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Semitendinosus Tendon Autograft for Reconstruction of Large Defects in Chronic Achilles Tendon Ruptures

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Abstract

Background: Chronic Achilles tendon ruptures are associated with considerable functional morbidity. When treated operatively, debridement of degenerated tendon ends may create large defects. Various procedures to reconstruct large defects have been described. We present a simple technique in which an autologous semitendinosus tendon graft is used to reconstruct defects larger than 5 cm in chronic Achilles tendon ruptures. The purpose of this study was to describe our operative technique and its functional outcome.

Methods: Achilles ruptures of more than 6 weeks duration were considered for the study. We treated 35 patients (20 males, 15 females) with symptomatic chronic Achilles tendon ruptures. The mean age was 47.4 years (range, 30 to 59). The smallest defect that we had reconstructed was 5 cm, and the largest was 9 cm in length. The average follow-up duration was 30.7 months (range, 20 to 42). Postoperatively, the strength of gastrocsoleus was measured by manual muscle testing (MMT) in non-weight-bearing and weight-bearing positions.

Results: All operated patients showed satisfactory functional outcome, good soft tissue healing, and no reruptures. The preoperative weight-bearing MMT of 2/5 improved to 4/5 or 5/5 postoperatively. In all patients, postoperative non-weight-bearing MMT was 5/5. All patients returned to their prerupture daily activity.

Conclusion: We present a technique that is simple, with low morbidity. We believe it is a valuable option especially when allografts are not available. It is inexpensive as suture anchors or tenodesis screws are not used. This can be a useful option if other tendons (flexor hallucis longus, peroneus brevis, etc) are not available for transfer.

Level of Evidence: Level IV, retrospective case series.

Keywords: Achilles tendon reconstruction, chronic Achilles rupture, semitendinosus tendon

Achilles tendon ruptures diagnosed or treated after 4 to 6 weeks are termed chronic ruptures.[15] Chronic ruptures of the Achilles tendon are debilitating injuries and normally present as a result of a misdiagnosed, neglected, or unrecognized acute rupture. Up to a fifth of acute ruptures can be missed[15] or not diagnosed until the patient presents after 4 to 6 weeks with a chronic rupture.[6-8,12,13,20] Achilles tendon ruptures are especially common in middle-aged men who occasionally participate in sports.[3,4,10,18]

Surgery is usually offered to active individuals with chronic ruptures who present with weakness on plantarflexion, inability to ascend stairs or stand on tiptoe, and/or a limp. Patients with sedentary life styles can compensate for ankle weakness with calf-strengthening exercises; hence, patients who are elderly or have medical comorbidities can be treated conservatively.

The need for augmentation of Achilles tendon ruptures was first introduced by Christensen in 1953.[5] Since then, many procedures have been described in the literature with different local autologous materials, such as the gastrocnemius-soleus V-Y plasty[1] or the turn-down of proximal Achilles tendon tissue described by Bosworth.[2] During operative reconstruction, 2 issues need to be noted: (1) the weak bridging fibrous tissue requires excision and (2) degenerated and calcified tendon ends require debridement. This may result in large defects. In such cases, end-to-end repair of the torn Achilles tendon is not possible and V-Y

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advancement may not be sufficient. The defects can be reconstructed using allografts, fascial augmentation, flexor hallucis longus (FHL),[9] flexor digitorum longus (FDL),[17] or peroneus brevis (PB)[19] tendon transfer.

We have used autologous semitendinosus tendon to reconstruct gaps of more than 5 cm with the ankle in neutral position. To our knowledge, the use of an autologous semitendinosus tendon has been reported in 2 studies.[14,16]

In the technique described by Maffulli et al,[16] a semitendinosus tendon graft is passed distally through the stump of the ruptured Achilles. However, in few ruptures, little or no distal Achilles stump is retained to pass the graft through. In our technique, we pass the graft distally through a tunnel in the calcaneus; hence, this technique can be used in cases with little or no distal Achilles stump.

Ji et al[14] reported 2 cases where V-Y plasty of the gastrocsoleus and mobilization of tendon ends was performed. The Achilles tendon was repaired end-to-end and was then augmented using a semitendinosus tendon graft. In our technique, we did not perform V-Y plasty of the gastrocsoleus or mobilize the tendon ends; hence, the biology of the Achilles tendon was preserved. The purpose of this study was to describe our operative technique and its functional outcome.

Methods

In the present series, we defined 6 weeks after injury as a chronic rupture. Thirty-five patients (20 males, 15 females; mean age 47.4 years; range, 30 to 59) underwent Achilles tendon repair at our institution from January 2010 to January 2012, and follow-up was until September 2013. The average follow-up duration was 30.7 months (range, 20 to 42). Diabetics, smokers, and patients over 60 years of age with chronic Achilles ruptures were not offered this operative technique.

None of the patients had previously undergone repair of a ruptured Achilles tendon. The diagnosis was made clinically in all cases. Diagnosis of rupture was made clinically by palpating the gap in the tendon and noting the weakness in plantarflexion. In 4 cases, ultrasonography was done to support the diagnosis. The average time from rupture to surgery was 7.1 weeks (range, 6 to 10). All patients in this study were farmers or heavy-duty workers. Their professions required a high level of physical activity. Their main complaints were weakness in plantarflexion and unsteady gait. Pain during walking was not the main complaint.

The decision to use autologous semitendinosus tendon for reconstruction was made intraoperatively, when the defect between Achilles ends was found to be 5 cm or more. The defect was measured after thorough debridement of degenerated, retracted tendon ends, and excision of intervening fibrous tissue. The defect was measured in neutral ankle position. In our series, the largest defect was 9 cm and the smallest was 5 cm.

Table 1. Manual Muscle Testing (MMT)—Non-weight-bearing.

Normal	5/5	Ability to plantarflex completely and/or hold in plantarflexion against gravity and maximum pressure
Good	4/5	Ability to plantarflex completely and/or hold in plantarflexion against gravity and slightly less than maximum pressure
Fair	3/5	Ability to plantarflex completely and/or hold in plantarflexion against gravity but can not hold if even slight pressure is applied
Poor	2/5	Ability to plantarflex completely eliminating gravity No movement against gravity
Trace	1/5	Feeble but palpable muscle contraction or prominent tendon during plantar flexion with no visible motion of the foot
Zero	0/5	No palpable muscle contraction

Preoperative Evaluation

Clinical examination was performed and a detailed history was taken. Ten of the 35 patients had a history of local corticosteroid injection more than 1 year before the diagnosis of the rupture. Any smoking history was particularly noted, and smokers were not offered the surgery. Nicotine levels were not determined. Strength of the gastrocsoleus was tested by MMT[11] in non-weight-bearing and weight-bearing positions (Tables 1 and 2). For non-weight-bearing MMT, the patient was asked to lie down in prone position and knee was flexed at 90 degrees. The examiner gave resistance to active plantarflexion and grading of strength was done. In 15 patients it was 2/5, while in 20 patients it was 3/5. For weight-bearing MMT, the patient was asked to stand on the affected limb with the help of external support. The patient was asked to do 20 consecutive heel raises. Preoperative weight-bearing MMT was 2/5 in all cases. None of the patients could do heel raises preoperatively.

Routine blood investigations were carried out. Patients with elevated blood sugar and HbA1c levels were considered diabetics and were not offered operative reconstruction. All patients underwent anteroposterior and lateral radiographs of the ankle. Many of the radiographs showed calcification of degenerated tendon. Ultrasonography of the Achilles tendon was performed in 4 patients. Because of the cost involved, magnetic resonance imaging was not performed in any case. Vascularity of the lower limb was assessed by palpating the distal pulses, and Doppler examination was not performed in any case.

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Table 2. Manual Muscle Testing - Weight-bearing.

In standing position: Patient successfully raises heel from floor through range of motion of plantarflexion.		
Normal	5/5	Patient should complete minimum 20 heel raises without apparent fatigue
Good	4/5	Patient can complete full range of motion between 10 to 19 times and then has difficulty in completing the movement
Fair	3/5	1-9 times
In prone position with feet off end of the table:		
Poor	2/5	Patient completes plantarflexion range but tolerates no resistance
Trace	1/5	Feeble but palpable muscle contraction or prominent tendon during plantarflexion with no visible motion of the foot
Zero	0/5	No palpable muscle contraction

Operative Technique

Spinal anesthesia was administered and the patient was positioned prone. Cefuroxime (1.5 g) was administered intravenously 30 minutes before elevating the tourniquet. A thigh tourniquet was applied. A vertical midline incision, starting approximately 8 cm proximal to the insertion of the Achilles tendon, was made and extended distally until the insertion or just below it. The length of the incision was 8 to 10 cm, depending on the exposure required for retracted tendon ends. The frayed tendon ends were debrided, and the calcified and hard tendon was removed, thus creating the final defect (Figure 1).

After thorough tendon debridement, excessive mobilization of tendon ends by soft tissue dissection was avoided. Traction on the proximal stump was performed manually by holding Ethibond No. 2 (Johnson and Johnson Ltd, Mumbai, India) sutures that were passed through the proximal stump of the tendon. Traction was maintained for 5 minutes. If end-to-end contact of the debrided ends was possible with 10 to 20 degrees of plantarflexion at the ankle joint, direct repair was undertaken. In these cases, a semitendinosus tendon was not used and these patients were not included in our study.

If end-to-end opposition was not possible, the ankle was kept in the neutral position and the defect was measured. Cases in which the defect was 5 cm or more were selected for reconstruction with an autologous semitendinosus tendon graft.

With the knee flexed in prone position, the semitendinosus tendon was harvested through a 3-cm incision medial to the tibial tuberosity (Figure 2). The length of the graft obtained was in the range of 22 to 30 cm. The

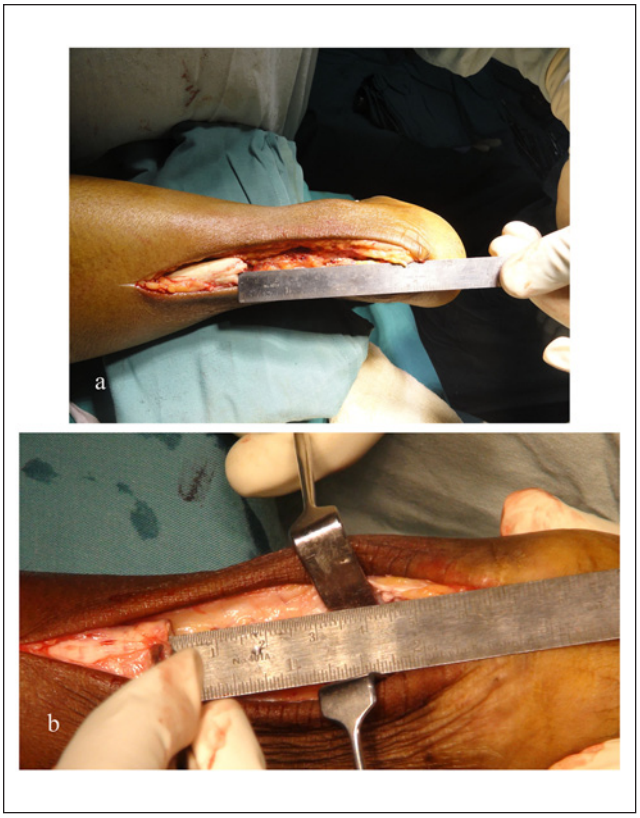

Figure 1. Debridement of intervening fibrous tissue and degenerated tendon ends creates a defect between the 2 tendon ends. The defect is measured in neutral ankleflexion. The largest defect was 9 cm (a) and the smallest was 5 cm (b).

semitendinosus tendon was prepared by shaving off the muscular part from the tendon. Whip sutures were placed on a length of approximately 3 cm of the tendon on either side (Figures 3a and 3b). In 8 cases out of 35, Haglund's deformity was found and was excised using an osteotome. A guide wire was passed from the medial to lateral side in the calcaneus, 1.5 cm below the point of insertion of the Achilles tendon (Figure 4a).

A 4.5-mm cannulated drill bit was then used over the guide wire to create a tunnel (Figure 4b). The prepared graft was then passed through this tunnel and retrieved inside the skin on the medial and lateral sides (Figure 5). In all cases, the graft was passed distally through the tunnel in the calcaneus and proximally through the Achilles stump (Figure 6a). It was then sutured to itself after being passed around its vertical axis (Figures 6b and 7). The manner used was decided on the basis of the thickness of the semitendinosus tendon and the length of the defect.

Proximally, in all cases, the graft was sutured to the Achilles stump side-to-side with Vicryl No. 2-0 sutures

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Figure 2. In the prone position, the knee is flexed and a 3-cm incision medial to the tibial tuberosity was made to harvest the semitendinosus graft.

Figure 3. A semitendinosus tendon was prepared by shaving off the muscular part from the tendon. Whip sutures were made with a straight needle using Ethibond No. 2, placed on approximately 3 cm of the length of the tendon on either side.

(Figure 6b). Distally when tissue stump was available, the graft was sutured side to side using Vicryl No. 2-0 sutures. When no stump was available, the graft was sutured to itself. A suture anchor or interference screw was not used in any case. While suturing the graft, care was taken to keep the ankle in the neutral position. This was done with the patient in the prone position, by flexing the knee and adjusting the tension of the graft. The incision was closed in layers without a drain. A below knee plaster splint was applied in gravity assisted equinus position (about 20 degrees of plantar flexion). The patient was maintained in a non-weight-bearing position in the splint for 4 weeks. It was then removed and partial weight-bearing with a walker was started. No brace was used, and full weight-bearing was started after 2 and half months.

The patients attended the Outpatient Clinic for physiotherapy. The rehabilitation program included calf stretching and strengthening, hamstring stretching and strengthening, and foot intrinsic muscle strengthening exercises.

Results

All incisions healed well without any wound complications. After healing, Achilles function was satisfactory (Figures 8a to 8c), and the patients resumed prerupture daily activity. Rerupture was not encountered in our series.

One year after surgery, non-weight-bearing MMT postoperatively was 5/5 in all cases. Preoperative weight-bearing MMT was 2/5 in all cases, which improved postoperatively to 4/5 in 15 patients and 5/5 in 20 patients.

All patients in this study were farmers or heavy-duty workers. They were able to work in the fields and on uneven surfaces. Most of them did not wear shoes. Their participation in social and cultural activities was unaffected.

Discussion

Relatively large defects in chronic Achilles ruptures can be reconstructed using an autologous semitendinosus tendon. In our series, we reconstructed defects ranging from 5 to 9 cm. Hence, degenerated Achilles tendon can be debrided thoroughly without concern regarding the length of the defect that may be created. To close the defect,

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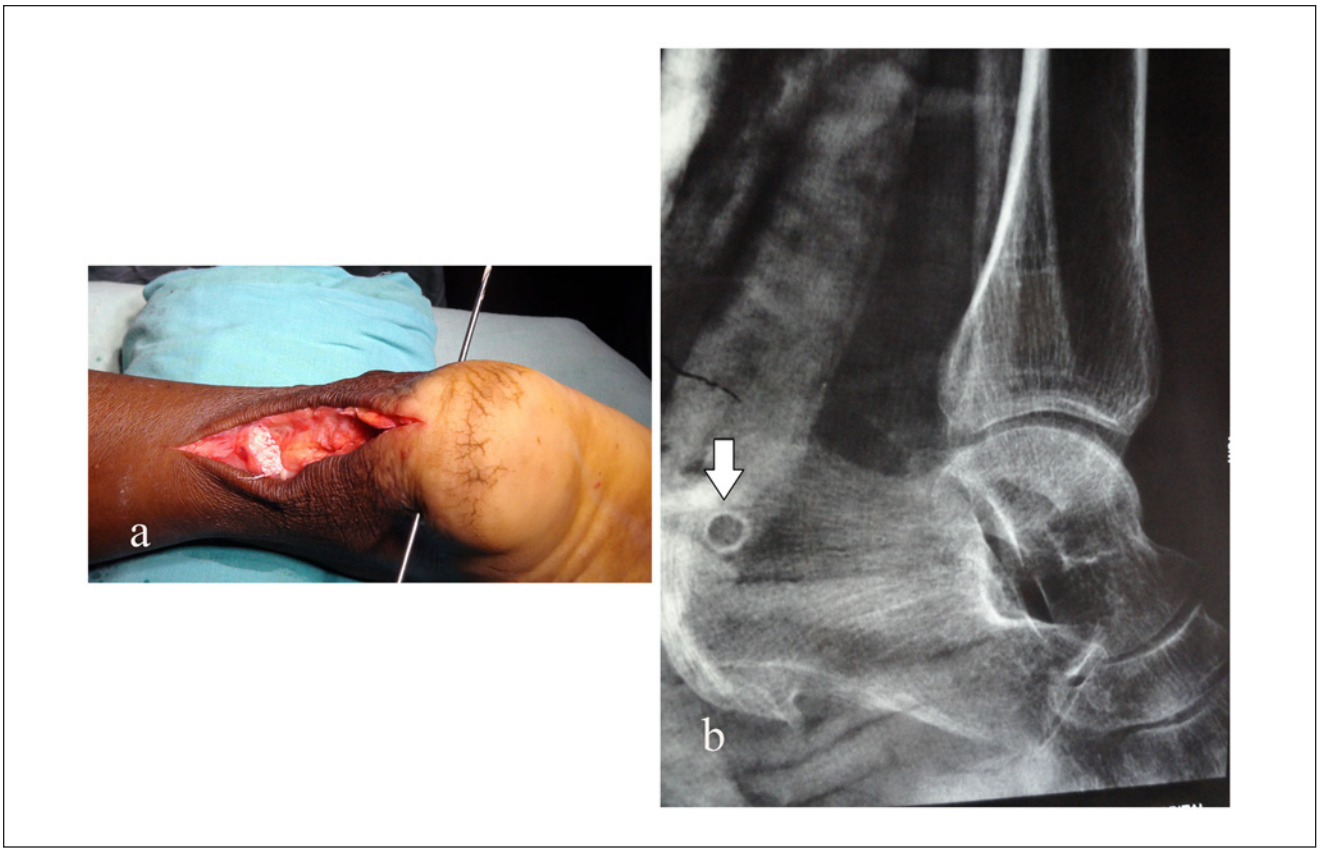

Figure 4. (a) A guide wire was passed from the medial to lateral side in the calcaneus, 1.5 cm below the point of insertion of the Achilles tendon. (b) A lateral radiograph showing a tunnel in the calcaneus (arrow) made by a 4.5-mm cannulated drill for passage of the prepared graft.

Figure 5. The prepared graft was passed through the tunnel in the calcaneus and retrieved inside the skin on the medial and lateral sides.

Achilles tendon ends do not need to be mobilized by extensive soft tissue dissection. This preserves the biology and decreases postoperative soft tissue complications. Forceful plantarflexion at the ankle was avoided to close the defect.

Two previous studies in the literature describe the use of a semitendinosus tendon for reconstruction of chronic Achilles ruptures.[14,16] Ji et al have reported 2 cases in which V-Y plasty of triceps surae was performed to achieve the required length.[14] Then, end-to-end suturing was performed. A semitendinosus tendon graft was used only for augmentation. In our technique, we did not perform V-Y plasty or mobilize the tendon ends extensively. We believe this helps to keep the biology intact. In a second study by Maffulli et al, a semitendinosus tendon was used in a minimally invasive approach[16] and the graft was passed through the ruptured Achilles stump both proximally and distally.

In our technique, we pass the graft distally through a tunnel in the calcaneus and proximally through the debrided healthy stump. This allows using the technique when the distal stump is very short.

A limitation of our study is that we have not objectively measured the strength of the gastrocsoleus by mechanical means like a Cybex machine. We have measured the strength by manual muscle testing.

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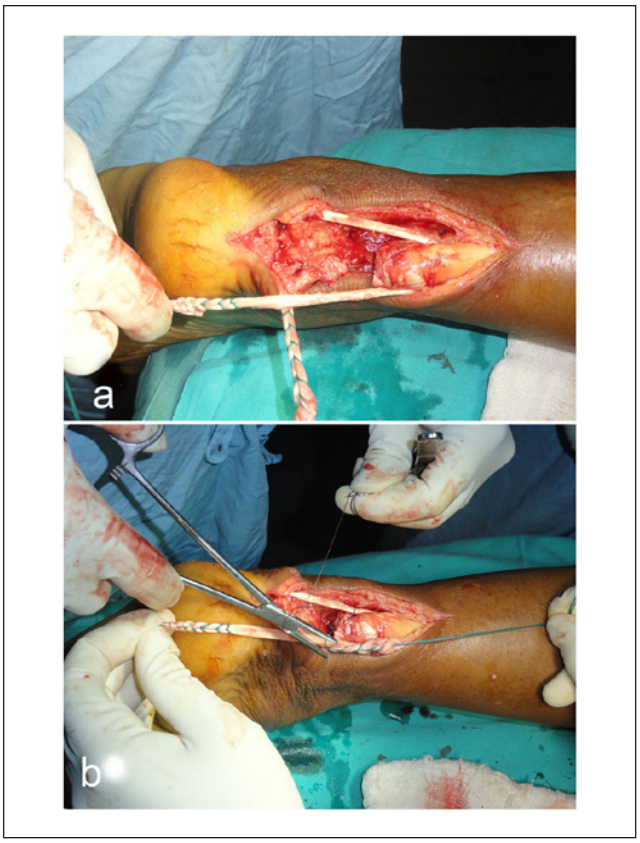

Figure 6. The graft was sutured side-to-side with the proximal Achilles stump using Vicryl No. 2-0 sutures.

Figure 7. Various designs in which the semitendinosus tendon graft was sutured to itself. The type of design was determined on the basis of graft thickness and defect length.

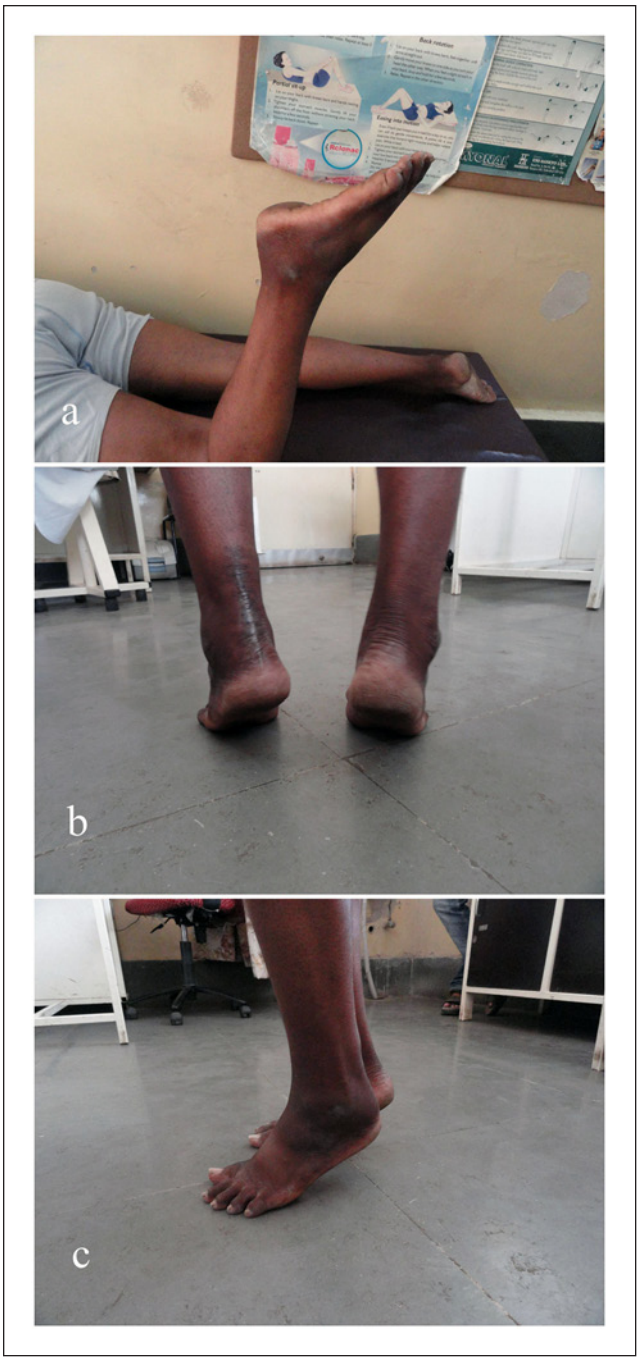

Figure 8. Clinical photographs showing the functional outcome after Achilles tendon reconstruction with semitendinosus tendon graft.

In conclusion, we found that autologous semitendinosus tendon can be used to reconstruct large defects in chronic Achilles ruptures. Preoperative weight-bearing MMT of 2/5 improved significantly to 4/5 or 5/5. All the patients in our series were farmers or heavy-duty workers who resumed working in the fields on uneven surfaces. Functionally all of them returned to the prerupture daily activity. There was no evidence of rerupture or soft tissue healing problem in our

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series. We feel that reconstruction of chronic Achilles tendon rupture with large defects using an autologous semitendinosus tendon is a simple method with low morbidity.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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