Original Article

Versatility of Local Fasciocutaneous Island Flaps for Resurfacing Soft Tissue Defects Overlying the Achilles Tendon

Ahmed A. Elhefnawy [1], Sherif A. Hantash [1], Wael H. Mahmoud[1*], Wesam I. Homouda [2], and Mohamed M. Khedr [1]

1. Department of Plastic and Reconstructive Surgery, Faculty of Medicine, Tanta University, Tanta, Egypt.
2. Plastic Surgery Department, Benha Teaching Hospital, Benha, Egypt.

***Corresponding Author:**

Wael H. Mahmoud

Department of Plastic and Reconstructive Surgery, Faculty of Medicine, Tanta University, Tanta, Egypt

Email: waelhussein558@gmail.com

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ABSTRACT

Background: Reconstruction of soft tissue defects overlying the Achilles tendon has always been a challenge. Various modalities of reconstruction have been described to resurface such defects. We aimed to assess the functional and cosmetic outcomes of all patients who had undergone reconstruction of small and medium sized soft tissue defects of the Achilles region using local fasciocutaneous island flaps.

Methods: This retrospective study was conducted from January 2020 to June 2022. 15 patients with small (≤ 30 cm^2) and medium (30-90 cm^2) sized soft tissue defects of the tendo-Achilles region, underwent reconstruction with local fasciocutaneous island flaps and had complete medical records, were included.

Results: Thirteen patients were male (86.7%). The mean age was 53.2 years. 5 cases (33.3%) had post-traumatic open AT injuries with skin avulsion, while ten patients (66.7%) had suture line complications after open repair of spontaneous Achilles tendon rupture. Defect sizes ranged from 12 to 63 cm2. Reverse sural flap was used in 5 patients (33.3%) and medial plantar flap in 10 patients (66.7%). All flaps survived completely. Complications were detected in 3 patients (20%); 1 distal superficial necrosis in a sural flap and 2 marginal minimal graft loss. Functional outcome was good in 12 patients (80%), excellent in 1 patient (6.7%) and fair in 2 patients (13.3%). 13 patients (86.7%) were satisfied with the cosmetic results.

Conclusion: Local fasciocutenous island flaps are reliable and simple solutions for covering small to moderate soft tissue defects overlying the Achilles Tendon, with acceptable functional and cosmetic outcomes.

KEYWORDS: Achilles tendon; Soft tissue defects; Fasciocutenous island flaps

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INTRODUCTION

Achilles tendon rupture (ATR) is a common injury, being the most commonly ruptured tendon in the human body[1]. The incidence of ATR has been reported to be increased over the past two decades[2]. Soft tissue defects exposing the Achilles Tendon (AT) are often the result of open injuries, wound problems associated with open repair of ATR, or pressure ulcers[3]. Resurfacing of such defects is very demanding due

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to specific anatomical limitations including, poor vascularity of the AT and the surrounding tissues, scarcity of skin and thin subcutaneous tissue[4]. Moreover, the soft tissue coverage ought to cushion the AT yet permit gliding[5].

Although there are many reconstructive modalities including, local fasciocutaneous or adipofascial flaps[4,6,7], muscle flaps[8], propeller flaps[9], and free flaps[10,11], there is still controversy regarding the optimal treatment. With the remarkable development of reconstructive microsurgery, recent studies have outlined the use of free flaps as the first choice in the management of such defects[12]. Even though free tissue transfer is the mainstay for coverage of large sized defects, for small and medium sized defects local axial flaps still play a major role and represent an effective alternative[5].

This study therefore set out to assess the functional and cosmetic outcomes of all patients who had undergone reconstruction of small and medium sized soft tissue defects associated with AT injuries using local fasciocutaneous island flaps.

MATERIALS AND METHODS

This retrospective study was performed in Plastic Surgery Department, Tanta University Hospital, Tanta, Egypt from January 2020 to June 2022. Fifteen patients with small (≤ 30 cm^2) and medium (30-90 cm^2) sized soft tissue defects overlying the AT, who underwent reconstruction with local fasciocutaneous island flaps and had complete medical records, were included. Patients with coexisting injuries (e.g., bony, head injuries, etc.) and large (>90cm^2) sized soft tissue defects were excluded from the study.

The collected data included patient demographics; comorbidities; nature of injury; size of defects; time of coverage (i.e. acute ≤72 hours, subacute 3days-6weeks, chronic >6weeks); type of flaps; post-operative complications (e.g., hematoma, infection, dehiscence, total or partial flap loss and graft loss); subjective satisfaction about cosmetic results; functional outcome using Percy and Conochie's criteria[13] (i.e. Excellent; full function, stable flap and return to the level of activity before injury, Good; slight stiffness, adherent scar but return to the level of activity before injury, Fair; moderate pain, definite weakness and decrease in activity level, Poor; unstable flap, limp and no return to the pre-injury level of activity); and follow up period as shown in **Table 1**.

All the procedures performed in our study were done after approval of the University Ethical Committee and obtaining of written informed consent from all participants in the study. All cases were subjected to full history taking and a through clinical examination. AT integrity was assessed clinically by Thompson test and asking them to stand on tiptoes. They also underwent quantitative and qualitative bacteriological study to rule out infection radiography of the limb to rule out fractures and arterial duplex scanning to assess the status of the posterior tibial and peroneal vessels in the affected limb.

Surgical technique

Careful preoperative planning and judicious assessment of the extent of the injury was done. Reverse sural artery flap was planned in five patients and the medial plantar artery flap was planned in ten patients. The choice of the flap was determined by the size of the defect and by the available uninjured tissue on the donor area; where medial plantar flap was used for small defects (≤ 30 cm^2) and in patients with patent posterior tibial artery and intact instep area, while sural flap was performed for moderate defects (30-90 cm^2), in patients with patent peroneal artery and when concurrent exposure of the Achilles region for tendon repair with flap elevation was needed.

All procedures were performed under spinal anesthesia. The patients were placed in the prone position. All subjects received IV broad spectrum antibiotics. Complete debridement of the wound edges was performed. A pneumatic tourniquet was used to provide a bloodless field. When the sural flap was planned **(Figure 1)**, a line was marked beginning at a point midway between the AT and lateral malleolus extending upwards to the midline at the popliteal crease. The peroneal artery perforators (pivot point of the flap) were identified using a hand held Doppler at approximately 5-6cm superior to the lateral malleolus tip. A skin island was centered on this line several centimeters distal to the popliteal crease and designed according to the size of the Achilles region defect. The skin island was incised circumferentially then the line of the pedicle down to the level of the dermis. Dissection

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Table 1: Patients ' data and outcomes

No.	Sex/Age, yr	Comorbidities	Nature of injury	Defect size, cm^2	Time of coverage	Type of flap	Complications	Functional outcome	Esthetic outcome	Follow-up,mo
1	M/43	Smoking	Open AT injuries with skin avulsion caused by RTA	63	Acute	Sural	None	Good	Satisfied	30
2	M/31	None	Discharging sinus (WC)	12	Chronic	Medial plantar	None	Good	Satisfied	12
3	F/50	DM/HT	Open AT injuries with skin avulsion caused by RTA	48	Acute	Sural	Minimal graft loss at donor	Good	Unsatisfied	27
4	M/55	HT/ Gouty Arthritis	Discharging sinus (WC)	24	Chronic	Medial plantar	None	Good	Satisfied	18
5	M/45	Smoking/IHD	Open AT injuries with skin avulsion caused by RTA	56	Acute	Sural	Superficial distal necrosis	Fair	Satisfied	27
6	M/38	None	Open AT injuries with skin avulsion caused by RTA	42	Acute	Sural	None	Good	Satisfied	24
7	M/50	Gouty Arthritis/ Smoking	Skin necrosis (WC)	15	Subacute	Medial plantar	None	Good	Satisfied	18
8	M/65	HT/ Gouty Arthritis	Discharging sinus (WC)	22.8	Chronic	Medial plantar	None	Fair	Satisfied	12
9	M/56	DM / Gouty Arthritis	Suture dehiscence (WC)	29.3	Subacute	Medial plantar	Minimal graft loss at donor	Good	Satisfied	18
10	M/45	None	Open AT injuries with skin avulsion caused by RTA	48	Acute	Sural	None	Good	Satisfied	21
11	F/59	DM / Gouty Arthritis	Suture dehiscence (WC)	24	Subacute	Medial plantar	None	Good	Unsatisfied	15
12	M/39	Smoking/DM	Suture dehiscence (WC)	26.3	Subacute	Medial plantar	None	Good	Satisfied	9
13	M/50	HT/ Gouty Arthritis	Skin necrosis (WC)	30	Subacute	Medial plantar	None	Excellent	Satisfied	21
14	M/62	Smoking/IHD/HT	Suture dehiscence (WC)	21	Subacute	Medial plantar	None	Good	Satisfied	12
15	M/55	Gouty Arthritis/ Smoking	Suture dehiscence (WC)	19.3	Subacute	Medial plantar	None	Good	Satisfied	15

(M): male, (F): female, (DM): diabetes mellitus, (HT): hypertension, (IHD): ischemic heart disease, (WC): wound complication, (RTA): road traffic accident, (AT): Achilles Tendon, Acute: ≤72hours, Subacute: 3days-6weeks, Chronic: >6weeks.

was started at the most proximal portion of the flap and carried down through the deep fascial layer overlying the gastrocnemius muscle. Until the sural neurovascular bundle and short saphenous vein were identified then ligated and cut. The deep fascia overlying the gastrocnemius muscle was sutured to the skin to ensure that it wasn't left out of the flap, while flap elevation.

Flap elevation was continued to the pivot point (5cm above lateral malleolus). At this stage, AT repair/reconstruction whenever needed was done. AT end-to- end repair was done in four cases by the triple bundle technique in combination with No. 2 Ethibond suture, while one case had tendinous gap of about 5cm required tendon reconstruction by a tensor fascia lata graft that was prepared in cylindrical manner and sutured by wrapping the distal and proximal portions of the AT. Following repair/ reconstruction of the AT, the tourniquet was deflated where flap vascularity was checked and hemostasis was done.

The fasciocutaneous flap was transferred to the defect in a tension- free manner, and the donor site can be reduced by reapproximation of the distal edges of the wound. The remaining donor site was covered by a STSG.

When the medial plantar flap was planned **(Figure 2)**, a skin island was designed on a curvilinear line (representing the course of the medial plantar artery) extending from the first web space to 1cm posterior to the medial malleolus. The distal edge of the flap was incised followed by transverse incision of the plantar fascia where the medial plantar neurovascular bundle was identified. The flap was raised at the level between the flexor digitorum brevis muscle and the plantar fascia, keeping the medial plantar vascular pedicle along with cutaneous nerve branches intact with the flap. Dissection was continued from distal to proximal, attention should be paid to preserve the nerve trunk in the foot. Tracing the medial plantar neurovascular pedicle proximally till the bifurcation with the lateral plantar neurovascular bundle where the abductor hallucis muscle was divided to free the neurovascular pedicle. The flap harvest was completed by a circumferential incision and ligation of the medial plantar artery at the distal edge of the flap. The divided muscle was repaired. At this stage, AT repair/reconstruction whenever needed was done followed by tourniquet deflation to check flap vascularity and do hemostasis **(Figure 3)**. The flap was rotated to cover the recipient site and held in place by loose interrupted sutures. The donor area was covered by STSG.

Post-operative care

Following surgery, limb was elevated to decrease venous congestion, with the ankle joint immobilized in plantar flexion with below knee plaster of Paris; a window was created in the dressing to monitor the perfusion of the flap every 8hours. When sural flap was used, the patient was placed in prone position in the bed to avoid pressure on the pedicle. STSG 1st dressing was done on the 5th post-operative day. The

Figure 1. A 43-year old male had open AT injuries with skin avulsion caused by RTA. **(A).**Pre- operative marking of the reverse sural flap. **(B).** Harvesting of the flap. **(C).** Reconstruction of the tendon defect with tensor fascia lata graft was done. **(D).** Insetting of the flap and covering the donor area and the pedicle with STSG. **(E, F).** Five months postoperative view shows good functional and esthetic outcome.

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Figure 2. A 55-year old male had suture line complications after open repair of spontaneous ATR that was referred for skin cover and salvage of tendon repair. **(A).** Two discharging sinus around AT were detected **(B).** Pre-operative marking of the flap. **(C, D).** Six months postoperative view shows good functional and esthetic outcome.

Figure 3. A 50-year old male had suture line complications after open repair of spontaneous ATR that was referred for skin cover and salvage of tendon repair. **(A).** Pre-operative view shows skin necrosis and exposed AT. **(B).** Intra-operative view shows that the flap was completely islanded and rotated to cover the defect. **(C, D).** Four months postoperative view shows good functional and esthetic outcome.

skin sutures were removed on the 10th post-operative day. Regular physiotherapy with passive and active movements of the ankle joints was allowed after the 3rd week. Non-weight bearing walking was allowed after 6 weeks and weight bearing walking was advised at 10-12 weeks. Follow up regularly every 3 months for 3 years was advised for all patients. Post- operative complications, subjects' satisfaction about esthetic results, and functional outcomes were assessed for all patients.

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RESULTS

Overall, 13 patients (86.7%) were males and 2 patients (13.3%) were females. The mean age of patients was 49.5 years (range, 31-65 years). Six patients (40%) remained active smokers. Seven cases (46.7%) had gouty arthritis, five cases (33.3%) had arterial hypertension, four cases (26.7%) had type Π diabetes mellitus and two cases (13.3%) had ischemic heart disease. Five patients (33.3%) had open AT injuries with skin avulsion caused by road traffic accidents (RTA), while ten patients (66.7%) had suture line complications after open repair of spontaneous ATR (i.e. 5 suture dehiscence, 2 skin necrosis and 3 discharging sinus around AT) that were referred for skin cover and salvage of tendon repair.

The size of the defects ranged from 12 to 63cm^2 (mean, 28.8cm^2). The time of coverage was acute in 5 cases (33.3%), subacute in 7 cases (46.7%) and chronic in 3 cases (20%). Reverse sural artery flap was used in 5 patients (33.3%) and medial plantar artery flap was done for 10 patients (66.7%). In four patients (26.7%) the gap of the ATR was <3cm, so primary repair was done, while in one patient (6.7%) it was 5 cm so reconstruction with tensor fascia lata graft was done. In the remaining ten patients (66.7%), no additional reinforcement to the previously done AT repair was done. In all patients (100%) the donor sites were skin grafted from the ipsilateral thigh.

All flaps survived. Nevertheless, one (6.7%) sural flap, in a heavy smoker patient (>20 cigarettes per day), developed venous congestion proceeded to distal superficial necrosis that healed by secondary intention with conservative management. All donor sites healed well. Notwithstanding, two (13.3%) diabetic patient had minimal graft loss at the margins that was treated conservatively and healed spontaneously. The overall rate of post-operative complications was (20%). After a mean follow up period of 18.6 months (range, 9-30 months), all patients were able to stand on toes unaided and had a stable non-bulky coverage of their defects. One case (6.7%) had excellent functional outcome, twelve cases (80%) had good functional outcome and two cases (13.3%) had fair results which could be attributed to local peritendinous adhesions. Thirteen patients (86.7%) were satisfied with the cosmetic results, while two female patients (13.3%) were not satisfied about the discoloration and the depression at the skin grafted sites.

DISCUSSION

Reconstruction of soft tissue defects exposing the AT represents a challenge to reconstructive surgeons and often requires a durable tissue to resist pressure and chronic irritation and a pliable one to provide a suitable gliding surface for the underlying AT to move without adhesions[1]. In general, conservative treatment even with VAC therapy is not suitable as it leads to intractable and chronic wounds[5]. Also, skin grafting is deemed to failure due to lack of well vascularized bed and repeated mechanical irritation[8]. The need for flap coverage is essential to resurface such defects. Various flaps have been reported; each of them has its own advantages and limitations[6]. Free flaps have always been the ideal option for reconstruction of soft tissue defects in the distal one-third of the leg, they enable resurfacing of defects of any size even with multiple components in a single stage with a very good success rate[12]. Nevertheless, they are bulky, need well trained team, special operating set and prolonged operating time, have potential donor-site morbidity and may not be applicable for older patients. So, they should be reserved for major avulsions and surgically competent patients[14].

Cross leg flaps can also be used for reconstruction of such defects, however they are cumbersome, multistage procedures and aren't suitable for elderly patients[15]. Local flaps are more convenient for small and moderate sized defects, as they have a comparatively short operative and hospitalization times, don't need for microsurgical expertise and reserve distant donor sites for future reconstruiction[3-5]. We aimed in this study to evaluate the functional and esthetic results following coverage of small and moderate sized soft tissue defects of the tendo-Achilles region with local fasciocutaneous island flaps.

We observed a predominance of ATR in middle aged males, which is consistent with other studies[1,3,14], possibly reflecting their susceptibility to injury and/or increase the prevalence of men sports participation. In our study, we noticed that soft tissue defects were commonly caused by suture line complications after open repair of spontaneous ATR (66.7%) followed by trauma (33.3%). In another

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study, Popp et al.[11] used fasciocuteneous infragluteal free flap for repair of AT injuries combined with overlying soft tissue defects that were caused by trauma in 4 cases, wound complications after open repair of spontaneous ATR in 2 cases and carbon dioxide laser removal of skin lesion in the Achilles region in one case. Soldatis et al.[16] reported that delayed wound healing and wound problems should be expected when open repair of AT is used through the posterior midline incision that passes through inadequately vascularized skin. These findings were confirmed by Yepes et al.[17], who documented that the least amount of vascularization of the skin directly posterior while the best amount of vascularization between the medial border of AT and the medial malleolus.

We considered soft tissue defects of AT (≤ 30cm^2) to be small and those between 30 and 90 cm^2 to be medium sized. In a similar study[5], soft tissue defects of the tendo-Achilles region were classified into three groups as follows: ≤ 30cm^2 (small), 30-90 cm^2 (moderate) and > 90 cm^2 (large). Similarly, they effectively managed to cover all small and medium sized defects with local fasciocutaneous flaps. Lin et al.[3] managed to cover defects ranged from 6 to 28 cm^2 with bipedicled fasciocutaneous flaps. They concluded that bipedicled fasciocutaneous flap a valuable tool for resurfacing of small and moderate soft tissue defects of the AT, even in patients with infection and severe vascular diseases. Unlike us, Lee et al.[10] used antero-lateral thigh flap in reconstruction of combined loss of the AT and the overlying soft tissue (i.e. skin defect ranged from 12.5 to 35 cm^2), where a piece of fascia lata was included to replace the missing segment of the AT. Although, all patients showed satisfactory functional results, the bulk of the flap was excessive and thinning of the flap should be considered.

In this series, we used the reverse sural flap in five cases (33.3%) and the medial plantar flap in ten cases (66.7%). The reverse sural artery flap is a fasciocutaneous island flap, was first reported by Masquelet et al.[18] in 1992.

Peroneal artery perforators anastomose with the superficial median sural artery to supply the flap through retrograde perfusion. Sural flap has been frequently used for soft tissue reconstruction of the lower leg, foot and ankle. In a similar study, Bullocks et al.[4] used the reverse sural flap for reconstruction of complex soft tissue defects associated with AT injuries. They found that the sural flap is simple as it doesn't require microvascular expertise, versatile as it can cover moderate to large sized defects adequately, durable and time saving option allowing simultaneous exposure of the AT with flap elevation. They noted that venous congestion may complicate the results of the flap which can be reduced by harvesting a wide pedicle for the flap. Similarly, Boopalan et al.[19] managed to reconstruct a 60 cm^2 soft tissue defect exposing AT injury (i.e. 10cm tendon defect) with reverse flow sural flap and fascia lata graft. The patient had good functional and clinical outcomes with minimal donor site morbidity.

The medial plantar artery flap is a fasciocutaneous island flap, was described by Harrison and Morgan[20] in 1981, harvested from the instep of the foot. Its neurovascular pedicle consists of the medial plantar artery, its venae comitants and cutaneous branches of medial plantar nerve. The medial plantar flap has become a cornerstone in foot and ankle reconstruction. Taniguchi and Tamaki21 succeeded in reconstruction of the AT and overlying skin defect with an island medial plantar flap and fascia lata graft. They demonstrated that the quality of the skin of the medial plantar flap is ideal for repair of the Achilles region as it resists external irritation from shoes, is relatively thin and contours easily to enable normal shoe wear and has also protective sensation as the flap is sensate. Moreover, the medial plantar flap can be used for reconstruction of the AT and skin simultaneously, when a composite medial plantar flap with vascularised plantar aponeurosis is harvested[22]. Nevertheless, its use is limited by the size of the defect and the major vascular pedicle included that may compromise the distal foot flow.

Our series demonstrated a low complication rate (20%) and good functional outcome (80%) of patients. Moreover, 86.7% of our patients were satisfied with the esthetic results. These findings agreed with Kumta and Maffulli[1], who used local fasciocutaneous flaps (i.e. 4 reverse flow peroneal flaps, 1 reverse flow posterior tibial flap and 6 medial plantar flaps) for coverage of soft tissue defects exposing the AT, and noted that all flaps and donor sites healed well and 63.6% of the patients had good functional outcome. Other studies[6,15], recommended the use of distal posterior tibial artery adipofascial flap covered with STSG for reconstruction of soft tissue defects of the AT as it gives good functional

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outcome with minimal donor site morbidity and satisfactory cosmetic results even in female patients. Jammula et al.[9] preferred to use island propeller flaps to cover the exposed AT and reported excellent functional results with stable covering in all except one patient that had flap failure due to impaired venous return. In another study, Gopalakrishnan et al.[5] reconstructed soft tissue defects of the Achilles region with fasciocutaneous flaps (i.e. 8 lateral supramalleolar flaps, 6 reverse sural flaps, 6 extended lateral calcaneal flaps and 2 posterior tibial artery perforator flaps). They considered fasciocutaneous flaps as most useful and suitable for reconstruction of AT defects with excellent functional outcome provided that adequate physiotherapy was done.

Finally, the present study was limited by the relatively small number of cases and its retrospective nature. Considerably, further prospective studies on a larger group of patients with different types of flaps and longer follow-up period are therefore recommended before assessment of the outcome is clearly understood.

CONCLUSION

Local fasciocutenous island flaps are reliable and simple solutions for covering small to moderate soft tissue defects overlying the Achilles Tendon, with acceptable functional and cosmetic outcomes. Moreover, they provide a convincing alternative for other complex reconstructive procedures, even if they fail, a free tissue transfer can still be performed.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests.

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