<sup>5</sup>

Therefore, one minimally invasive surgical approach with a short incision near the break end of the tendon emerged, with a variety of improvements,<sup>7,8,24,25</sup> such as the method of Achillon repairment. The advantage of Achillon repairment was minimally invasive, while the disadvantage was poor vision without one direct suture. The needle could not be easily controlled to go across the center position of the Achilles tendon accurately,<sup>33</sup> so the pull force of suture lines was not in the center of Achilles tendon and the bearing position was changed, which led to some slippage and Achilles tendon re-rupture. In addition, Achillon method cost higher than the traditional Achilles tendon repair. From an economic point of view, the expense of Achillon method restricted its using range. The risk of sural nerve injury was presented when puncture leading, despite of preoperative MR examination for assistance of localization<sup>35</sup>.

### **Analysis of postoperative complications of Achilles tendon rupture**

Among the postoperative complications, the re-rupture of Achilles tendon is the most serious, which means the long course of treatment has failed. Although it can be repaired again, the adverse effects are still great. Surgeons focus on the reliable repairing and successful healing of Achilles tendon. No matter what kind of incision or repair method was used, there was still a certain incidence of re-rupture after Achilles tendon repair.<sup>2</sup> Some researches deem that there is no difference among all kinds of operation methods in the incidence of re-rupture. Separation of tendon ends may occur at the time before and after the closure of the wound, before or during the immobilization of the plaster, or when the muscles of lower leg contracts. It is difficult for both doctors and patients to find tendon separation, which will result in the bad healing of Achilles tendon and re-rupture after removal of the external fixation. Standardized suture should be used during the operation. When stitching by using the Bunnell's suturing, the operator should pay attention to cross the central tendon and put the pulling force of line in the center position, and to force on pulling the ankle joint with tension before finishing suture for the prevention of postoperative anastomotic slippage of Achilles tendon. Routine placement of drainage reduces congestion in the wound, which reduces the

incidence of wound infection and nonunion. Injuries of the sural nerve and saphenous nerve are more common in the minimally invasive surgical approach.<sup>32,34</sup> The reason is that blindness or lack of exposure results in accidental injury.<sup>11,18</sup> If using two pairs of longitudinal small incision on both sides of the proximal segment of the Achilles tendon, operators could fully reveal the nerve and tendon transport, with little impact on blood but accurate positioning of Achilles tendon suture and easy incision healing.

### **The advantages of the modified approach**

After analyzing the mechanism of the complications of minimally invasive surgery for Achilles tendon,<sup>6,11,15,21,26,27</sup> we designed a modified approach: a short oblique S shape incision along the striae of posterior ankle with two pairs of small incisions at the proximal lateral margin of the Achilles tendon. The position and direction of the skin striae can reveal the tension and blood supply of the subcutaneous soft tissue. When the ankle is in plantar flexion posture, the foot varus exists, which makes more folds in the skin behind the medial malleolus than lateral malleolus, so the skin striae direction becomes oblique. Accordingly, the S shaped short incision at the break end of the Achilles tendon was designed to be about 3cm long and the skin was cut diagonally from medial side to lateral side, along the skin striae of the posterior ankle joint. The approach had the following advantages: ① The skin tension was low, which reduced the possibility of postoperative wound nonunion. ② The site of operation could get adequate exposure in this incision, which made the end of Achilles tendon clear. ③ The approach complied with the blood supply direction of the Achilles tendon from both sides to the center, which caused less damage to blood supply. ④ The cutaneous nerve could be exposed clearly through two pairs of small incisions at the proximal lateral margin of the Achilles tendon, which avoided cutaneous nerve injury in the operation. ⑤ The stitches could be sutured to the center of Achilles tendon accurately, which ensured that the force position was located in the center of Achilles tendon after suture. ⑥ Bunnell method of cross stitching in Achilles tendon was used to make the suture more stable and firm rather than U shape suture in blind puncture of Achillon method. ⑦ It cost less compared with Achillon method and no extra material was needed. ⑧ The modified approach was not difficult and time-consuming. In this study, the modified group had less postoperative complications and better functional recovery compared with the conventional group.

### **Discussion on intraoperative details**

In this study, 1 patients suffered from lateral sensory disturbance of the foot after the modified approach surgery and the sensory function recovered 3 months after the operation. The reason was the injury of one branch of the sural nerve in the short incision after the ankle. In this regard, we analyzed that the lateral part of the short incision behind the ankle should follow the direction of the sural nerve to reduce the possibility of nerve injury. The protection of cutaneous nerves should be taken into account in any operation site<sup>12,30</sup> to avoid reducing the overall effect of surgical treatment for such a reason.

The best time for the repair of Achilles tendon was in 6 hours after rupture, but in clinic most Achilles tendon repair surgeries were carried out a few days later. At that time, the broken end of Achilles tendon retracted and the nutrient supply contacted with surrounding tissue was destructed. After sewing the Achilles tendon ,there was a longitudinal gap before the ends of tendon when the ankle joint plantar flexing, blood clots would fill the gap, turned into the granulation tissue and reconstruct the blood circulation , resulted in adhesion<sup>30</sup>. The stale ends of tendon were not good for union. The blood clots in the ends of the tendon should be removed to prevent adhesion and improve tendon growth before sewing the Achilles tendon.<sup>14</sup> Over-and-over whip suture was deemed unnecessary because it would affect the blood supply and tendon healing. All these patients were sutured with 1-0 PDS-II line in the center of Achilles tendon with force. Then continuous sparse suture around the edge with 4-0 threads was completed to avoid the tendon tissue scattered, reduce the tendon adhesion<sup>1</sup> and reduce the bleeding into the gap of the ends which would result in the Achilles tendon malunion and re-rupture. Conventional oral administration of Aspirin Enteric-coated Tablets was used to prevent deep vein thrombosis after operation.<sup>16,29</sup>

## **CONCLUSION**

The modified surgical approach for Achilles tendon repair was recommended: one short S shape incision across the posterior part of the ankle combined with two pairs of tiny incisions at the edges of the Achilles tendon. With this approach fewer complications and better functional recovery could be achieved.

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