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Is Posterolateral Incision Better than Direct Posterior Incision in Chronic Tear of Achilles Tendon Reconstruction? A comparative Study of Series of Cases

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SUMMARY

Background. Wound gaping and dehiscence following open repair or reconstruction for chronic (more than 4 weeks old) Achilles tendon ruptures is a great concern and the subject of debate. The location of the incision is crucial. There is no consensus as to the safest incision location. This study aims to observe the effects of posterior midline and posterolateral surgical incision (modified skin incision) on wound dehiscence.

Methods. It was hypothesized that using Posterolateral incision improves wound healing and minimizes chance of wound dehiscence. In our study, open reconstruction was performed for 172 active young soldiers with chronic Achilles tendon ruptures. We consider tear as chronic when it was older than 4 weeks duration and was untreated. Patients were divided into Group A (posterolateral) and group B (direct posterior approach) and TA tendon reconstruction was performed using the Bosworth technique. Patients were followed for two years for wound complication. We used the American Orthopedic Foot, Ankle Society (AOFAS) score, ankle-hind foot score, the Achilles tendon Total Rupture Score (ATRS), VAS for pain and functional evaluation using Heel rise height index (HRHI).

Results. In our comparative study between 2 groups, in group B, 7 patients (11.6%) developed wound dehiscence whereas none in group A. We did not record any sural nerve injury, limitation with ankle motion, footwear related complication and skin adhesion in posterolateral incision group. The AOFAS score averaged 93.5 ± 4 in posterolateral incision (group A) and 78.8 ± 7 in direct posterior incision (group B). Three soldiers developed re-rupture following the fresh injury in group A.

Conclusions. Based on our results, posterolateral skin incision gives equally good results as direct posterior incision however, this approach minimizes the risk of wound-related complication especially wound dehiscence following TA tendon reconstruction.

KEY WORDS

Posterolateral skin incision; wound dehiscence; Achilles tendon rupture; open reconstruction.

INTRODUCTION

Achilles tendon rupture is one of the most common tendon injuries in orthopaedics practice (1, 2). A chronic or neglected tear always required surgical reconstruction and possess great challenges in wound healing. Chronic tear is defined as tear older that 4weeks (3). However, Maffulli N. defined as it is 6 weeks (4). In chronic tear primary repair is very difficult because of two reasons firstly due to retraction of torn tendon ends and secondly increased in gap (5). Regarding choice of tendon graft is concerned Maffulli N. reported that if gap between torn tendon ends is less than 6 cm peroneus brevis is effective whereas if gap is more than 6 cm semitendinosus tendon graft is indicated (6). Maffulli N., in his study on 62 patients of chronic TA Tendon rupture 21 patient who had more than 6 cm gap underwent less invasive technique of reconstruction using free ipsilateral semitendinosus graft, 20 patients who had less than 6 cm gap underwent reconstruction using peroneus brevis, and another set of 21 patients who also had less than 6 cm gap underwent reconstruction using flexor hallucis longus, and he did not note any significant advantage of one technique over the others (7). Wound related complication following surgical reconstruction of chronic tear is noted by many authors ranging from minor wound infection, wound dehiscence, keloid formation, skin necrosis (8-10).

In the literature the wound complication rate following reconstruction of chronic Achilles tendon rupture varies from 8% to 9.7% (9-11). Yepes *et al.* (11) noted that the location of the surgical incision may be a risk factor for wound complication, and he further noted that since Achilles tendon is covered with a peritenon, fascia, and a thin layer of skin. The ideal skin incision must provide adequate exposure and good tissue healing with minimal scar formation. Hammit *et al.* (12) however, suggested posterior direct approach rather than posterolateral or posteromedial approach. He noted that this approach provides excellent exposure with minimal wound related complications. The explanation for less wound complication was that the approach provides dissection between angiosomes, which preserved the blood supply to the skin flaps. In the present literature, a debate regarding the safest incision is continuing. Whether direct midline incision over Tendon which lies between the two angiosomes or slightly off the midline medial or lateral incision to avoid the vascular watershed area is still subject of study (13, 14). Taylor noted that the posteromedial aspect is supplied by the posterior tibial vessels of the ankle and the posterolateral aspect by Peroneal vessels (14). Yepes *et al.* (11) in a cadaveric study using angiography of the skin and subcutaneous tissues covering the Achilles tendon noted that the posterior cutaneous midline was less vascular as compared to that of the medial and lateral areas adjacent to the tendon which has better vascularity. He further suggested that the skin incisions be placed one cm medial to the Achilles tendon and to incise the peritenon without dissecting it from the subcutaneous fat. However, Attinger *et al.* (13) have recommended that the safest incision between two angiosomes and thus incisions be made along the central raphe over the Achilles tendon in between the peroneal and posterior tibial angiosomes.

The sural nerve injury is a great concern for posterolateral incision as it is located about 1-2 cm lateral to the lateral border of the Achilles tendon. It crosses the Achilles tendon 8 to 10 cm proximal to the superior aspect of the calcaneal tuberosity (15). Traumatic or iatrogenic sural never injury leads to loss of sensation in the lateral mid and hindfoot. Since its lateral location in the lower leg, the posteromedial incision is safer as compared to the posterolateral incision.

The present study aimed to compare the rates of wound dehiscence between direct posterior midline incision and posterolateral incision.

MATERIALS AND METHODS

This is a prospective randomized study of 172 soldiers who underwent TA tendon reconstruction of chronic tear (tear older than 4 weeks duration) between Mar 2010 and Feb 2019 with 2 years follow up. The study was conducted in accordance with institutional and international (Declaration of Helsinki) standards. Ethical approval was obtained from the Ethics Committee of Base Hospital Guwahati, India (File no: 151/BH/EC). Patients with traumatic confirmed full-thickness TA rupture were included. Acute tear, previous history of surgery on Achilles tendon, open injuries, or a percutaneous repair was excluded. All patients were soldiers without any medical co- morbidities. A pre-anesthesia checkup was performed before taking up for surgery. If any medical co-morbidity was detected during pre-anaesthesia checkup, he was excluded from the study. History of alcoholism and smoking was taken and were recorded. In group A, 7 patients had history of alcoholism (60 ml twice week), 10 patients had history smoking (5-8 cigarettes per days) and 28 had both, however, in group A 5 patients had history of alcoholism (60 ml twice week), 8 patients had history smoking (5-8 cigarettes per days) and 17 had both. All patients mentioned supra were underwent assessment of the ankle-brachial index (ABI) and Duplex ultrasonography to rule out any subclinical Peripheral vascular disease. In the present study if patients had history of alcoholism or smoking for more than 5 years were excluded in the study.

112 patients of age group 21 to 50 years (mean 35.5 years) were assigned as group A (modified posterolateral incision group) and 60 patients as control group B (direct posterior incision group). Randomization was done with every third

patient and postoperative evaluation was done by independent surgeon not participating in the present study. We followed sequentially numbered, opaque, sealed envelopes for concealment of patient allocation to minimize bias.

Study design

Total 220 soldiers with Tendo Achilles tendon tear reported to emergency room of Orthopaedic department. Only 172 who met with inclusion criteria were included in the study, 30 soldiers were excluded from study as they did not meet inclusion criteria, 14 soldiers declined to participated in study and 4 soldiers were excluded from study due to other reasons (**figure 1**). All included patient were available to follow-up till 2 years post-surgery.

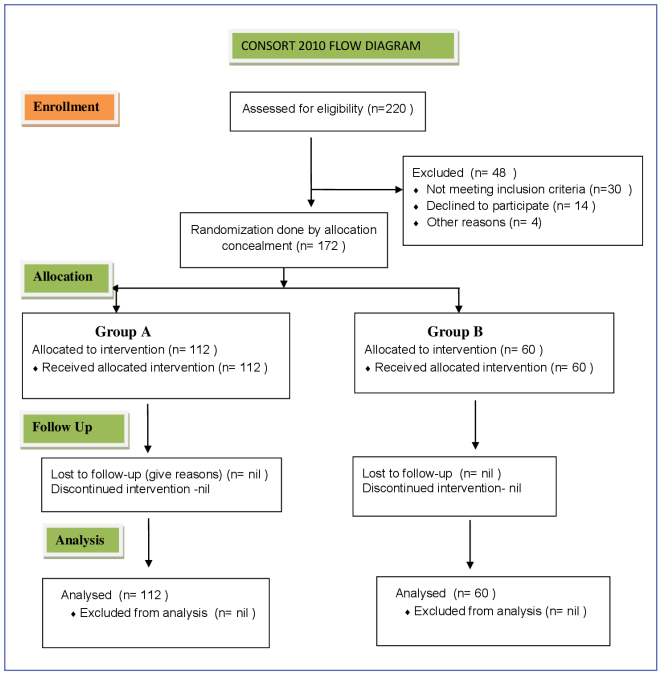

Figure 1. Study design.

Statistical analysis

The calf circumference, ankle range of motion, footwear restriction, duration of wound healing, VAS score and AOFAS score were compared between two groups using the paired sample t-test; $p < 0.05$ was considered significant. Data collected were analyzed with a multi-purpose computer analysis program, Statistical Package for the Social Sciences version 19.0 (IBM; SPSS, Chicago, IL, USA) was used.

Operative technique

All patients underwent surgical reconstruction using the Bosworth procedure in prone position under spinal anesthesia and under tourniquet control. A straight posterior midline incision starting proximally 10 cm below the knee joint was given (**figure 2 a**). The incision was continued distally and then gently curved laterally about 6 cm above the insertion of the tendon. After the skin incision, the sural nerve and short saphenous vein were isolated. Graft 1.5–2-cm-wide strip was marked and harvested from the central portion of the raphe (**figure 2 b**). The graft was left attached just two cm proximal to the rupture site. The entire graft passed through the proximal ruptured tendon and passed through the distal tendon stump by making a split in it. (**figure 2 c**). If the distal stump was small, a drill hole was made in calcaneum 1 cm below and a graft was passed through it. The graft was passed in a lateral to medial direction ensuring free graft movement in tunnel then it was sutured with proximal part of main tendon (**figure 2 d**). The graft was then sutured in proper tension in plantar flexion of the ankle (**figure 2 e**). The wound was then closed, firstly closure of paratenon using 2.0 Vicryl, secondly the subcutaneous tissue using 2.0 Vicryl and finally skin closure using staplers and silk (stapler was used in proximal part and 2.0 Silk suture in distal part of incision).

After surgery removable plaster cast in 20° plantar flexion and the knee in 30° flexion was applied for 4 weeks. Intravenous antibiotics were given for three days postoperative. Wound dressing was changed after 48 hrs and then at 7th postoperative day and suture removed on 15th postoperative days.

Plaster was removed after 4 weeks, below knee cast was applied for another 4 weeks in 20° plantar flexion. A walking short leg cast was applied with the ankle plantigrade for

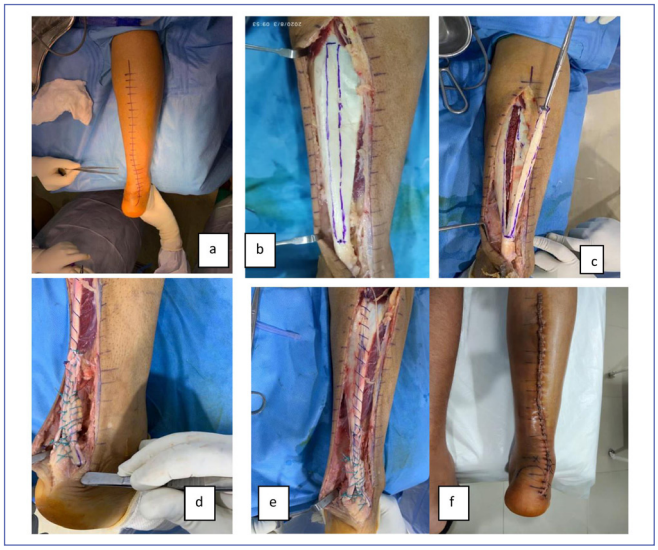

Figure 2. Posterolateral incision group A.
From top clockwise, **(a)** modified skin incision posterolateral, **(b)** marking of graft, **(c)** harvesting of graft, **(d)** passing of graft through Calcanium tunnel, **(e)** final suturing of graft, and, **(f)** final wound closure.

4 more weeks. The plaster was finally removed at 3 months and gradual calf strengthening and stretching exercises were started along with weight-bearing. Post operative rehabilitation was same in both groups.

Figure 3. Healed surgical posterolateral scar, range of ankle motion and endurance at 6 month of follow-up group A.
(A) Healed surgical scar, **(B)** Planter flexion, and **(C)** Dorsiflexion.

Figure 4. Healed surgical posterolateral scar and full weight bearing at 6 month of follow-up group A.

Evaluation at follow-up

Each patient was evaluated in follow-up at 3 months, 6-month 12 months, 24 months and finally at two years using the scoring system described by Leppilahti *et al.* (16) Status of wound and range of ankle motion, and full weight bearing at 6 months of follow-up has been shown in **figures 3** and **4**. Heel rise height index (HRHI) was performed on a single leg and on both leg while the patients was standing, with his both knees extended position. When the heel was raised, the distance of the heel bottom from the floor was measured with a tape. Measurement was taken on both side the operated and unaffected sides was calculated **figure 5**.

Wound complication in direct posterior incision group has shown in **figure 6**.
The scoring included subjective factors (pain, stiffness, muscle weakness, and footwear restrictions) as well as objective factors (range of ankle motion and isokinetic calf muscle strength). Out of 100 points, ≥ 90 points were considered as excellent, 75–89 points as good, 60–74 points as fair and < 60 points considered as poor. A subjective symptoms questionnaire was given to all patients and were asked to fill the response.

Figure 5. Heel rise height index (HRHI) inspection and evaluation.
Patient was standing on his toes and measurement was taken from heel to floor on both sides to compare HRHI. Black line indicates level of heel and level of ground. Yellow line indicate distance between heel and floor.

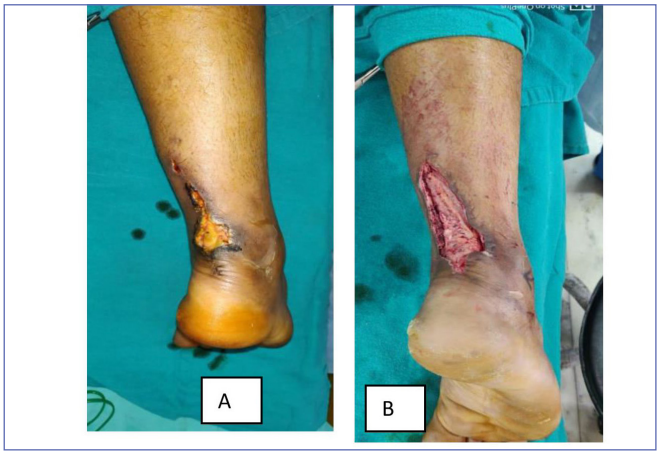

Figure 6. Wound complication in Direct Posterior incision.
(A) Wound dehiscence after 3 weeks postoperative. **(B)** Wound dehiscence that needs flap cover.

RESULTS

The demographical characteristics of the included patients were shown in **table I**. BMI does not possess any significant risk factor in rupture however, sports injury was a significant risk factor (p = 0.032) for tendon rupture. History of alcoholism and smoking was also not a risk factor too.

We used the Leppilahti scoring system for evaluation (**table II**). At the end of two year follow up in group A, 98 patients had excellent results, 9 had good results, 3 had fair results and 2 patients had poor results. Whereas in-group B, 45 patients had excellent results, 8 had good results, 4 had fair results and 2 had poor results.

Preoperative and post operative scores (at 2 years follow up) in both groups have been summarized in **table III**.

In group A, mean AOFAS scores increased from 60.27 ± 10.71points preoperatively to 93.5 ± 4.2 points at the latest follow-up (p = 0.0334), however it was 63.24 ± 9.23 and 78.8 ± 7.4 respectively in group B. Mean ATRS score also showed significant improvements from 15.57 ± 6.27 points preoperatively to 88.73 ± 11.95 points at the last follow-up (p = 0.0251) in group A however it was 11.26 ± 4.21 and 69.03 ± 7.26 respectively in group B. Pain during weight bearing was assessed by the VAS which improved from a mean of 8.2 + 0.3 (range: 6 to 10) preoperatively to a mean of 1.2 + 0.1 (range: 0 to 2) at the last follow-up in group A, however it was 7.9 + 0.1 and 2.8 + 0.8 respectively in group B (**table III**). Thus, a significant difference was seen in VAS score in group A than in group B.

A significant clinical difference was noted between two groups at two years follow up in the AOFAS score (p = 0.0334). The mean AOFAS score was 93.5 ± 4.2 in group A and 78.8 ± 7.4 in group B. The difference between VAS scores was also significant (p = 0.0211). Mean VAS score was 1.2 + 0.1 in group A and 2.8 + 0.8 in group B (**table IV**). All patients were able to perform a single-limb heel rise test and had returned to their preinjury level. Returned to their preinjury level was assessed by Heel rise height index (HRHI) adopted by Imaya (17). HRHI was noted preoperatively in group A and B, 45.18 ± 14.6 and 55.24 ± 23.56 respectively (p = 0.713). However, the same was noted postoperatively in group A and B, 89.76 ± 21 91.44 ± 11.11 respectively (p = 0.683) which was statistically non-significant. Hence, as far as reconstruction of TA tendon is concerned, we did not note any significant difference in HRHI scores. Three months after surgery, MRI scan was done which showed some signs of inflammation, which disappeared at the end of 6 months and two years postoperatively. At the latest follow-up, MRI scan showed full continuity of the reconstructed Achilles tendon.

In group B, deep infection was noted in 4 (6.6%) patients however it was as less as 1.7% in group A (p = 0.0217), delayed wound healing was noted in 9 (15%) patients in group B (p = 0.0344) and wound dehiscence was seen in 7 (11.6%) in group B (p = 0.0154). None of the group A patient showed wound dehiscence. When infection involved tendon, we considered as deep infection and was managed by vacuum assisted dressing and antibiotics according to culture report. The infection has healed in 3-week time.

Table I. Demographical characteristics of included patients in both groups.

Characteristics	No of patients		P-value
	Group A	Group B	
Age (mean) 35.5 years	112	60	
Mode of injury			
Sports	91	39	0.032
Training	12	8	
Direct hit	9	13	
Duration of rupture			
30 -90 days	101	51	0.042
> 90 days	11	9	
BMI			
< 18.5 kg/m²	32	10	0.632
18.5 - 25 kg/m²	63	21	0.685
> 25 kg/m2	17	29	0.730
Alcoholic (60 ml twice a week)	7	5	0.221
Smoking (5-8 per days)	10	8	0.732
Both	28	17	0.341
Mean length of gap between TA tendon ends (in mm)	58 (27-105)	55 (24-104)	0.776

Table II. Leppilahti scoring system of both groups at final follow up at 2 years.

Factor	Point	No of patients at 6 months		No of patients at 1 year		No of patients at 2 years	
		Group A	Group B	Group A	Group B	Group A	Group B
Pain							
Non	15	102	39	103	52	109	55
Mild, no limitations in recreational activities	10	5	9	9	2	3	1
Moderate, limitations in recreational, but not daily activities	5	3	5	-	2	-	2
Severe, limitations in recreational and daily activities	0	2	7	-	4	-	3
Stiffness							
Non	15	90	51	97	52	109	56
Mild, no limitations in recreational activities	10	6	5	5	2	3	2
Moderate, limitations in recreational, but not daily activities	5	4	1	7	4	-	1
Severe, limitations in recreational and daily activities	0	2	3	3	2	-	-
Calf muscle weakness (subjective)							
Non	15	99	53	103	56	112	58
Mild, no limitations in recreational activities	10	7	3	9	3	-	1
Moderate, limitations in recreational, but not daily activities	5	5	2	-	1	-	1
Severe, limitations in recreational and daily activities	0	1	2	-	-	-	-
Footwear restrictions							
None	15	87	7	106	18	112	34
Mild	5	21	22	6	13	-	9
Moderate, unable to tolerate fashionable shoes, required modified shoes	0	4	31	-	29	-	17
Active range of motion (ROM) difference between ankles							
Normal (< 6°)	15	102	48	106	42	112	53
Mild (6°–10°)	10	7	8	3	6	-	4
Moderate (11°–15°)	5	2	3	3	5	-	2
Severe (> 15°)	0	1	1	-	7	-	1
Isokinetic muscle strength (score)							
Excellent	15	83	48	97	53	112	56

Factor	Point	No of patients at 6 months		No of patients at 1 year		No of patients at 2 years	
		Group A	Group B	Group A	Group B	Group A	Group B
Good	10	19	9	13	3	-	2
Fair	5	4	3	1	4	-	2
Poor	0	6	-	1	-	-	-
Leppilahti score							
Excellent	90-100	77	38	89	41	98	45
Good	75-89	24	11	15	11	9	8
Fair	60-74	8	4	6	3	3	4
Poor	< 60	3	7	2	5	2	3
Satisfaction level							
Fully satisfied	15	97	36	108	38	110	55
Satisfied with minor issues	10	10	17	4	11	2	1
Satisfied with minor issues	5	5	4	-	3	-	2
Dissatisfied	0	-	3	-	2	-	2

Table III. Preoperative and two years post operative scores in both groups.

Score	AOFAS (mean SD)		ATRS (mean SD)		VAS (mean SD)		HRHI (mean SD)	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Group A	60.27 ± 10.71	93.5 ± 4.2	15.57 ± 6.27	88.7 3 ± 11.95	8.2 + 0.3	1.2 + 0.1	45.18 ± 14.6	89.76 ± 21
Group B	63.24 ± 9.23	78. 8± 7.4	11.26 ± 4.21	69.03 ± 7.26	7.9 + 0.1	2.8 + 0.8	55.24 ± 23.56	91.44 ± 11.11
P-value*	0.742	0.0334	0.612	0.0251	0.651	0.0211	0.713	0.683

*Paired sample t-test; Pre-Preoperative; Post-Postoperative.

Table IV. Comparing the calf circumference, ankle range of motion and Leppilahti score between both groups.

Parameters at 4 years	Group A	Group B	P-value*
Calf circumference (cm)	35 ± 3.9 (31-43)	33 ± 2.8 (27-38)	0.0766
Ankle motion (°) Plantar flexion	32 ± 7 (19-44)	28 ± 6 (15-34)	0.0013
Ankle motion (°) Dorsi flexion	15 ± 5 (10-20)	13 ± 5 (9-18)	0.0643
Leppilahti score (at 2 year) Excellent	98 (112) 87.5%	45 (60) (75%)	0.0221
Footwear restrictions (at 2 year)			
None	112/112 (100%)	34/60 (56.6%)	0.0235
Mild	-	9/60 (15%)	0.0213
Need footwear modification	-	17/60 (28.3%)	0.0430
VAS (Mean SD)	1.2 + 0.1	2.8 + 0.8	0.0211
AOFAS score (Mean SD)	93.5 ± 4.2	78.8 ± 7.4	0.0334
ATRS Score (Mean SD)	88.73 ± 11.95	69.03 ± 7.26	0.0251

*Paired sample t-test.

DISCUSSION

There is a constant debate what will be the best management of TA tendon rupture in the present literature. Maffulli G. (18) in his study included 26 patients with TA tendon rupture and compared three different types of management in acute rupture, including non-surgical plaster immobilization, traditional open surgery and percutaneous repair. He noted that surgical repair, percutaneous and open repair gives better functional outcomes than conservative management.

As far as chronicity of tear and outcome after repair is concerned Maffulli N. included 21 patient who presented between 2 weeks to 30 days from day of Achilles tendon tear and underwent minimally invasive technique of repair, and noted that there was no difference in outcome as compared with those underwent repair within 14 days of rupture (19). Maffulli N. *et al*., enrolled 21 patients of re-ruptured of TA tendon for minimally invasive reconstruction with the ipsilateral peroneus brevis (5 patients) or the semitendinosus tendon graft with or without interference screw fixation (10 and 6 patients, respectively). He observed that minimally invasive reconstruction is safe and effective surgical procedures for reconstruction of re-rupture of the Achilles tendon (20).

In the present literature there is debate on which incision in better, direct posterior incision, posteromedial or posterolateral incision. However, direct posterior incision has some wound healing complication. In present study we like to present our experience of using posterolateral skin incision which is equally good than other incision as for as exposure and TA tendon reconstruction is concerned but it has definite lesser wound healing complication than direct posterior approach.

In our study with modified posterolateral incision, none of the patients showed delayed wound healing or wound dehiscence, which was more common in direct posterior midline incision.

In young patient generally open surgical repair/ reconstruction is preferred over conservative treatment and especially where the patient is a soldier. Open surgery provides good outcome, rapid recovery, early rehabilitation and early return to duty and to sports. Many published data suggest that after open repair risk of re-rupture is less (11, 21, 22).

However, non-surgical treatment is preferred for elderly, diabetics, and patient with peripheral vascular disease (21, 22). The major concern following TA tendon reconstruction is delayed wound healing and wound dehiscence (23-25). It has been documented in the literature that the delayed wound healing may be due to thin skin and poor blood supply over tendon area (13). In the present literature the wound complications after open reconstruction vary from 11-21% (24) and 8-9.7% (26). Bruggeman *et al*. reported 17 wound (10.4%) complication in 164 patients treated by open TA tendon repairs (9). Cretnik *et al*. (27) reported that minimally invasive repair minimizes wound complication however some author did not note any significant difference between open *versus* minimally invasive repair (28-30).

As far as muscle strength is concerned, we did not note any weakness in gastrocnemius, this finding is supported by study done by Goren on 20 patients with chronic TA tendon rupture (more than 6 months old rupture) underwent repair (10 patients were treated by open surgery, and another 10 patients were treated percutaneously). He noted that there was no difference in functional outcome and the biomechanical strength (31).

However, few author noted Calf muscle endurance was affected after repair and noted various risk factors like, increased tendon compliance, tendon lengthening, inadequate rehabilitation, persistent pain, gender and level of activity (32-35).

Many meta-analyses have shown that Achilles tendon ruptures repaired by open methods have a significantly lower re-rupture rate compared to nonsurgical treatment, but open reconstruction/repair has other complications such as superficial and deep infections, sural nerve injury, delayed wound healing and wound dehiscence requiring secondary surgeries like flap cover (36-39).

In the search of a method to minimize wound complications after reconstruction, we noted that there are very few studies based on blood supply at ankle area. In this regard, Yepes *et al*. (11) have shown that the deep fascia and anterior paratenon, which usually remain intact in Tendon rupture that, have very good blood supply from the posterior tibial and peroneal arteries. He suggested that after reconstruction tendon should be covered with these well-perfused tissues which may compensate the inadequate blood supply in this region and may minimize wound complication. He also recommended that medial incision can be used to minimize wound complications. Skin adhesions (superficial skin tethering) and deep adhesions causing tendon pain, and difficulty in using footwear have been reported as complications of both surgical and non-surgical management with rates of 5–7.1% (40-42). Thus, superficial and deep adhesion interfere with use of footwear and ankle motion.

In present study, we noted that even covering the repaired tendon with peritenon, which has rich vasculature, the placement of skin incision plays an important role in wound healing. Placing skin incision directly over the tendon has higher wound complication rate as compared to posterolateral incision.

Limitation of study

The study was conduction on the military soldiers without any medical co-morbidities and thus result may not be applicable to whose who has medical co-morbidities, as latter may be a risk factor for wound healing and infection.

CONCLUSIONS

In this study direct posterior appears to be associated with high wound complication rate for delayed reconstruction of chronic TA tendon rupture. This may be due to skin over the TA tendon being less vascular as compared with skin on the posterolateral side. The direct posterior skin incision is also associated with postoperative skin adhesion to underlying tendon and the use of footwear is delayed because of its direct contact with footwear. Our study suggests that posterolateral incision has promising results in chronic TA rupture reconstruction as compared to direct posterior incision.

FUNDINGS

None.

DATA AVAILABILITY

Data are available under reasonable request to the corresponding author.

CONTRIBUTIONS

SKR: critical analysis and writing. SKR, TPG. MB: performed surgeries. TPG: conceptualize and design of the study. GKG, ABK: English writing. SKR. GKG, OS, MB, ABK: data collection. OS: statistical analysis.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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