

# Mini-invasive surgical repair of the Achilles tendon—does it reduce post-operative morbidity?

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**Abstract** The surgical benefit of minimally invasive tendo Achilles repair ( $n=25$ ) with early weight-bearing mobilisation after rupture of the tendo Achilles was compared with operative treatment using an open technique ( $n=34$ ) with full weight-bearing after 8 weeks of surgical repair. The minimally invasive technique provided no evidence of wound problems and a functional benefit from early weight-bearing mobilisation. However, we noted that increased post-operative morbidity in terms of wound infection ( $n=7$ ) leading to delayed wound healing and wound pain requiring opiate-based analgesia post-operatively in the open repair group may have an additional impact on the patients and health care providers. This study showed that the mini-invasive open surgical repair of the Achilles tendon with the Achillon™ instrument and early weight-bearing mobilisation in an orthosis for the accelerated rehabilitation may offer cost-effectiveness and less financial burden on the health care provider in terms of associated nursing and physiotherapy costs.

**Résumé** Le bénéfice chirurgical de la réparation du tendon d'Achille par voie mini-invasive ( $n=25$ ), permettant un appui avec mobilisation précoce est comparé au traitement de la rupture par voie sanglante conventionnelle ( $n=34$ ) avec un appui différé à 8 semaines après la réparation chirurgicale. Il est important de noter l'augmentation de la morbidité avec infection profonde ( $n=7$ ), défaut de cicatrisation et douleur nécessitant, notamment des traitements analgésiques à base d'opiacés. Cependant cette technique par voie mini-invasive ne semble pas, à l'évidence, entraîner plus de problèmes

mais, au contraire est bénéfique du fait de la mobilisation et de l'appui précoces. Ce travail montre que la réparation par voie mini-invasive du tendon d'Achille avec la technique Achillon™ et un appui précoce en orthèse permettent une récupération rapide et surtout un rapport coût bénéfice intéressant.

## Introduction

Surgical repair with a limited open technique [1], percutaneous [5], had been reported with good to excellent outcome in comparison to open operative treatment, especially in a young adult group [2]. However, the operative intervention by an open repair method described in the literature is associated with delayed wound healing due to infection and delayed weight-bearing following surgery [2, 4]. Obviously this leads to health implications for the patients and a financial burden to the health care provider in terms of associated nursing and physiotherapy costs [1].

Immediate post-operative pain with an open operative procedure requiring analgesia has been underreported. The potential of another surgical method to minimise wound complications has been advocated but associated with other complications [1, 2, 5]. The surgical repair of a rupture of the tendo Achilles with the Achillon™ instrument and immediate weight-bearing has shown fewer complications and faster rehabilitation [1]. Thus, this procedure may impose less financial burden on the health care provider.

We therefore studied prospectively two groups of patients treated operatively for acute Achilles tendon rupture admitted to our institution in order to compare post-operative morbidity, usage of hospital resources and immobilisation regimen involving immediate weight-bearing with traditional non-weight-bearing.

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In the first group, patients who had been treated operatively by open methods and delayed immobilisation for 8 weeks were assessed. In the second group, those treated by a mini-invasive technique and immediate weight-bearing were studied.

The aim was to assess the benefit of the mini-invasive surgical method, which reduces hospitalisation cost, post-operative wound care cost and requirement of post-operative analgesics together with improved rehabilitation and return to normal activity for young patients (age below 45) with a rupture of the Achilles tendon.

## Material and methods

### Pre-operative assessment

The patients were admitted from the accident and emergency department of our institution, University Hospital Lewisham, over a 3-year period with Achilles tendon rupture satisfying our inclusion criteria (Tables 1 and 2). All patients had ruptured their tendon within the previous 7 days. A first group of 34 patients had repair of the tendon with an open method as an inpatient under instruction from the admitting consultant. A second group of 25 patients had repair as a limited open technique with an Achillon instrument and immediate weight-bearing.

The average age of the patients was 36.8 years (range: 25–48). All had closed rupture within 5–7 cm from the calcaneal tuberosity. All patients were non-professional athletes with keen sporting interest. At the time of injury they were participating in a pivot sporting activity such as badminton, tennis and basketball.

The diagnosis was made clinically. On physical examination all patients presented with a palpable gap in the tendon 38 mm (range: 31–48 mm), with positive Thompson test. The mean time interval between the injury and index operation was 3.6 days (12 h to 7 days). None had any radiological investigation. All the patients were treated with the same anterior pre-operative cast adjusted in the equinus position and analgesia. All the procedures were performed or assisted or supervised by the main authors. All patients

**Table 1** Inclusion criteria for surgical repair of the ruptured tendon

Criteria
1. Age 18–50 years
2. Closed traumatic rupture
3. Acute injury less than 1 week
4. Consented to surgical repair
5. No co-morbidity
6. Compliant with rehabilitation
7. Presented to our institution

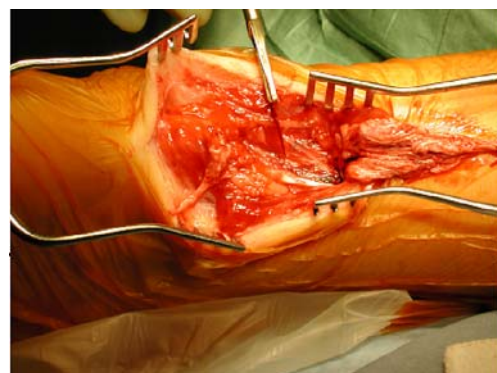
**Table 2** Exclusion criteria for surgical repair of the ruptured tendon

Criteria
1. Open traumatic wounds
2. Previous history of psychiatric illness
3. Social problem
4. Diabetes
5. Re-ruptures

were operated upon under general anaesthetic, in the prone position under tourniquet. All patients received one dose of cefuroxime 15 min before the procedure.

*Operative technique (open repair)* A total of 34 patients had a simple, open end-to-end operative repair performed under general anaesthesia. Through a medial longitudinal incision approximately 10 cm long, the Achilles tendon was repaired with delayed absorbable sutures and skin with nylon (Fig. 1). The average operating time was  $85.74 \pm 17.8$  min (range: 81–123 min). The limb was then placed in the temporary gravity equinus plaster overnight. All the patients were treated with nerve block with or without oral morphine as post-operative analgesia while an inpatient and co-dydramol and ibuprofen after discharge.

*Operative follow-up* The equinus position of the hindfoot was not changed for the first 2 weeks and mobilised non-weight-bearing. The position of the plaster cast or the number of heel raises in the orthosis was then reduced at 2-weekly intervals before being removed at 8 weeks. The orthosis is a device that provides direct contact with a portion of the lower part of the leg below the knee, rendering resistance to unwanted movement. The device is fitted to the patients for single use. It is designed to support the ankle joint and weak gastrosoleus muscles which had been repaired. This device is made up of plastic and leather fitting, without any mechanical hinges, but with fasteners to keep the orthosis well applied to the lower leg foot and ankle. This type of orthotic device is used to improve or



**Fig. 1** Open repair of the Achilles tendon

eliminate pain in the legs. Full weight-bearing was allowed after 8 weeks. The rehabilitation exercises were performed sequentially over the 3 months following the removal of the orthosis under the supervision of a physiotherapist. Five patients were lost to follow-up; the remaining 20 with complete data sets at 1 year were analysed.

#### Minimally invasive repair group

The patients were placed in a temporary below-knee anterior equinus splint in the equinus position in the accident and emergency department and asked to attend the orthopaedic outpatient department or on the morning of the consultant's operating day for surgery. All patients were operated upon under general anaesthetic, in the prone position (Fig. 2) with a tourniquet time of 32 min (range: 19–52 min). The average operating time was  $38.47 \pm 7.89$  min (range: 27–58 min). The 3-cm incision was medial to the palpable gap. The paratenon was identified after minimal localised soft tissue dissection. The torn tendon stump was identified. The Achillon instrument guide was introduced as described by Assal et al. [1]. Three sutures were placed in the peritendinous position in both stumps and then tightened under direct visual control, while placing the ankle in the equinus position. The tendon sheath and skin were carefully closed. Patients in this group were placed back into the below-knee gravity equinus cast for the immediate post-operative period until the orthosis was available and then mobilised with full weight-bearing and encouraged to move the ankle within the orthosis. They were prescribed paracetamol and ibuprofen as take home analgesia.

#### Achillon follow-up

At the first follow-up all wounds were assessed and sutures removed. Patients were then clinically reviewed every



**Fig. 2** Mini-invasive technique

2 weeks for 8 weeks. The equinus position of the plaster or the number of heel raises in the orthosis (Fig. 3) was reduced at each visit until a plantigrade position of the ankle was achieved. The orthosis or plaster cast was removed at 8 weeks. One patient was lost to follow-up; 24 patients had complete data sets at a minimum follow-up of 14 months. One patient with a history of human immunodeficiency virus (HIV) and delayed wound healing was excluded from analysis due to his absence at final follow-up.

#### Patient evaluation

Each patient was subsequently reviewed at 3 months, 6 months and 1 year. The primary outcome measure was the time taken to return to normal activities, as reported by the patient. Data relating to the return to normal sporting activity, walking, stair climbing and work activity were also recorded.

#### Results

With regard to immediate wound pain and analgesia use, there was a difference between the groups in the requirement of the type of post-operative analgesia used. Opiates or opiate-based analgesia were used in the open repair group, whereas in the minimally invasive group, patients reported no pain with paracetamol or ibuprofen. The



**Fig. 3** The orthosis with heel raises for the equinus position

number of days on which analgesia was required post-operatively was higher in the open technique group (mean: 7 days vs 2 days). All patients in the Achillon treatment group and six in the open group did not require prescribed analgesia before performing daily activities after 1 week.

Two cases of severe wound infection leading to dehiscence requiring further surgery (Fig. 4) and five cases of minor surgical site infection leading to delayed wound healing (Fig. 5) were reported as wound complications in the open group. All the patients in the mini-invasive group reported their satisfaction with wound healing and minimal scar at the incision site (Fig. 6).

Based on self-reports, the time taken to return to normal walking was a median of 11 weeks (8–20 weeks) in the Achillon treatment group and 17 weeks (12–24 weeks) in the open group. There was also an earlier return to normal stair climbing, with a median of 13 weeks (9–21 weeks) in the Achillon treatment group and 19 weeks (13–27 weeks) in the open technique group. The majority of the patients in minimally invasive groups had returned to their pre-injury state after 3 months and 6 months after the injury in the open group, an improvement, which was maintained at final follow-up. Although the mean age for each group was 36.8 in the open and 42 years in the minimally invasive group, we have observed earlier return to activities of daily living in the minimally invasive group.

There were similar ratios of right- to left-sided tendon ruptures in the two groups and more men in both groups.

We observed the maximum functional deficit of the gastrosoleus complex 1–2 weeks after either the orthosis or cast was removed. There was some difference in the range of ankle movement at the 6-month follow-up except patients with major wound complication where ankle stiffness persisted at the 1-year follow-up. Patients in the open group complained of some degree of stiffness of the ankle joint during the follow-up visit.

As regards the use of hospital resources, no patients in the Achillon treatment group in comparison to all in the



**Fig. 5** Delayed wound healing of surgical site in the open group

open group required admission to hospital before performing the operation. In this study, mean hospital stay was 3.3 days (2–5 days) from the time of index operation in the open group and all patients in the other group returned home on the same day.

## Discussion

This study has shown that mini-invasive repair with the Achillon instrument may allow us to perform surgery with less bed usage, less consumption of post-operative analgesics and other associated indirect costs to the health care provider. It also allows faster rehabilitation. It provides further evidence that minimally invasive repair with early weight-bearing rehabilitation has advantages over traditional open repair with delayed mobilisation for patients who have undergone surgery for a ruptured Achilles tendon. The practical advantages for patients in early weight-bearing mobilisation were earlier return to normal walking and stair climbing than their open group counterparts.

This study describes another problem with the surgically repaired tendon rupture, the post-operative pain and use of



**Fig. 4** Severe wound infection and dehiscence after open surgery



**Fig. 6** Mini-invasive group surgical scar



an opiate-based analgesic, which also delays rehabilitation. In our study, patients treated by the open repair method required opiates, which inevitably slowed rehabilitation. Consequently, it may have adversely affected the open repair group's results. On the other hand, we found non-opiate and less usage of analgesia in the post-operative period in the minimally invasive group.

The difference in complication rate after surgery was as important as the primary outcome measure. Wound complication and atrophy of the calf muscles after an injury to the tendo Achilles are reported to alter the outcome [2–9]. We observed two major wound complications and five cases of delayed wound healing in the open repair group, which had been reported earlier in the literature [4]. The first patient developed persistent wound infection, which was treated with oral antibiotics and silver dressings conservatively for 6 months until healing occurred. A second patient was treated by larval therapy and delayed mobilisation. He made a prolonged recovery. None of these patients had any co-morbidity, which could have influenced the wound healing mechanics. One patient with a history of HIV reported to have a wound healing problem in the limited invasive group in this small cohort of patients. However, we have only compared the wound healing in patients without any co-morbidity.

Traditionally patients are operated upon after admission to hospital and followed up in the outpatient clinic and supervised physiotherapy in our institution. This study shows that the mean hospital stay is 3.3 days in the open repair group after their operation and patients in the other group did not require admission. However, other factors may have influenced the patients' discharge decision, in particular, the support of a physiotherapist.

Less use of hospital resources in the minimally invasive repair group may initiate low cost to the health care provider, although there is an issue of initial cost related to the cost of the orthotic device, which is £170.15 each (Banfield J, Supply Manager, University Hospital Lewisham, personal communication). The total cost of offering this sort of surgery would be less if all were treated as a day case surgery rather than as trauma cases. In all our patients we have chosen single-use devices, but devices are available for multiple use. This may lower the cost as well in terms of surgical time, nursing time and cost related to the drugs used. We believe that an economic analysis will be necessary to address this issue.

We also compared the benefits of the traditional open technique and delayed weight-bearing with the limited open technique with early full loading in an orthosis. Early mobilisation of the ankle [6], early functional treatment [4] and early full weight-bearing after operative repair of the Achilles tendon had been advocated. We also advocated early mobilisation of the ankle together with early loading

in the minimally invasive group. None of our patients in this group reported any adverse consequences. We advised all patients, in both groups, that they should not drive in either a plaster cast or an orthosis. Consequently, many patients in sedentary jobs were forced to stay at home simply because of transport difficulties, although some of the patients did return to work within a week after minimally invasive repair with an orthosis. Patients perceived this early return to normal activities of daily living as the most important outcome measure. The ability to bear weight within the orthosis certainly encouraged some patients to return to activity. We advocated early loading of a healing tendo Achilles after minimally invasive repair to prevent detrimental alterations in muscle characteristics and the favourable influence on maturation of collagen fibres within the tendon as reported [7].

The clinical measurements at 6 months after the surgical repair suggested improved active range of movement of the ankle. Minimal scar tissue may have also influenced the range of motion. Although the range of movement is only a surrogate measurement of tendon lengthening, our results in the minimally invasive group did not indicate that early weight-bearing produced stretching within the healing tendon. We believe the ends of the tendon are held in contact by an operative repair and minimal soft tissue damage produces less post-operative pain, which is why the musculotendinous unit could really be loaded.

We have chosen an orthosis in the immediate post-operative period for its flexibility. However, in some patients we offered a full equinus plaster because the orthosis was not available. We speculate that the orthosis may have helped our patients to return earlier to a normal gait cycle. The practical advantages of being able to mobilise after minimally invasive surgery and same day discharge puts greater emphasis on the patient to be more compliant to follow a structured rehabilitation protocol. This is also an additional benefit to the health care providers.

Open surgery with delayed rehabilitation following rupture of the Achilles tendon may produce disuse atrophy very quickly, which is difficult to reverse [7]. We noted two patients reported to have 50% loss of muscle bulk as compared to the other side in the open repair group. We have assessed this clinically, although calf circumference is reported to be an insensitive tool for assessing this [3], whereas controlled early loading and movement, which is possible in the minimally invasive group, helps to preserve the calf muscle volume.

In summary, our first group provides further evidence of wound complication and wound pain requiring more opiate use that may alter improved functional outcome for patients after operative repair of their ruptured tendo Achilles. The two cases of major wound complication in the group

suggest that careful patient selection needed for open repair may influence one to choose the less effective non-operative treatment.

The second group provides evidence of an improved outcome from same day discharge and early full weight-bearing mobilisation for minimally invasive repairs of ruptures of the Achilles tendon. In addition, the practical advantages of early full weight-bearing did not predispose these patients to a higher complication rate. In particular, there was no evidence of tendon lengthening or a higher re-rupture rate.

## Conclusion

We found decreased operating time, better wound healing, reduced hospital stay and no post-operative morbidity in this cohort of patients. The minimally invasive open technique of repair of the tendo Achilles with the Achillon™ instrumentation offers an advantage of repairing the tendon under direct vision, preserving its vascularity. We would, therefore, advocate the use of the minimally invasive procedure with early weight-bearing mobilisation for the rehabilitation of all patients with acute ruptures of the Achilles tendon.

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