Different Sutures in the Surgical Treatment of Acute Closed Achilles Tendon Rupture

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Abstract The aim was to compare the postoperative efficacy of the PDS II and Ethibond W4843 sutures in fresh, closed Achilles tendon rupture. With methods of random grouping (level of evidence II b), a total of 128 patients with fresh Achilles tendon rupture were operated on with PDS II or Ethibond W4843 suture. Postoperative objective examination and the American Orthopaedic Foot & Ankle Society (AOFAS) scoring system were used for the evaluation. Group A underwent 12–39 months of follow-up, for an average of 22 months. Group B underwent 12–37 months of follow-up, for an average of 23 months. The postoperative AOFAS score of group A within 3 months was 93 ± 9.6 points. One case exhibited re-rupture, five cases exhibited incision infection, one case manifested deep infection, and seven cases exhibited Achilles tendon adhesion. The postoperative AOFAS score of group B within 3 months was 97 ± 7.8 points. Eleven cases had incision infection, and 13 cases manifested Achilles tendon adhesion. Minimal differences were observed in the incision infection, re-rupture rate, and Achilles tendon adhesion in the study of the PDS II and Ethibond W4843 sutures. But, based on the AOFAS score and pain score, the Ethibond suture performed better.

Keywords Surgical treatment · Ethibond suture · Achilles tendon rupture

Introduction

The Achilles tendon is the most powerful but most easily ruptured tendon in the human body [1, 2], and the rupture commonly occurs in sports activities [3]. Although the pathological mechanism is not clear [4], an Achilles tendon rupture can be treated through surgical and nonsurgical approaches amidst some controversy in the comparison [5]. Conservative treatment has fewer wound complications, but higher re-rupture rate [6–8]. Surgical treatment provides postoperative satisfaction and faster speed of recovery, but has higher probability of complications including scars, wound infection, delayed healing, Achilles tendon adhesion, and ankle activity limitation [9, 10]. In recent years, it is noted that the suture material can greatly reduce the incidence of complications, as well as supply sufficient intensity so that patients can perform early functional exercises. The PDS II and Ethibond sutures have been used in these surgeries and yielded good results. The PDS II suture was used commonly, but the use of the Ethibond W4843 suture (uniformly coated with polybutylate, a special material with superior flexibility and operability) has gradually increased in recent years. So, we investigated the effects of the PDS II and Ethibond W4843 sutures on the repair of Achilles tendon rupture.

In this study, we included 128 cases of closed Achilles tendon rupture repaired with the Bunnell method from January 2006 to December 2010 to study the postoperative results of the PDS II and Ethibond W4843 sutures.

This study was conducted in accordance with the Declaration of Helsinki and with approval from the Ethics Committee of Shanghai Changning District Central Hospital and Huashan Hospital affiliated to Fudan University. Written informed consent was obtained from all participants.

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Materials and Methods

Clinical Data

Case inclusion criteria were the following: (1) duration of the rupture <2 weeks, (2) the fracture plane is 2–8 cm above the calcaneal tuberosity, and (3) closed rupture. Exclusion criteria were the following: (1) duration of the rupture >2 weeks, (2) patients who took steroids or quinolones, (3) patients with chronic Achilles tendon pain, (4) open injury, and (5) with a generally poor situation or unable to collaborate.

PDS II suture was obtained from Johnson & Johnson Ltd., registration number SFDA (imported) 2003 No. 3650565. The Ethibond W4843 polybutylate suture was obtained from Johnson & Johnson Ltd., registration number SFDA (imported) 2003 No. 3650558.

A total of 128 cases were studied and randomly divided into the PDS II suture (group A) and the Ethibond W4843 polybutylate suture (group B), depending on the suture used during surgery. Group A had 32 males and 9 females, aged 16–73 years, with an average age of 45.3 years old. The cases included 38 sports injuries (25 caused by playing badminton, 10 caused by playing basketball, and 3 caused by running), 1 of traffic injury, and 2 of sprained ankle. The operative time was 1–10 days after the injury, with an average of 2.5 days. Group B had 63 males and 24 females, aged 19–65 years, with an average age of 44.7 years old. The cases included 75 sports injuries (56 caused by playing badminton, 14 caused by playing basketball, and 5 caused by running), 6 of traffic injury, 5 of sprained ankle, and 1 of dance injury. The operative time was 1–11 days after the injury, with an average of 2.7 days.

The patients in the two groups all mentioned they felt a pounding sensation at the heel, had difficulty walking because of pain, had weak foot plantar flexion, and had difficulty raising their calf. At examination on admission, their Achilles tendon area manifested depression and tenderness, Thompson sign (+). A preoperative B ultrasound or MRI was performed to confirm whether the rupture occurred at 2–8 cm above the end point of the Achilles tendon. General information on the two groups is shown in Table 1. This study was conducted in accordance with the Declaration of Helsinki and with approval from the Ethics Committee of Shanghai Tongren Hospital. Written informed consent was obtained from all participants.

Fig. 1 Before the Achilles' tendon rupture surgery

Surgical Methods

Subarachnoid block anesthesia was administered, and antibiotics were provided at 30 min before surgery. The surgeries were performed by the same group of doctors. The patients were operated on in prone position with a pneumatic tourniquet on their thigh. A curved incision about 8–10 cm was taken medial to the Achilles tendon. The hematoma was cleared and the stump exposed while protecting the aponeurosis. The nonviable tissues were resected, and the horsetail-like stump was trimmed (Fig. 1). Group A used the PDS II suture, whereas group B used the Ethibond W4843 suture. The suture was threaded with a double recto needle at 4 cm away from the stump, using the Bunnell method. The stump was stretched to a suitable involution, and the line knot was left inside, with moderate tension applied on the Achilles tendon. In cases where the strength is not enough, a 3.0 Vicryl suture can be used to strengthen the suture line and for the aponeurosis to become smooth (Fig. 2). Postoperative management revealed that ankle dorsiflexion can reach up to 90° and the Achilles tendon exhibited a certain amount of tension.

Postoperative Handling

A long-leg plaster was placed and immobilized for 3 weeks; then, the short-leg plaster was immobilized for 3 weeks with gradual knee flexion. After 6 weeks, the plaster was removed. Some patients were asked to wear high-heeled shoes, grasp the heels, and squat at a slight degree. After 3 months, the patients were allowed to return to normal activities and gradually participate in sports activities.

Table 1 General data of the two groups

Group	Cases		Gender (cases)	Age	Duration from injury to surgery	Injured foot	
	Male	Female				Left	Right
A	41	32	9	45.3±8.3	2.5±1.5	18	23
B	87	63	24	44.7±7.1	2.7±1.9	35	52

Fig. 2 After the repair with the W4843 suture

Evaluation Index

Follow-ups were conducted by two designated physicians on the 3rd week, 6th week, 3rd month, 6th month, and 12th month after the surgery. The American Orthopaedic Foot & Ankle Society (AOFAS) hindfoot score system was used to record the extent of the wound healing, the sensation at the sural nerve area, and the angle of ankle dorsiflexion and plantar flexion. Excellent results meant ≥ 90 points, good results meant 75–89 points, acceptable results meant 50–74 points, and bad results meant < 50 points. Pain was scored using the visual analogue scale (VAS), where 0 stands for “painless” and 10 stands for “the most intense pain.”

Statistical Method

The SPSS 19.0 statistical package was used for data analysis. Data were expressed as mean $\pm$ standard deviation ($\bar{X} \pm S$). The function scores were compared through t test, and the incidence of the postoperative complications used a χ^2 test, where $P < 0.05$ was considered to be statistically significant.

Results

The operative time was 29–62 min, with an average of 38 min for group A. The hospitalization sessions were 3–11 days, with an average of 4.7 days; follow-up sessions lasted for 12–39 months, with an average of 22 months. Group B patients

had an operative time of 27–58 min, with an average of 32 min. The hospitalization sessions were 2–9 days, with an average of 4.1 days. Follow-up sessions lasted for 12–37 months, with an average of 23 months.

Group A resumed normal walking ability 3 months postoperatively; the AOFAS score was 93 ± 9.6 points, and the VAS score was 1.3 ± 0.8 . After the surgery, one case re-ruptured (strenuously exercised after 5 months postoperatively); five cases of surface infection were reported and were healed after 14–36 days. One patient reported that the wound produced exudate but recovered after debridement was done twice. The rest were all in phase I healing, without nerve injury. Seven cases of Achilles tendon adhesion were also reported. Twelve cases experienced minimal foot dorsiflexion (5° to 10°), and the rest experienced foot dorsiflexion $\geq 15^\circ$.

Group B resumed normal walking ability 3 months after the surgery. The AOFAS score was 97 ± 7.8 points, and the VAS score was 1.1 ± 0.4 . Seven cases of surface infection were reported and then healed 16–25 days later. The rest were all in phase I healing, without nerve injury or re-rupture. Thirteen cases of Achilles tendon adhesion were reported. Nineteen cases had fewer ankle activities or minimal foot dorsiflexion (5° to 10°), and the rest experienced foot dorsiflexion $\geq 15^\circ$. The results are shown in Table 2.

Discussion

According to Nilsson-Helander [11], the re-rupture rate and the postoperative functional assessment of surgical and non-surgical treatments for acute Achilles tendon rupture are very close. Cetti [12] believed that the Achilles tendon re-rupture rate of surgical treatment was significantly lower than that of the nonsurgical treatment. Coutts also [13] thought that end-to-end repair and postoperative therapy of short-leg fixation on the Achilles tendon rupture were safe.

The surgical methods to repair ruptured Achilles tendons can be divided into two categories: open surgery and percutaneous surgery. Gigante [14] compared 40 patients who underwent open surgery and percutaneous repair and found that the percutaneous surgery had no difference in the recovery degree of the Achilles tendon, ankle function, and B ultrasound results. Mat et al. [15] reported that percutaneous

Table 2 Comparison of postoperative effects in the groups

Group	Cases	Incision infection rate (% , cases)	Re-rupture rate (% , cases)	Adhesion rate (% , cases)	Ankle joint limitation rate (% , cases)	AOFAS score (points, $\bar{X} \pm S$)	Pain score (points, $\bar{X} \pm S$)
A	41	14.6 (6/41)	2.4 (1/41)	17.1 (7/41)	29.3 (12/41)	93 ± 9.6	1.3 ± 0.8
B	87	12.6 (11/87)	0 (0/87)	14.9 (13/87)	20.9 (19/87)	97 ± 7.8	1.1 ± 0.5
<i>P</i>		0.757	0.32	0.757	0.293	0.013	0.001

surgery can easily damage the sural nerve and cause lateral numbness and is also prone to breakage and adhesion. Therefore, we believe that open surgery still has an important role in the treatment of ruptured Achilles tendons. The common materials include sutures and adhesive materials. Johannes [10] reported that the sutures have a more obvious biomechanical superiority than the adhesive material. Wapner [16] suggested the use of nonabsorbable sutures in open surgery.

Previous suturing of Achilles tendon rupture used to employ tendon sutures or PDS II suture, but in recent years, the application of Ethibond sutures increased gradually. However, no report comparing the performance of the two sutures has been published. The result of our comparison confirmed that although the Ethibond group has similar intraoperative complications with the PDS II group, it has less postoperative complications and provides a number of advantages in function improvement and pain control.

No sural nerve injury was reported in the two groups, which may be related to the better exposure. With regard to the incidence of incision infection, group A had 6 cases (14.6 %), whereas group B had 11 cases (12.6 %), $P>0.05$. In the re-rupture rate, group A had one case (2.4 %) and group B had no case (0 %), $P>0.05$. For the postoperative adhesion rate, group A had 7 cases (17.1 %), whereas group B had 13 cases (14.9 %), $P>0.05$. In the ankle-movement limitation rate, group A had 12 cases (29.3 %) and group B had 19 patients (20.9 %), and the P value is still >0.05 . The above results prove that in group A, there was no significant increase in the re-rupture rate, the incidence of incision infection, and chances of adhesion and there was a similar influence on ankle-movement limitation as group B. With regard to the AOFAS score, group B obtained 93 ± 9.6 points, which is better than that of group A (97 ± 7.8 , $P<0.05$). This result proves that group B has certain advantages in postoperative functionality. With regard to the pain degree indicated by the VAS score, group B had better scores than group A (1.3 ± 0.8 and 1.1 ± 0.5 points, $P<0.05$). This result further confirms that group B has more effective pain control.

We suggested that the surgery should be done before the swelling appears or after it has subsided. Otherwise, the fibrous tissues would be too fragile, which would lead to a low fixation degree. Several methods are reported, according to Brett W. McCoy [17] research with cadavers. The methods of Krackow, Bunnell, and Kessler have no significant difference as regards Achilles tendon suture strength. So, we used the Bunnell method. Given that the suture went inside the Achilles tendon, the line knots were embedded in the stump, reducing the stimulus and making the involution tight and smooth. This condition leads to minimal foreign body reactions and complications and provides a necessary prerequisite base for the physiological healing of the Achilles tendon rupture.

We believe that the ideal Achilles tendon repair material should meet the requirements of uniform tensile strength, easy

knotting, safety and flexibility, easy operation, minimal tissue injury, and low line-knot reactions. Although the PDS II suture is smooth and causes minimal tissue damage, it is an absorbable suture; thus, it has less strength than nonabsorbable sutures. The PDS II suture also has a certain hardness, which can lead to tissue and suture breakage. The Ethibond W4843 suture can provide enough strength and tensile strength, which is convenient during surgery and conducive to the early activities. The Ethibond suture cannot be absorbed, which can provide strong, permanent tensile protection. Noninvasive operation should be performed to avoid destroying the ventral vascular bundle. The stump ends should be carefully combed, and the anastomotic stoma should be kept smooth. The standard should be the following: when ankle plantar flexion reaches 15° , the broken ends should not overlap. Extreme overlapping results in excessive tightness when the foot dorsiflexed and affects ankle movements. However, the suture should be kept tensile to avoid Achilles tendon weakness. The membranes of the tendon should be distinguished to avoid adhesion.

For postoperative rehabilitation, the patients were subjected to long-leg immobilization for 3 weeks followed by short-leg immobilization for 3 weeks and then weight-bearing exercises on the ground. Strom [18] pointed out that early functional and weight-bearing exercises should be performed instead of long-leg plaster and the patients can resume normal activities earlier. A prospective study [19] also indicated that patients with early activities after operation had fewer complications and exhibited better functional recovery. Maffulli [20] also described similar results. Therefore, whether short-leg immobilization should be applied prior to early functional exercises still needs to be confirmed.

In summary, the long-term efficacy of the PDS II and Ethibond polybutylate sutures still needs to be further studied because of the follow-up schedules and the number of cases. Likewise, we need more biomechanical studies to support our conclusion. The Ethibond W4843 polybutylate and PDS II sutures have insignificant difference in performance with regard to incision infection, re-rupture rate, tendon adhesion, and ankle-movement limitation. The Ethibond suture has certain advantages, so it can be used as an ideal surgical material. The Ethibond suture can take the place of the PDS II suture in the future in the surgical treatment of acute closed Achilles tendon rupture.

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