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Non-operative functional treatment for acute Achilles tendon ruptures: The Leicester Achilles Management Protocol (LAMP)

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ABSTRACT

Objectives: The purpose of this study is to present outcomes and objective measures of assessment for acute Achilles tendon (AT) ruptures treated with an eight-week functional dynamic treatment protocol in a VACOped® boot with immediate full weight bearing mobilisation, the Leicester Achilles Management Protocol (LAMP).

Methods: A prospective study of all patients treated with the LAMP with minimum 12-month follow-up was performed. Patients completed the Achilles Tendon Rupture Score (ATRS) and in the latter part of the study, objective measures of the calf muscle girth and heel raise height were obtained.

Results: 442 patients were treated with the LAMP. There were nine (2%) re-ruptures in the 442 non-operative treated group of patients throughout the study period. ATRS at twelve months or more were available in 234 patients and objective measures in 77 patients. The mean age was 50 years. The mean ATRS was 75.5 at an average of 23 months post injury. Men had a statistically significant higher ATRS score when compared to women ($p < 0.05$). There was statistically significant difference in the calf muscle girth and the heel raise height when compared to the uninjured side at 12-months post-injury ($p < 0.05$). These differences did not correlate with the ATRS ($p > 0.05$).

Conclusions: The LAMP is a simple yet effective regime for the non-operative treatment of acute AT ruptures, which can be universally adopted without the need for many resources. Compared to other studies, the overall time in the boot is less with low complication rates and similar patient reported outcomes.

Introduction

The Achilles tendon (AT) is the most frequently ruptured tendon in the body [1]. The incidence of acute AT ruptures is rising [2–4]. Most studies attribute the increased incidence with a greater population participation in sporting activities.

There has been much debate on the management of acute AT ruptures. Operative repair was historically felt to have been superior to non-operative treatment because of its published lower re-rupture rates [5]. However, the associated complications of operative repair, with a reported rate of up to 34%, remained the 'Achilles heel' of surgery [5]. These original studies did not assess patient function and preferred to focus on re-rupture rates and complications as their primary outcome measures.

Over the past decade functional dynamic regimes have come to the fore as a competitive method of treating acute AT ruptures when compared to surgery [6]. These dynamic regimes have shown similar re-rupture rates, and function, to surgery but without the added complications of operative treatment [7,8]. Dynamic regimes allow movement at the ankle joint, and this with conjunction with full-weight bearing, has been shown to aid in the healing and remodelling of the AT following rupture [9–11]. This theoretically allows for the formation of a healed tendon with well-orientated collagen fibres in the direction of stress. Yet despite the growing evidence supporting dynamic functional regimes, operative repair remains the default method of treatment in many institutions, whilst others use arbitrary criteria to dictate treatment [12–14].

One reason for this may be the lack of consensus on the duration and method of non-operative treatment using functional treatment regimes. The SMART regime, published in 2015, involves functional treatment for up to 16 weeks [13]. Metz et al apply an equinus cast for a week followed by six weeks of treatment in a VACOped® boot [15]. Ecker et al reported on their functional treatment regime with the use of an equinus cast and a special boot for six weeks [12]. The latter two studies are not supported with patient reported outcome measures.

Imaging of a ruptured AT also causes debate. Some feel that ultrasound assessment is imperative to confirm the diagnosis,

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identify the location/pattern of the rupture and demonstrate gap size between tendon ends [13,16–18]. Others feel that ultrasound assessment is useful only in cases where clinical assessment is equivocal [7,12]. Some units decide between operative and non-operative treatments based on ultrasound and recommend operative treatment if the gap does not reduce to less than 10 mm, or sometimes even 5 mm, on dynamic ultrasound assessment [13,19].

Physiotherapy-led clinics are becoming widely utilized in healthcare as they provide a high level of specialist input which has proven to be cost effective [20]. Extended scope physiotherapist (ESP) practice has shown a high level of correlation with orthopaedic surgeons for clinical decisions [21]. ESP's play an important role in patient education and rehabilitation.

The purpose of this paper is to establish a standardised functional dynamic treatment regime for the non-operative management of acute Achilles tendon ruptures by sharing our experience using the Leicester Achilles Management Protocol (LAMP).

Methods

This is a prospective study of all patients with acute AT ruptures treated non-operatively using the LAMP. From February 2011 to January 2014, all patients with acute AT ruptures were reviewed in a specialist AT rupture clinic led by the senior author (MB). In January 2014, a dedicated multidisciplinary AT rupture clinic was started including two health care assistants, one senior musculoskeletal physiotherapists (AJ) and one consultant Orthopaedic foot and ankle surgeon (MB).

The diagnosis of an acute AT rupture was confirmed on clinical assessment. Further imaging was performed only in cases where the clinical assessment was equivocal. All patients irrespective of whether or not the tendon edges apposed on clinical assessment were offered non-operative treatment with a standardised eight-week functional dynamic treatment regime, LAMP, using a VACOped® boot (OPED, Valley, Germany) with immediate weight bearing mobilisation (Table 1). Exclusion criteria include age <18; delay in presentation (>2 weeks); open injury; concurrent lower limb injury or patient's preference being for surgery.

Prior to January 2014, patients were discharged to the care of a physiotherapist following completion of the eight-week LAMP and were only reviewed if clinically required. Following the initiation of our dedicated multidisciplinary AT rupture clinic in January 2014, immediately following completion of the LAMP, an Achilles tendon strengthening programme was commenced as demonstrated in Table 2. Formal physiotherapy treatment was then arranged at 2 weeks post completion of the LAMP.

The ATRS in patients treated between February 2011 and January 2014 were obtained via a postal questionnaire following local Hospital Research and Ethics department approval. From January 2014, all patients were clinically reviewed at completion of the LAMP, six months and twelve months post injury. They were requested to complete the ATRS and underwent objective assessment of the calf muscle girth and heel raise height by a single assessor (AJ) and compared to the uninjured contralateral side. Calf muscle girth was measured at a fixed-point 10 cm below the popliteal crease. Heel raise height was measured by asking the patient to stand on their tiptoes and the distance from the ground to the heel was recorded. These objective assessments were only undertaken during the latter part of the study due to evolution of the dedicated multidisciplinary AT rupture clinic and are now standard practice. Complications, including re-rupture rates and symptomatic venous thromboembolic events (VTE) were recorded.

Statistical analysis was performed using SPSS version 21. Pearson's correlation was used to correlate the ATRS score with age. The ATRS score between men and women was compared using the Mann-Whitney *U* test. The objective measures (affected limb versus unaffected limb) were assessed using the Wilcoxon signed rank test and were correlated with ATRS using Spearman's rho analysis. The ATRS in patients assessed by the dedicated multidisciplinary Achilles rupture clinic was compared to those assessed prior to its implementation by the Mann Whitney *U* test.

Table 1
The Leicester Achilles Management Protocol (LAMP).

Time from diagnosis	VACOped® position
0–4 weeks	Locked in 30° plantarflexion
4–6 weeks	Dynamised 15–30° plantarflexion
6–8 weeks	Dynamised 0–30° plantarflexion
At 8 weeks	Boot removed

Results

During the study period, 457 patients were treated for an acute AT rupture. Further imaging in the form of an USS or MR imaging was performed in 47 (10%) patients due to uncertainty in diagnosis. 15 patients were treated operatively either due to a delayed presentation of >2 weeks or due to surgical preference following informed consent. These cases were therefore excluded giving a total of 442 patients treated non-operatively with the LAMP functional dynamic treatment regime (Fig. 1). 208 patients were lost to follow-up after not responding to correspondence and phone calls. These cases were all in the retrospective cohort.

There were 26 (5.9%) episodes of a symptomatic venous thromboembolic event. Twenty-five patients had a deep venous thrombosis (DVT) with one patient having both a deep venous thrombosis and a non-fatal pulmonary embolus (PE). Of these, seven cases were identified to have had a DVT on initial presentation to the Achilles clinic before commencement of the LAMP.

There were nine (2%) re-ruptures in the 442 non-operative treated group of patients throughout the study period. All of these occurred within three months of completion of treatment and of these, at least two were due to failure to comply with rehabilitation advice.

The ATRS at twelve months or more was available in 234 (53%) patients. These patients were therefore used for the remainder of the analysis. Of the 234 patients there were 189 (80.8%) males and 45 (19.2%) females. The mean age was 50 years (range; 21–82). The mean ATRS score was 75.5 (SD 21.3; 95% CI 72.8–78.2) at a mean follow up of 23 months' post injury. Pearson's assessment demonstrated a statistically significant but weak negative correlation between age and ATRS score (correlation coefficient −0.144; $p = 0.028$). Men had a statistically significant higher ATRS score (mean 78.2; SD 20) when compared to women (mean 64; SD 23.3, Mann-Whitney *U* Test $p < 0.005$).

One hundred and one patients were reviewed at 12 months or more following injury in the dedicated multidisciplinary Achilles rupture clinic. Objective measures were available in 77 (76%) of these patients, consisting of 66 (85.7%) male and 11 (14.3%) female patients. The mean age was 51 years and the mean ATRS score was 79.3 (SD 17). There was no significant difference in the mean ATRS in this group when comparing men to women (80.6 vs. 71.3 respectively; $p = 0.091$).

There was a statistically significant difference in the calf muscle girth (38.3 cm affected Vs. 39.2 cm unaffected, $p < 0.01$), and the heel raise height (8.5 cm affected Vs. 11.01 cm unaffected, $p < 0.01$) when comparing the affected with the unaffected side.

Spearman's rho analysis revealed very weak negative but statistically insignificant correlation between the ATRS score and

Table 2
Achilles tendon strengthening programme.

Exercise	Repetitions/Duration	Frequency
Isometric exercises	10 repetitions	Three times a day
Dorsiflexion/Plantarflexion ROM	10 repetitions	At least once a day
Seated Heel raises	10 repetitions	Three times a day
Walk outdoors in comfortable footwear	10 min	At least twice a day

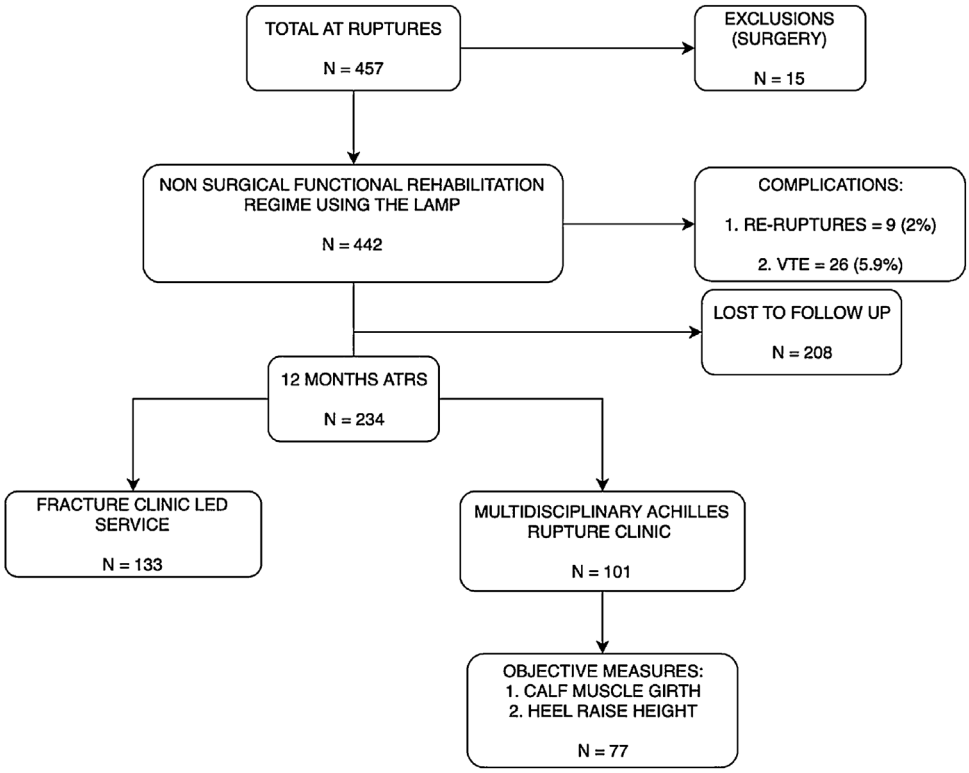

Fig. 1. Flowchart of patients treated with acute AT ruptures.

the calf muscle girth (correlation coefficient −0.093; p = 0.43) and heel raise height (correlation coefficient −0.174; p = 0.13). There was no significant difference between men and women when comparing the difference in calf muscle girth (0.97 cm vs. 0.45 cm respectively; p = 0.11) or heel raise height difference (2.5 cm vs. 2.36 cm respectively; p = 0.74).

One hundred and thirty three patients were seen in the fracture clinic led by the senior author with 101 in the dedicated multidisciplinary Achilles rupture clinic. There was a statistically significant difference in the 12-month ATRS score, (mean 72.5 vs. 79.5; p = 012) in favour of the dedicated multidisciplinary AT rupture clinic.

Discussion

This is the largest prospective series demonstrating patient reported outcomes and objective assessment at least 12 months post injury in patients following acute AT ruptures treated using the same standardised non-operative functional dynamic protocol regardless of age, apposition of tendon ends on clinical assessment or functional status. 442 acute AT ruptures were managed with the same non-operative dynamic functional regimes using an orthosis allowing immediate full weight bearing mobilisation. The overall results demonstrate a low re-rupture rate (2%) with good functional results. These functional results improved when patients were managed in a physiotherapist delivered outpatient clinic.

Surgeons are motivated towards restoring anatomy to as near normal as possible with a view that this leads to optimal function. Whether the restoration of normal anatomy translates into improved clinical outcomes can be debated and has been at the forefront of recent randomised controlled trials in trauma, including the PROFHER, UK Heel fracture and Ankle Injury Management (AIM) trials [22–24]. Many of these studies failed to show improved outcomes with surgery. Acute Achilles tendon ruptures demonstrate another condition where the search for anatomical restoration through surgery may not be the ideal treatment for the majority of patients.

The mean ATRS in this study group was 75.5 at a mean of 23 months post injury for 234 patients. The SMART study demonstrated an ATRS score of 72.4 at nine months post injury with a study population of only 43 patients [13]. This study has been widely quoted to advocate the use of non-operative management of AT ruptures and we have supported this with a larger cohort that has been followed up for a longer period of time. Other studies do demonstrate a higher ATRS (82–87), however, the duration of follow up is short, the method of treatment with functional rehabilitation is not consistent or the sample size is selective and small [11,25]. For percutaneous surgical repair, ATRS results are between 84–89 [26,27]. With an unknown minimally clinical

important difference, it is still unclear whether percutaneous surgery offers a functionally significant improvement over dynamic functional regimes. The question can only be answered following a randomised controlled trial involving a homogenous group of selected patients. Metz et al conducted such a trial but failed to incorporate functional outcome as their primary end-point and so the question remains [15].

In our study, objective assessment demonstrated a statistically significant difference in the calf muscle girth and heel raise height when compared with the uninjured extremity. Although statistically significant, the difference was small and did not correlate with the ATRS. It is therefore likely that this difference is not clinically relevant as has been demonstrated in previously published studies [25,28].

We feel that the difference in re-rupture rate between surgical and modern non-operative regimes is now negligible. This has been shown in three randomised controlled trials comparing open surgery to dynamic functional regimes [8,15,29,30]. Our complications included a re-rupture rate of 2% in all 442 patients treated with this functional dynamic regime. Similar functional regimes demonstrate re-rupture rates between 2.9–12% [8,15,31,32]. This re-rupture rate is amongst the lowest of all large studies looking at AT ruptures.

Symptomatic VTE rate was 5.9% in all 442 patients in our study. This is comparable to previous published work [7,15,33–35]. In our study seven patients with a symptomatic VTE were diagnosed prior to the initiation of treatment but following AT rupture. Not all VTE events following AT ruptures are as a result of the treatment employed. Chemical thrombo-prophylaxis is not routinely prescribed too all patients with acute AT ruptures treated with the LAMP. Patients who are felt to be at high risk of developing VTEs such as those with risk factors including thrombophilia, hormonal treatment, history of malignancy, high BMI, past history or family history of DVT or PEs were given six weeks of subcutaneous low-molecular weight heparin injections.

The numbers of complication events were too small to enable any meaningful statistical sub-group analysis. Overall complication rates in open AT rupture repair have recently been quoted at being up to 40% [36], calling into the question as to whether open surgery is ever warranted in modern practice. Minimally invasive surgery lowers the surgical risk to wound problems but still has risks of nerve injury, deep infection and risks associated with anaesthesia [37].

The use of imaging to confirm acute AT rupture is contentious. Some institutions image all patients. Others, only if the tendon edges are not clinically apposed. These findings are then used to dictate the management plan. The presence of a gap of more than 5 or 10 mm has been used to support operative treatment. These figures are theoretical and arbitrary. From our experience the AT rarely ruptures with a clearly defined edge and rather forms “a horse’s tail” appearance. In the LAMP, imaging assessment is only used in cases where the diagnosis is in question. Dynamic assessment of the tendon gap using ultrasound is not performed, even in cases where clinically the tendon edges fail to appose. We have not separately recorded these patients and therefore are unable to correlate the presence of a gap on clinical assessment with the ATRS. However, Lawrence et al, despite identifying a significant difference in the peak plantar flexion strength in patients with a gap of more than 10 mm failed to correlate this with a significant difference in the ATRS [25]. Westin et al reported a higher re-rupture rate in non-surgically treated patients when the gap on ultrasound scan was more than 10 mm. This was however, based on a cohort of only 45 patients [38].

There were four times more male patients in our cohort and this demographic finding has also been shown in previous publications [39]. Despite this lower incidence in females, the patient reported outcomes appear significantly inferior as compared to males. The trend of lower incidence and poorer outcomes has also been demonstrated in other studies following AT ruptures [40,41]. No explanations have been provided in published literature. One theory is that the vascularity of the tendon post-menopause may compromise healing and hence be responsible for the poorer outcomes in female patients. We did not make a record of menopausal status. However, the statistical difference existed when comparing men and women <51 years of age and also no statistical difference existed when comparing women <51 years of age to those >51 years. More research needs to be directed to functional outcomes of AT injuries in female patients to optimise outcomes in this group.

The first group of patients treated prior to January 2014 were not given rehabilitation advice on completion of the LAMP. They were also not as closely followed up as compared to the dedicated multidisciplinary Achilles Rupture Clinic. The ATRS are significantly different favoring the latter group. A dedicated multidisciplinary Achilles Rupture Clinic enable patients to be followed up more closely with specific rehabilitation advice, given by a Specialist Physiotherapist, which has demonstrated better functional outcomes. It also reduces the burden of an overstretched fracture clinic service. All patients with an acute AT rupture in our department are now managed in this dedicated multidisciplinary Achilles Rupture Clinic.

The limitations of this study are acknowledged. Although this large cohort of patients has been prospectively reviewed and followed up with complications recorded, 12-month objective measures were available in 77 patients and 12-month PROMs (ATRS) for 234 patients. Data collection in the setting of a busy fracture clinic is challenging and furthermore the majority of these injuries occur in a mobile working population making postal questionnaires difficult. We accept the loss to follow-up rate of almost 50% is a criticism of such a paper but we feel this is comparable to other large series [13]. Following the implementation of the dedicated multidisciplinary Achilles rupture clinic data collection has improved. Despite this such loss to follow-up will create a sample bias. From our experience it tends to be the less satisfied patients who reply to such postal questionnaire and as a result functional outcomes are lower. This may also go someway to explain why the physiotherapy-led service obtains superior results. Although the LAMP was implemented in February 2011, the service has evolved. Full data including ATRS as well as objective measures including calf muscle girth, heel raise height and heel raise repetitions are now collected on all patients presenting for follow up at six and 12 months.

We also acknowledge that as two patient cohorts have been included, the strength of the study may be questioned. The first group was sent out a postal questionnaire whilst the second group was assessed in clinic at routine time intervals. However, although at different time points, the data has been collected prospectively and all patients have been treated with the same functional treatment regime.

Conclusion

The LAMP is a simple yet effective regime for the management of acute AT ruptures, which can be universally adopted without the need for many resources. Routine ultrasound assessment is not necessary unless the diagnosis is in doubt. The regime is very easy to adopt and involves the use of a VACOped® boot for eight weeks. Compared to other studies, the overall time in the boot is less with a low complication rate and similar patient reported outcomes. Overall we find this is a cost effective, reliable and predictable method of treating acute Achilles tendon ruptures.

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Ethical approval

N/A.

Conflict of interest

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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