ORIGINAL ARTICLE

Minimally invasive repair of ruptured Achilles tendon

CME

SK Chan 陳世強
Stephen CY Chung 鍾礎逸
YF Ho 何遠芳

Objective To study the clinical outcomes of minimally invasive repair of ruptured Achilles tendon.

Design Retrospective study.

Setting Orthopaedics and Traumatology Department of a public hospital in Hong Kong.

Patients Fifteen consecutive patients admitted to the hospital from August 2002 to April 2005 with closed Achilles tendon rupture, had it repaired by a minimally invasive method. Parameters including patient epidemiology, nature of injuries, and isometric force measurement of ankle plantar flexion were recorded to justify the effectiveness of the Achilles tendon repair.

Results Isometric peak force measurement of ankle plantar flexion 1 year after injury showed an average regain of 95% of the calf muscle strength, compared to the normal side. All wounds healed well, without major complications such as deep infection, sural nerve injury, or re-rupture of the Achilles tendon. All patients were able to resume their pre-injury activity level and previous occupation.

Conclusion This minimally invasive surgical technique using the Achillon suture guide produces encouraging results in the operative management of ruptured Achilles tendon.

Introduction

The Achilles is the strongest tendon in the body, and can normally withstand several times a subject's body weight. Not surprisingly, closed rupture of this tendon is a commonly encountered sports injury.

Various methods have been used to treat ruptured Achilles tendon. Some authors support conservative treatment, while others advocate surgery. Conservative treatment using a short leg resting cast in an equinus position is probably justified for elderly patients who have lower functional requirements or those at increased risk of poor surgical healing, such as individuals with diabetes mellitus or in receipt of immunosuppressive drugs. However, conservative treatment is associated with high rate of tendon re-rupture (up to 20%).[1,2] Operative treatment can ensure tendon approximation and improve healing, and thus a lower re-rupture rate (about 2-5%). However complications including wound infections, skin tethering, sural nerve damage, and hypertrophic scar may still ensue in around 4 to 19% of patients.[1-3]

Percutaneous methods described by Ma and Griffith[4] and Bradley and Tibone[5] avoid most of the disadvantages of open surgical treatment, but the degree of tendon regeneration cannot be ensured. Moreover, haematoma cannot be removed and proper approximation of the tendon stumps cannot be confirmed, which leads to a higher rate of re-rupture and other problems (including sural nerve damage and nodule formation at the site of sutures).[5] Assal et al[6] described a minimally invasive technique to repair the Achilles tendon using a suture guide termed an "Achillon". In our retrospective study, we reviewed the effectiveness of this technique and wished to share our short- and long-term experience, with particular reference to management of patients with delayed presentation of Achilles tendon rupture.

Methods

From August 2002 to April 2005, we repaired the Achilles tendon with the minimally invasive

Key words
Achilles tendon; Rupture; Surgical procedures, minimally invasive; Sutures; Treatment outcome

Hong Kong Med J 2008;14:255-8

Department of Orthopaedics and Traumatology, Caritas Medical Centre, Shamshuipo, Kowloon, Hong Kong
SK Chan, FHKCOS, FHKAM (Orthopaedic Surgery)
SCY Chung, MB, BS, MRCS (Ed)
YF Ho, FHKCOS, FHKAM (Orthopaedic Surgery)

Correspondence to: Dr SK Chan
E-mail: drpcsk@yahoo.com.hk

微創手術治療跟腱斷裂

目的 研究利用微創手術治療跟腱斷裂的臨床結果。

設計 回顧研究。

安排 香港一所公營醫院的矯形外科及創傷學系。

患者 2002年8月至2005年4月期間，連續15名因跟腱斷裂而入院求診，並施行微創手術的病人。本研究記錄了病人資料、受傷類別、量度得出的踝跖屈長力以測量手術治療跟腱斷裂是否有效。

結果 與沒有受傷的一邊比較，受傷後1年的踝跖屈最高的長力可以回復至脛前肌的95%。所有傷口癒合良好，並沒有深層感染、腓腸神經損傷、或跟腱再斷裂的併發症。全部病人均可以回復受傷前的活動情況及職業。

結論 以微創手術治療跟腱斷裂的結果令人滿意。

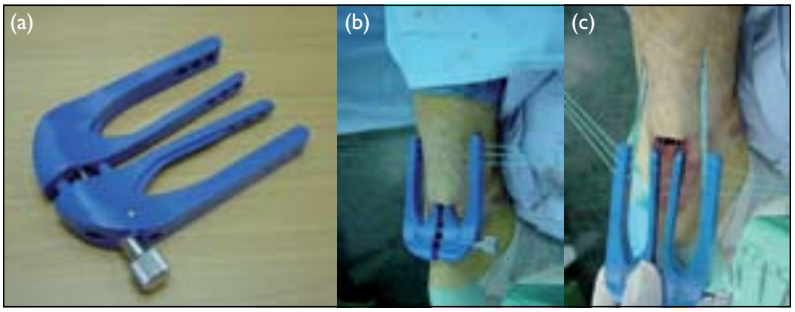

FIG 1. (a) The Achillon suture guide. (b) Ethibond sutures passed through the Achillon. (c) Withdrawal of the Achillon to pull the suture loop out

TABLE 1. Patient demographics and epidemiology

Patient No.	Sex	Age (years)	Injury	Occupation
1	M	20	Basketball	Sailor
2	M	38	Badminton	Clerk
3	F	45	Walking	Clerk
4	M	36	Running	Construction site worker
5	M	27	Basketball	Sales
6	M	42	Tennis	Clerk
7	M	49	Running	Driver
8	M	29	Basketball	Clerk
9	M	45	Badminton	Police
10	M	39	Badminton	Clerk
11	M	53	Walking	Construction site worker
12	M	64	Walking	Delivery
13	M	21	Badminton	Clerk
14	M	45	Football	Cleaner
15	M	29	Badminton	Sales

technique using the Achillon device, described by Assal et al[6] in 15 consecutive patients presenting to our centre with complete closed rupture of the Achilles tendon. The patients all had a demonstrable palpable gap between the ruptured ends, a positive Thompson test, and a distal stump of more than 2 cm from the insertion. Patients with incomplete or open rupture of the tendon or with a distal tendon stump of less than 2 cm from its insertion were excluded. All but two patients had acute rupture; the interval from the time of rupture to repair was within 1 week. Two others presented 6 and 8 weeks after rupture.

Our operative technique entailed a tourniquet applied to the thigh so that the involved limb was exsanguinated. Patients were positioned prone with both legs draped in order to compare the tension of the ruptured Achilles tendon after repair with that on the contralateral side. A single prophylactic 1 g dose of intravenous cephalosporin was administered on induction.

A 2-cm incision was made over the palpable gap of the ruptured Achilles tendon. We preferred a longitudinal skin incision, as transverse incisions were associated with a risk of sural nerve injury,[7] despite better cosmetic outcomes from the latter. Haematoma could be cleared to reveal the tendon stumps after the paratenon was opened up longitudinally.

The technique of using the Achillon suture guide was first described by Assal et al,[6] and involves using a U-shaped device with four limbs for tendon approximation (Fig 1a). By placing the inner two limbs within the paratenon enclosing the ruptured tendon ends and the outer limbs outside the skin, a long needle with Ethibond sutures can be passed through the holes of the four limbs while the Achilles tendon was still secured between the inner limbs (Fig 1b). When the Achillon was withdrawn, the sutures that pass through the tendon could be retrieved for approximation of the ruptured ends of the Achilles tendon (Fig 1c). This method reduces the risk of sural nerve entrapment as the suture knots are within the paratenon. The paratenon was repaired with vicryl sutures. After wound closure, the ankle was kept at 30-degree plantar flexion with a short leg plaster cast.

Postoperative care and rehabilitation

The short leg plaster cast was kept in the 30-degree equinus position for 3 weeks. Thereafter the cast was changed to a hinged ankle brace, allowing gradually increasing ankle dorsiflexion up to neutral at 6 weeks after the operation.

Patients avoided any weight bearing on the injured limb for 6 weeks, and then commenced partial weight bearing while walking for another 3 weeks. Full weight bearing while walking was allowed 9 weeks after surgery. Gentle sports activities such as jogging could usually be resumed at 3 months. More vigorous exercise like running could be resumed after 6 months and contact sports at 9 months after

the operation.

Functional outcome assessment

We employed the Blankenship force dynamometer to assess the final isometric peak force of plantar flexion of both ankles when the patients had returned to their pre-injury activity level. This dynamometer measures peak muscle strength in a quantifiable way. Patients were laid supine with the dynamometer placed at their feet. The patients were instructed to apply maximum plantar flexion pressure onto the dynamometer sensor, and mean applied force in pounds was measured. On average, three maximum peak force records were obtained from the injured and the non-injured ankle. These measurements were taken by the same physiotherapist, so as to eliminate inter-observer errors.

Results

Fifteen patients (14 male) with closed Achilles tendon rupture had such surgical repairs performed from August 2002 to April 2005. Their ages ranged from 20 to 64 years with a mean of 39 years. Three of these patients had diabetes mellitus, two of whom presented after a delay, their rupture having ensued 6 and 8 weeks earlier.

Twelve of these patients sustained their injuries during competitive sports, while three did so whilst walking (Table 1). On the basis of a simple questionnaire, we were able to show that of the 15 patients, seven had warm-up exercise before the injury, three had heel pain prior to the injury, and five had exercised less than 1 hour per week.

Blood loss was minimal as expected for a small wound and use of the tourniquet. There was no major complication (tendon re-rupture, deep wound infection, or sural nerve injury). One patient with a history of diabetes mellitus developed a stitch abscess 3 weeks after the operation. The wound healed with conservative treatment, following the use of oral antibiotics and wound dressing. Another patient endured skin tethering to the underlying tissue (over the surgical wound), which resolved after subcutaneous release under local anaesthesia.

The follow-up period ranged from 20 to 43 months, with a mean of 31 months. At 1-year follow-up, isometric plantar flexion force was measured using the Blankenship dynamometer. On average the injured side could achieve 95% of the power attained on the non-injured side (Table 2). All patients could return to their previous occupation and sports activities. The injured ankle regained a normal range of movement (as on the contralateral side). All patients were satisfied with the results of their operation and wound's appearance (Fig 2).

TABLE 2. Isometric force measurement of both Achilles tendons

Patient No.	Injured side	Average force of injured side (lbs)	Average force of non-injured side (lbs)	Force changes (%)
1	Left	71.3	58.4	122
2	Left	30.3	28.5	110
3	Right	49.6	49.1	101
4	Right	85	87.5	97
5	Left	37.5	42.9	88
6	Right	97.9	91.2	101
7	Right	88	97.4	90
8	Left	71.3	71.8	99
9	Left	70.8	73	97
10	Right	70.5	88.9	79
11	Right	19.2	41.8	46
12	Left	19.9	27.1	73
13	Left	49.5	56.5	88
14	Right	63.5	65.8	97
15	Left	92.3	78.5	117

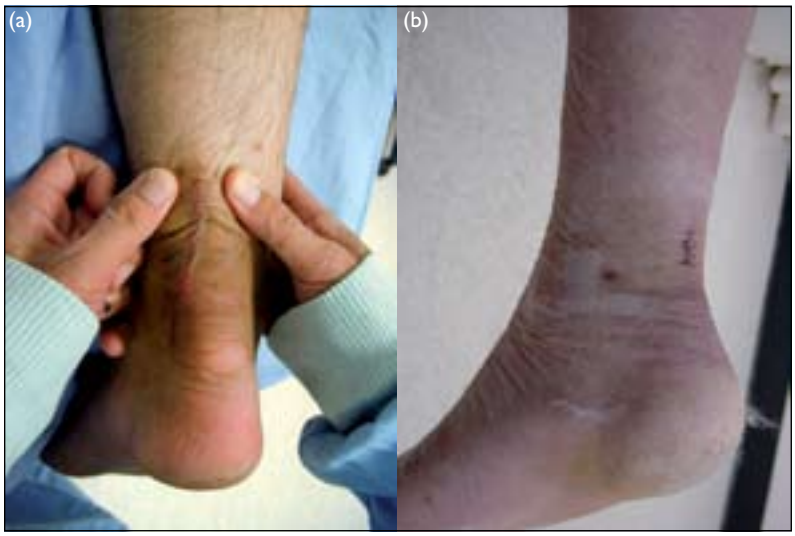

FIG 2. (a) After open method of repair, bulky wound and skin tethering to the underlying Achilles tendon. (b) Wound after minimally invasive repair

Discussion

Open repair of the Achilles tendon is reported to have a high infection rate. The possible reason is related to the poor blood supply of the tendon, especially at the watershed area where the rupture commonly occurs. Moreover, the suture material can act as foreign body to enhance survival of bacteria and suture knots can further reduce blood supply of the tendon.

In case of open surgery, the final repaired tendon is usually bulky and prevents closure of the paratenon. The paratenon is a protective layer

between the tendon and the skin, which is a barrier to superficial infection spreading into the deep layers. It also prevents skin tethering to the tendon and provides a valuable blood supply to the repaired tissues. The minimally invasive method limits the exposure of the tendon, reduces the amount of suture material used, and allows closure of the paratenon, all of which enhance blood supply so as to facilitate maximal healing. These advantages could explain why the wound infection rate is much lower than that with the open repair technique.

From our experience, patients with diabetes mellitus have higher wound infection rates following open repair of Achilles tendon rupture. In this series, we achieved two successful results, treating ruptured Achilles tendons in patients with diabetes mellitus presenting after a delay of 6 and 8 weeks. Nevertheless, the tendon ends could still be approximated by gentle traction of the proximal ends when the ankle is put in an equinus position. The fibrotic ends of the chronically ruptured tendons were cut into a brush-like pattern to increase the corresponding surface areas and facilitate subsequent healing.

In the study by McClelland and Maffulli,[8] 25 patients had repair of acute Achilles tendon rupture using the modified percutaneous technique. Two (8%) patients reported paraesthesia in the sural nerve territory. We believe sural nerve entrapment can be avoided with the Achillon, because the suture can be retrieved from within the paratenon. The only possible way of injuring the nerve is by direct puncture during needle penetration through the limbs of the Achillon. This can be avoided by appreciating the anatomy of the sural nerve.[7] Nevertheless a small skin-stab incision can be made at the proximal-lateral site of the ruptured tendon in this high-risk area, so as to prevent this complication. In case of a short distal tendon end, the use of the Kakiuchi wire is suggested, because it helps narrow down the distance between the stitches, allowing a more secure suture knot to hold the tendon.[9]

We believe that our having no re-ruptures was also related to good compliance of our patients to the rehabilitation protocol. The initial use of a plaster cast for 3 weeks allowed a certain degree of tendon healing before switching to an ankle brace, for which compliance with instructions could be variable.

Although we achieved satisfactory clinical outcomes, our study design and patient numbers were not large enough to provide a statistically valid conclusion on the merits of the Achillon suture guide as the best system for repairing Achilles tendon. We believe a randomised controlled study for different methods of Achilles tendon repair can be conducted in the future. It would then be possible to develop criteria or guidelines for choosing various operative strategies for the management of ruptured Achilles tendon.

Conclusion

This study showed results comparable to the favourable findings reported in Assal et al's paper[6] describing the minimally invasive technique for repairing ruptured Achilles tendon. Success in the management of two patients with delayed rupture encourages us to use this device even in difficult cases. We conclude that the minimally invasive technique using an Achillon suture guide is a safe and reliable operative treatment for ruptured Achilles tendon.

Acknowledgement

We thank Mr Kelvin Kwok (Physiotherapist I, Caritas Medical Centre) for his help in assessment of the functional outcome of the patients.

References

1. Carden DG, Noble J, Chalmers J, Lunn P, Ellis J. Rupture of the calcaneal tendon. The early and late management. J Bone Joint Surg Br 1987;69:416-20.
2. Cetti R, Christensen SE, Ejsted R, Jensen NM, Jorgensen U. Operative versus nonoperative treatment of Achilles tendon rupture. A prospective randomized study and review of the literature. Am J Sports Med 1993;21:791-9.
3. Zwipp H, Südkamp N, Therman H, Samek N. Rupture of the Achilles tendon. Results of 10 years' follow up after surgical treatment. A retrospective study [in German]. Unfallchirurg 1989;92:554-9.
4. Ma GW, Griffith TG. Percutaneous repair of acute closed ruptured achilles tendon: a new technique. Clin Orthop Relat Res 1977;(128):247-55.
5. Bradley JP, Tibone JE. Percutaneous and open surgical repairs of Achilles tendon ruptures. A comparative study. Am J Sports Med 1990;18:188-95.
6. Assal M, Jung M, Stern R, Rippstein P, Delmi M, Hoffmeyer P. Limited open repair of Achilles tendon ruptures: a technique with a new instrument and findings of a prospective multicenter study. J Bone Joint Surg Am 2002;84-A:161-70.
7. Webb J, Moorjani N, Radford M. Anatomy of the sural nerve and its relation to the Achilles tendon. Foot Ankle Int 2000;21:475-7.
8. McClelland D, Maffulli N. Percutaneous repair of ruptured Achilles tendon. J R Coll Surg Edinb 2002;47:613-8.
9. Kakiuchi M. A combined open and percutaneous technique for repair of tendo Achillis. Comparison with open repair. J Bone Joint Surg Br 1995;77:60-3.