

## Clinical Study

# Management of Neglected Achilles Tendon Division: Assessment of Two Novel and Innovative Techniques

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**Objective.** Repair of injured Achilles tendon in neglected cases is one of the difficult and challenging procedures for surgeon. Here, we share our experience with the use of two innovative techniques for repair of chronic rupture of Achilles tendon. **Design.** Prospective Study. **Setting.** Tertiary care hospital. **Patients.** Twelve patients with chronic Tendo Achilles rupture were followed up over a period of three to five years. **Intervention.** Patients were divided in two groups, A and B. In Group A, the repair was done with Gastroc-soleus turndown flap and weaving with Plantaris tendon graft and in Group B, with modified Kessler's technique strengthened with the free plantaris tendon graft. **Outcome Assessment.** Clinically and by Modified Rupp Scoring system. **Results.** At an average follow-up of 4 years (Group A, 3.7 and Group B, 4.4 years), the majority of the patients had excellent to good results as assessed with Modified Rupp Scoring with few minor complications in both the groups. There was no significant difference in the baseline variables such as age and gender and also in the Rupp's score between the two groups. **Conclusion.** The two techniques are novel and simple and have been found to be useful for repair of chronically ruptured Achilles tendon.

## 1. Introduction

Achilles tendon repair in neglected cases is one of the difficult and challenging procedures for the treating surgeon. Several methods and modifications have been described in the literature to treat this complicated situation with rather simplified modifications [1–5]. Success of procedure selected in a given case is dependent upon surgeon's skills, nature of the defect, patients' compliance, adequacy of repair, availability of graft reinforcement, and proper rehabilitation.

Augmentation of surgically repaired fresh total Achilles tendon rupture has not been found to have any advantage over simple end-to-end repair [6]. There is no consensus on the technique of repair, type, and strength of suture and method of postoperative rehabilitation.

We hypothesized that the technique of Gastroc-soleus turndown flap augmented with plantaris tendon would be as efficacious as the simple end-to-end repair of divided Tendo Achilles augmented with plantaris. Since chronic Achilles tendon injuries are more difficult to manage due to

surrounding tissue fibrosis, larger defect, and muscle wasting, augmentation of repaired tendon in one way or the other would perhaps be desirable.

## 2. Patients and Methods

A prospective study was carried out from the year 2004 to 2009 enrolling 29 patients in which a diagnosis of Tendo Achilles rupture was made by performing Thomson's test [7] and palpating a defect in continuity of Tendo Achilles. Ultrasonography was done to assess the defect and for presence or absence of plantaris tendon. The patients were subjected to repair by one of the two proposed techniques. Inclusion criteria were chronic rupture at least 6 weeks old, unilateral rupture, and skeletal maturity.

Patients with bilateral injury (1), fresh ruptures (11), avulsion of bone (1), and with absence of plantaris tendon (4, 13.8%) were excluded. Thus, a total of 12 patients were available for final follow-up. Of the available patients, 7

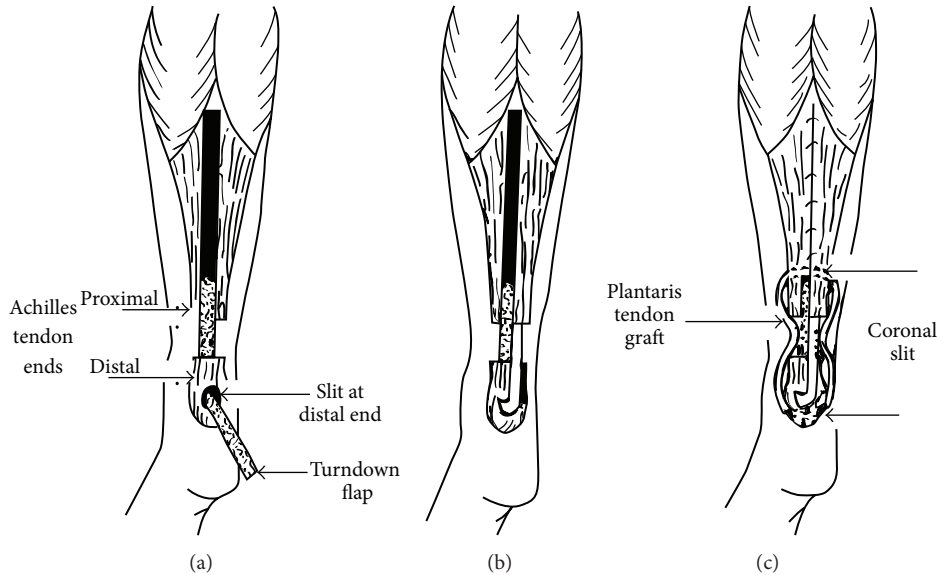


FIGURE 1: Diagrammatic illustration of gastroc-soleus turneddown flap ((a), (b)) and plantaris augmentation (c). Plantaris tendon graft passed through coronal slit and sutured with turndown flap.

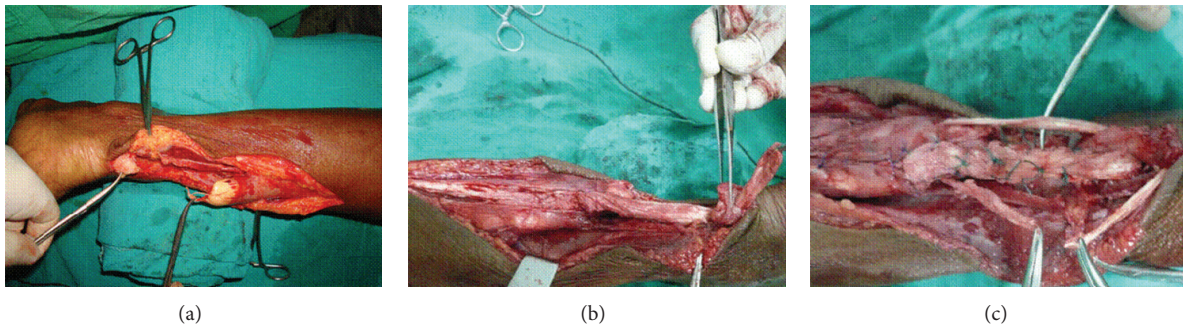


FIGURE 2: (a) 5 cm gap between two ends of Achilles tendon to be managed by GTPA. (b) Turndown flap passed through a slit made in distal end TA. (c) Plantaris tendon graft passed through coronal slit.

patients (5 males, 2 females) were treated with Gastroc-soleus turndown flap with plantaris augmentation (GTPA), and the remaining 5 (4 males, 1 female) were managed with primary repair with Kessler's suture technique and free plantaris autografting (KFPA). The age of Patients in the study ranged from 20 to 55 years. Average time between injury and surgery was approximately 3 months (range 2–4 months, Table 2).

**2.1. Statistical Analysis.** Mann Whitney *U* test was used to find the statistical significance of quantitative variables and Fisher's exact probability test for qualitative values.

**2.1.1. Surgical Technique 1: Gastroc-Soleus Turndown Flap with Plantaris Augmentation (GTPA).** Achilles tendon was explored by a lazy S incision under spinal anesthesia. The gap between two ends of ruptured/divided tendon was identified. Plantaris tendon graft around 18 cm in length was harvested from the same limb. A central turndown flap, of  $14 \times 2$  cm size distally based from proximal end of Achilles tendon was raised. The base of the flap was placed 2.5 cm from the

proximal cut end (Figure 1). This flap was passed through a slit made in distal end of tendon, turned up and both the raw surfaces of the turned down and turned up, flap were sutured together with nonabsorbable 3–0 polypropylene/No. 5 polyester suture. The plantaris tendon graft was passed spirally through coronal slit in distal and proximal ends, and both ends were sutured together (Figures 2(a) and 2(c)). Plantaris tendon and turned down flap were also sutured to each other with 4–0 polypropylene.

**2.2. Postoperative Management.** The patients were immobilized in above knee and below knee plaster splint for 2 weeks each with foot in planter flexion. Neutral position of ankle joint was achieved gradually over the next 2 weeks. Passive physiotherapy and partial weight bearing were allowed in further 3 weeks. This was followed by total weight bearing with restriction of strenuous exercise postoperatively.

**2.3. Surgical Technique 2: Primary End-to-End Repair with Kessler's Suture and Free Plantaris Autografting (KFPA).**

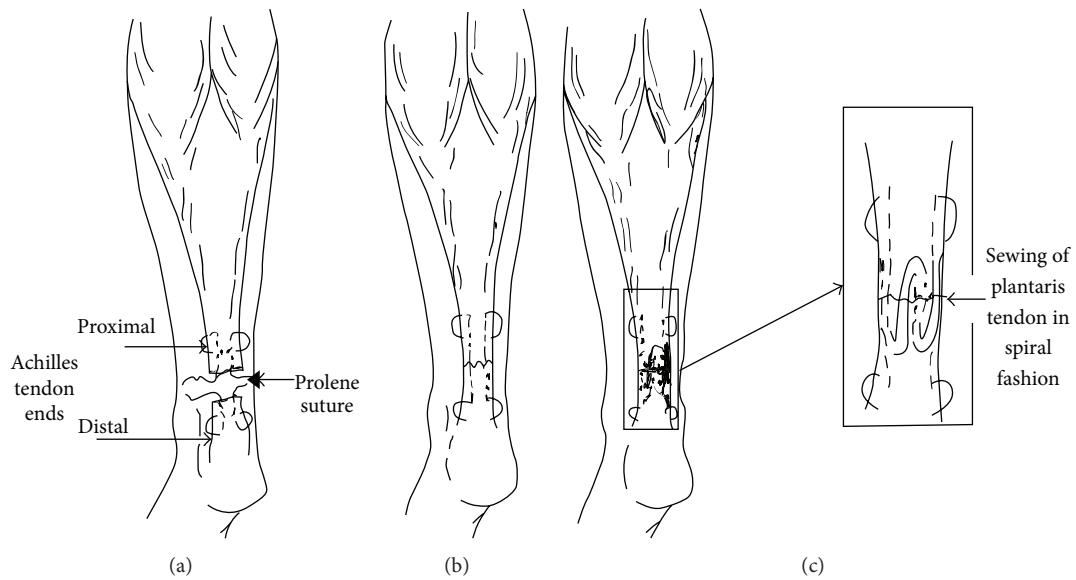


FIGURE 3: Diagrammatic illustration of primary repair with Kessler's suture ((a), (b)) and free plantaris autografting (KFPA) and sewing in spiral fashion (c).

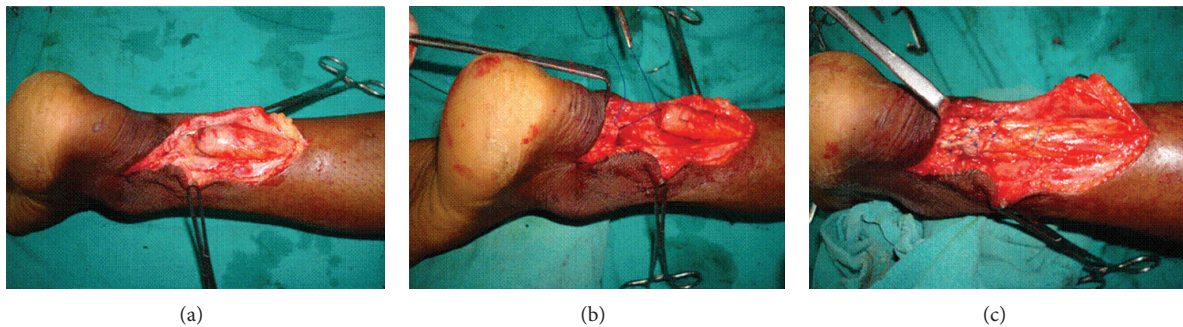


FIGURE 4: (a) 2 cm gap without soft tissue loss to be managed by KFPA. (b) Repair with Kessler's technique. (c) Sewing of plantaris tendon.

Achilles tendon was explored by a lazy S incision. Fibrous ends of the tendons were trimmed and mobilized. Plantaris tendon was harvested. Modified Kessler's stitch with number 1 prolene was applied between two divided ends of tendon and epitendon was repaired with 4-0 prolene with the foot in planter flexion. Sewing of plantaris tendon in spiral fashion away from the epitendon suture was additionally done (Figures 3, 4(a), 4(b), and 4(c)). Postoperative management was similar to previous technique.

All cases were operated by senior author (PJ). KFPA technique was initially advocated but, since 2007, majority of neglected cases with gaps  $\geq 3$  cm were managed by GTPA technique. Mean operative time was 72 minutes for GTPA and 58 minutes for KFPA technique.

**2.4. Evaluation.** All patients were followed up for assessment of integrity of repair and functional status. At each follow-up, ankle range of movements was measured by goniometer. The calf thickness was measured and compared with that of contralateral limb. The neurological status of foot, single limb hopping, strength of plantar flexors with heel raised

standing, and ability to perform repeated heel raises were assessed. At the final follow-up, patients' satisfaction was assessed with Kerkhoffs' Modified Rupp Scoring system [8] (Table 1). Results of this scoring were rated as excellent ( $>30$  points), good (15-30 points), fair (5-15 points), and poor ( $<5$  points).

### 3. Results

As the GTPA technique was started later (since 2007), patients in this group had an average follow-up of approximately 3.7 years while patients with KFPA had a longer average follow-up of 4.4 years. Steroid injection (6 of 12 patients, 50%) in tendon was the most common cause of chronic rupture as these patients were having a tendinitis in the past. On an average, in both the groups, the injury was neglected for approximately a mean of 3 months (Table 2).

Ankle ROM and Calf diameter was found to be within 95th percentile of the operated and normal limb in both the groups. At final follow-up, all the patients could return to their daily activities and could perform single leg hopping

TABLE 1: Modified Rupp's Scoring system for subjective evaluation.

(1) Patient satisfaction	
Excellent	5
Good	1
Fair	-1
Poor	-5
(2) Do you experience pain during weight bearing?	
None	5
With extended weight bearing	1
With slight weight bearing	-2
Continuous	-5
(3) Do you experience pain independent of weight bearing?	
None	5
Pain a/w changes in weather	1
Pain sometimes a/w rest	-2
Continuous pain	-5
(4) Has your ankle function decreased since the operation?	
No	±2
Tendency to swelling	±2
Reduction of muscle strength	±2
Tendency to cramp	±2
(5) Do you fear rerupture?	
Yes	-1
No	1
(6) Do you have limitations of your work?	
Does not apply	0
None	5
Minor	-1
Major	-3
Changed profession due to TA problem	-5
(7) Do you have limitation of sports activity?	
Does not apply	0
None	5
Minor	-1
Major	-3
Stopped due to problems with Tendo Achilles	-5
Total score	
>30	Excellent
15-30	Good
5-15	Fair
<5	Poor

for 30 seconds, repeated heel raises, and heel standing. There was no significant difference between the two groups at the final follow-up with regard to pain, stiffness of ankle joint, calf muscle weakness, range of ankle motion, and overall outcome. There was no significant difference in the baseline variables such as age, gender, and so forth, and also in the

Rupp's score between the two groups. Modified Rupp's score was excellent in 4, good in 2, and fair in 1 in GTPA, and excellent in 2, good in 2, and fair 1 in KFPA groups, thus making a total of 50% as excellent, 33.3% as good, and 16.6% as fair results with a satisfactory outcome (Table 3). There was no statistically significant difference in the overall Rupp's score between the two groups, thus proving our hypothesis.

**3.1. Complications.** No patient in these groups ever had sural nerve neuropraxia. Superficial marginal flap necrosis in one patient of Group A was managed conservatively. Superficial suture point infection ( $n = 3$ , 1 in Group A, 2 in B) was also managed conservatively (Group A) and by exploration and extracting the buried suture (Group B). At 6 months follow-up, these patients were having little discomfort at the heel but no limitation in ROM as they were followed up for long. Functional recovery was near complete at the time of final follow-up.

## 4. Discussion

Many methods have been described in the literature for Achilles tendon repair. Selection of particular method depends upon the type and size of the defect. When there is no major defect, the surgeon can have different options like percutaneous suture method, modified Kessler, Bunnel, and Krackow techniques. But in our patients, we found larger gaps (>2 cms) between two cut/ruptured ends of Achilles tendon. For management of neglected Achilles tendon rupture with significant gap, the basic requirement is to bridge the defect by tissue or synthetic materials which can unite the cut ends with satisfactory strength and allow full range of tendon excursion. The popular options are Lindholm technique [9], Bosworth technique [10], and V-Y repair [11]. In Group A, we raised an inferiorly based and centrally situated tendon flap attached for 2.5 cm at the distal part of proximal cut end of tendon like Bosworth but in our method, the harvested central strip was much broader and shorter in length (14 cm × 2 cm in our technique as compared to Bosworth in which tendon strip of 1.5 cm × 17.5 to 22.5 cm) assuming that broader and shorter tendon strip can provide more viability to the tendon strip and strength to repair and be superior in terms of graft stiffness, ease of handling and with lesser residual weakness of ankle dorsiflexion as demonstrated in our series of Group A patients. Our use of flap is totally different from Bosworth technique. We sutured raw surfaces together after passing it through the slit made in proximal healthy part of distal cut end of the tendon. Secondly, we further strengthened our repair by plantaris tendon graft (Figure 1) which was not described by Bosworth.

Maffulli has very rightly advised to individualize the treatment according to concern and health of the patient [12]. End-to-end repair is possible for gaps of <2.5 cm between the divided ends of the tendon [13]. Apart from Achilles tendon itself, Perez Teuffer [14] deployed peroneus brevis and Wapner et al. used flexor hallucis longus for Achilles tendon repair. Although these were good options, we avoided sacrificing another tendon in an already injured limb because

TABLE 2: Patients' characteristics: Group A (GTPA) and B (KFPA).

Pt name	Age	Sex	Side involved	Duration since injury (months)	Duration of follow-up (years)	Mode of injury	Complications	Rupp's score
Group A								
RS	32	M	L	3	4	Steroid injection	Superficial marginal necrosis	25
HP	20	M	R	2	3	Traumatic	—	31
KP	22	M	L	2	4	Cut injury	—	31
JK	54	F	R	3	5	Steroid injection	Superficial suture point infection	14
JD	45	M	R	4	3	Steroid injection	—	32
MR	48	M	L	3	3	Steroid injection	—	22
VK	25	F	L	3	4	Cut injury	—	33
Mean	<b>33</b>			<b>2.85</b>	<b>3.71</b>			
Group B								
ONS	33	F	L	2	5	Traumatic	—	31
RB	46	M	R	4	5	Steroid injection	Superficial suture point infection	23
JK	55	M	R	3	5	Cut injury	Superficial suture point infection	14
FR	29	M	L	2	4	Cut injury	—	32
IA	52	M	R	4	3	Steroid injection	—	30
Mean	<b>43</b>			<b>3</b>	<b>4.4</b>			
"P" value	<b>0.323</b>	<b>0.746</b>	<b>0.575</b>	<b>0.774</b>	<b>0.181</b>			<b>0.843</b>

TABLE 3: Rupp's score in both the groups at final follow-up.

Modified Rupp's Scoring	Group A (GTPA)	Group B (KFPA)	Overall total (%)
Excellent	4 (57.14%)	2 (40%)	50%
Good	2 (28.57%)	2 (40%)	33.3%
Fair	1 (14.28%)	1 (20%)	16.6%
Poor	0	0	0

in our opinion by doing so, there may be some functional loss related to transferred tendon. We reserved these tendon grafts in cases of rerupture of repair by our techniques in either of the group. Plantaris tendon is the most useful locally available tendon for further strengthening of Achilles tendon repair and has been advocated for use by surgeons in different ways. In Group B, we utilized the free plantaris tendon graft in a novel way to strengthen the repair. Lynn [1] advised the Achilles tendon repair using the plantaris tendon as a reinforcing membrane. They placed the previously harvested plantaris tendon in a fascial needle and passed it circumferentially, first through the posterior and then through anterior part of the tendon 2 cm from the rupture and fanned out and tucked over the repair after primary repair of tendon by Kessler's stitch. In White and Kraynic [15] modification of Perez Teuffer's technique, they also utilized the plantaris tendon strengthening after repairing the Achilles tendon by bridging the gap with peroneus brevis tendon. They placed the harvested plantaris tendon on a fascial needle and passed it in a figure of eight manner through the ruptured ends of the tendon. In our described method, we did the darning by previously harvested plantaris tendon-free graft by placing it

on fascial needle and passing it spirally through the cut ends of the tendon and tucking it over the repair after applying modified Kessler's stitch, without sacrificing peroneus brevis.

Our technique (KFPA) offered advantage over other technique of Lynn [1] that fanning the tendon in membrane form might lose the tensile strength of repair and application of Bunnell's suture has the disadvantage of knots being left exposed on the tendon surface [10]. In contrast to Kraynick's modification of Perez Teuffer's technique, we did primary repair with modified Kessler's intratendinous suture to reduce intratendinous ischemia caused by classical Bunnell's suture and instead of increasing the bulk of repair by doing a figure of eight threading of plantaris tendon, we passed the graft spirally. We also repaired epitenon separately from the spiral graft in order to improve the vascularity of repair. Frequently, these neglected injuries present to us with more complex defects of soft tissues including loss of skin cover, either primarily or secondarily due to a previously failed operative intervention. Many methods like grafting to technically demanding free flap repair have been described in the literature for this purpose. The first and the foremost quality of the flap for providing skin cover over repaired

tendon site is to allow adequate tendon excursion besides being easy to harvest, locally available, less morbid, and acceptable cosmetically. In our opinion, adipofascial flap described by Mohanty and Jain [16] and local fascial flap described by Fong et al. [17] fulfill all the criteria mentioned above for providing a suitable cover over tendon repair. The strength of our two techniques is that they are simple, surgeon friendly, less complex, and useful method of tendon repair in neglected cases with large interfragment gap as shown in their final outcome. Peroperative risk of sural nerve damage was minimal as we stayed posteromedially to the ruptured Tendo Achilles. An average follow-up of nearly four years in both the groups may be considered satisfactory in view of the opinion of Olsson et al. [18] that only minor improvements occur after the first year of repair. However, main disadvantage includes a small sample size in either of the group. Comparative analysis between both the groups could not yield significant difference as it required more number of patients. Biomechanical studies are also required to determine the tensile strength and vascularity at the repair site. Also, identification of factors leading to poor or successful outcome needs to be done with regression analysis. Hadi et al. in a review of management options for chronic rupture of Achilles tendon advocate that the surgery is the best option and emphasize on the need of randomized controlled trials with validated functional outcome measures [19].

In conclusion, the techniques described by us are newer and relatively easy ones based on present knowledge of tendon healing and its augmentation which seems to provide a reasonably good outcome.

## Disclosure

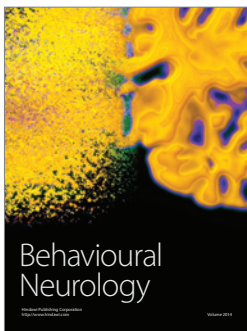
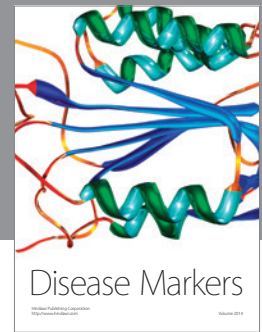
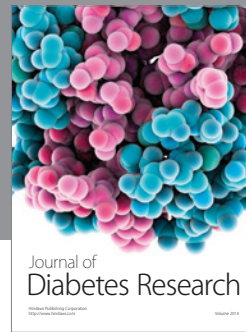
Level of evidence is IV.

## Conflict of Interests

None of the authors has any conflict of interests regarding the publication of this paper.

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