International Journal of Medical Arts

Volume 5, Issue 6, June 2023

https://ijma.journals.ekb.eg/

Print ISSN: 2636-4174

Online ISSN: 2682-3780

Available online at Journal Website
https://ijma.journals.ekb.eg/
Main Subject [Plastic Surgery]

Original Article

One Stage versus Two Stages Distally Based Reverse Sural Flap for Leg and Foot Reconstruction: A Meta-Analysis Study

Saber Abdullah Younis *[1], Ahmed Sabry Ahmed Hassan [1], Yasser Helmy [2]

[1] Department of Plastic and Reconstructive Surgery, Damietta Faculty of Medicine, Al-Azhar University, Damietta, Egypt

[2] Department of Plastic and Reconstructive Surgery, Faculty of Medicine, Al-Azhar University, Cairo, Egypt

Article information

Received: 16-01-2023

Accepted: 13-06-2023

DOI: 10.21608/IJMA.2023.187933.1602.

*Corresponding author

Email: saberyouniss971@gmail.com

Citation: Younis SA, Hassan ASA, Helmy Y. One Stage versus Two Stages Distally Based Reverse Sural Flap for Leg and Foot Reconstruction: A Meta-Analysis Study. IJMA 2023 June; 5 [6]: 3324-3338. doi: 10.21608/ IJMA.2023.187933.1602.

ABSTRACT

Background: The coverage of the distal third of the leg and foot was still a challenge for reconstructive surgery due to its limited distensibility and mobility, low blood supply, and lack of muscle tissue interposition between noble structures and the integument. These features make randomized grafts and flaps unsuitable for wounds in this region.

Aim of the work: To assess the potentiality of [two stages] versus [one stage] distally based reverse sural flap for distal third of leg and foot reconstruction.

Patients and Methods: This meta-analysis included the recent updates as we retrieved 77 references to studies. After examination of the titles and abstracts of these references, we eliminated all of those which did not match our inclusion criteria and those which were clearly ineligible from the review. We obtained full text copies of the remaining seven potentially eligible trials for further evaluation.

Results: Seven studies assessing rate of Partial necrosis among two groups showing that there were insignificant differences. seven studies assessing rate of complete flap necrosis among two groups showing that there were insignificant differences. seven studies assessing rate of secondary procedures among two groups showing that there were insignificant differences. three studies assessing rate of hospital-stay\days among two groups showing significant longer stay among single staged group.

Conclusion: The distally based reverse sural flap is a versatile flap for the reconstruction of soft tissue defects of the lower leg and heel.

Keywords: Sural flap; One Stage; Two Stages; Meta-analysis

INTRODUCTION

The coverage of the distal third of the leg and foot was still a challenge for reconstructive surgery due to its limited distensibility and mobility, low blood supply, and lack of muscle tissue interposition between noble structures and the integument. These features make randomized grafts and flaps unsuitable for wounds in this region. The use of microsurgical flaps and pedicle flaps based on the cutaneous perforating arteries of the leg, specifically reverse flaps, leads to the best outcomes, some patients require a more complex surgical technique. The sural fasciocutaneous flap, popularly called distal sural flap, had become one of the most important tools in the therapeutic armamentarium of re-constructive surgery for lesions in the distal third of the leg, ankle and foot [1].

The reverse-flow sural flap appropriate for the defects of the distal third of the leg and the anterior part of the foot [2]. Reverse sural flap was raised based on anastomosis of peroneal artery and median sural artery, along with the sural nerve and short saphenous vein had been described to be successful [3].

The sural arteries, paired with a motor branch of the tibial nerve at level of the tibiofemoral joint line, enter the deep surface of medial and lateral heads of the gastrocnemius muscle. Their cutaneous branches [medial and lateral superficial sural arteries] supply the skin of the posterior leg. The perforating vessels in the calf region mainly originate from medial sural arteries and peroneal artery [4].

The lateral malleolar artery and the lateral calcaneal artery could serve as the main perforators for a very low flap pivot point. The pivot point should be set at approximately 7 to 8.5 cm proximal to the lateral malleolus to retain all major perforators [5]. The greater mobility and versatility of the reverse-flow sural flap, in addition to sparing important arteries, had shown increasing success rates and few complications [1].

A reverse sural flap delay procedure had been recommended to prevent flap complications [6]. Various techniques had been tried in the past to improve the flap's venous drainage. For example, supercharging the flap [by anatomizing the small saphenous vein to any recipient area vein], exteriorizing the divided proximal stump of the small saphenous vein, intermittent phlebotomy, medicinal leeches, and low molecular weight Dextran [7].

The classical reverse sural flap was a single stage flap harvest either the flap was islanded or pedicled. Two staged fascio-cutaneous and adipo-fascial flaps represent an extremely useful technical modifications of the classical reverse sural flap. They believe that adipo-fascial variety of reverse sural flap should be performed with caution in cases of heel defect as it is a weight-bearing area [8].

Reverse-transferred flaps could be sorted into three patterns, The reverse flow island flaps, such as the reversed anterior tibial artery flap, the posterior tibial artery flap, and the peroneal artery flap; The distally perforator based flaps, which avoid scarifying of the main deep arteries, such as the lateral and medial supra-malleolar flap; and The distally based neuro- veno-fascio-cutaneous flaps that were supplied by the chain linked longitudinal directed vascular plexuses from a wide neuro-veno-adipo-fascial pedicle. These three locoregional types of flaps could be elevated easily and substituted for microsurgical free flaps for foot and ankle reconstructions in some conditions [9].

Patient with medical comorbidities such as diabetes, neuropathy or peripheral vascular disease, the flap is less predictable. Venous congestion rather than arterial ischemia tends to be a greater problem with this flap especially if designed as an island flap. In these patients, surgical delay procedure may be considered [10].

The sural neurocutaneous flap was initially described in 1992. It was extensively employed for soft tissue reconstruction in distal leg and heel defects. The single staged cutaneous islanded reverse sural fap [SS-RSF] is the traditional method of flap transfer. This method is associated with a variety of flap problems, most notably venous congestion. The two-stage reverse sural fap [TS-RSF] is another type of flap transfer. The pedicle of the flap is exteriorized in the first stage of the two-stage surgery. In the second stage, the flaps are divided and re- inset. Advantage of [TS-RSF] include, Flap advancement is possible in case of partial fap necrosis, Subcutaneous tunneling of the pedicle is not required, so occurrence of venous congestion is minimized, tendoachilles tendon morbidity is decreased as there is intact skin over that region, in SS-RSF, if the skin bridge is divided over the pedicle and resurfaced with a split thickness skin graft, it can cause restriction of plantar flexion in the future. This problem is avoided with TS- RSF, TS-RSF can be particularly useful in children as the dissection around small neurocutaneous vascular channels is minimal, technical expertise is minimized as flap pedicle is not skeletonized [11].

PATIENTS AND METHODS

Data sources: A literature search will be performed in PubMed, Cochrane, PLOS which are index in Clarivate - Scopus listed articles and web of science, approach through Egyptian Knowledge Bank [EKB] to download the articles for the last ten years [from 2013 till 2022].

Study selection: published studies to assess the potentiality of [two stages] versus [one stage] distally based reverse sural flap for distal third of leg and foot reconstruction.

Data extraction and synthesis: Data were extracted systematically, adhering to the Preferred Reporting Items for Systematic reviews and Meta-Analyses [PRISMA] guidelines. Summary measures will pool in a random-effects model meta-analysis.

Outcomes and measures: The study had assessed 1] Versatility and length of the flap, 2] Flap survival and flap congestion, 3] Functional outcome, 4] Complications and 5] Aesthetic outcome.

Search strategy: From the electronic searches, including the recent updates, we retrieved 77 references to studies. After examination of the titles and abstracts of these references, we eliminated all of those which did not match our inclusion criteria and those which were clearly ineligible from the review. We obtained full text copies of the remaining 7 potentially eligible trials for further evaluation figure [1].

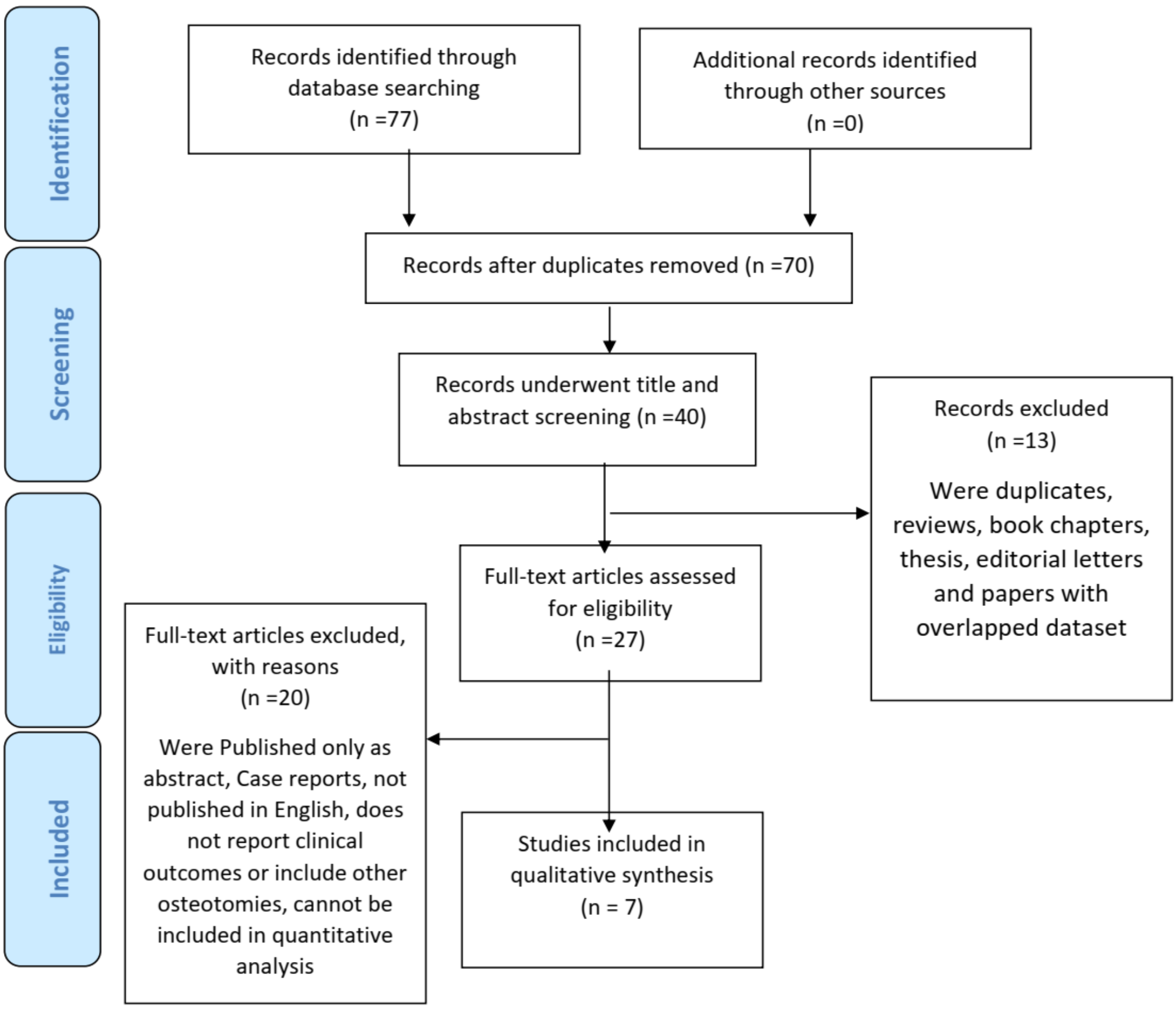

Figure [1]: PRISMA flow diagram showing process of studies selection

RESULTS

Study characteristics: Seven studies were included 5 were retrospective studies, 2 were comparative as shown in table [1].

Patients' characteristics: 206 cases were included with mean age 34.6 years as shown in table [1].

Lesion characteristics: As regard etiology most commonly were High-energy mechanical injuries, gunshot explosive wounds, complications after osteosynthesis, Injury following high-energy trauma, diabetes neuropathy and ischemia, traumatic, chronic, nonhealing ulcers, car accident, heat stress , regarding site were distal leg, ankle joint, Achilles tendon ,heel area, middle and forefoot, distal third leg, Hind foot dorsum of proximal third of foot. Mean size of defect was 84.5 cm, mean surgical time was 127±18 minutes and mean follow up was 18 months as shown in table [2].

Outcome: As regard outcome healed was in 102\113 in single tagged vs 100\103 in two staged, partial necrosis founded in 22\113 in single staged vs 6\103 in two staged and complete flap necrosis in 9\113 in single staged vs 2\103 in two staged as shown in table [3].

Complication: Complications founded in 77\113 of single staged vs 23\103 in two staged in form of venous insufficiency 11\113 single staged vs 4\103, wound dehiscence in 6\113 in single staged vs 2\103 in two staged, desquamation in 29\113 single staged vs 9 \103 two staged as shown in table [3].

Long term outcome: Secondary procedure in 15\113 single staged vs 1\103 two staged, pedicle morbidity in 2\113 single staged vs 1\103 two staged, donor site morbidity in 2\113 single staged vs 1\103 two staged, mean time to failure was 2.7 days and mean hospital stay was 26.7 days as shown in table [4].

Healing: Seven studies assessing rate of healing among two groups showing that there were insignificant differences [table 5, figure 2].

Venous insufficiency: Seven studies assessing rate of venous insufficiency among two groups showing that there were insignificant differences [table 6, figure 3].

Wound dehiscence: Seven studies assessing rate of wound dehiscence among two groups showing that there were insignificant differences [table 7, figure 4].

Desquamation: Seven studies assessing rate of desquamation among two groups showing that there were insignificant differences [table 8, figure 5].

Partial necrosis: Seven studies assessing rate of Partial necrosis among two groups showing that there were insignificant differences [table 9, figure 6].

Complete flap necrosis: Seven studies assessing rate of complete flap necrosis among two groups showing that there were insignificant differences [table 10, figure 7].

Secondary procedures: Seven studies assessing rate of secondary procedures among two groups showing that there were insignificant differences [table 11, figure 8].

Hospital-stay\days: Three studies assessing rate of hospital-stay\days among two groups showing significant longer stay among single staged group [table 12, figure 9].

Table [1]: Study and Patients' characteristics

Author	Study type	Patients' characteristics		
		No.	Age	m\f
Shtutin *et al.* [12]	Retrospective	21	39.6	19\2
Rihan *et al.* [10]	comparative study	20	45	14\6
Sahu *et al.* [11]	Retrospective	12	34.2	9\3
Saaiq and Zimri [7]	comparative study	34	28.82	27\7
Cui *et al.* [13]	Retrospective	10	41.5	7\3
Raza *et al.* [14]	Retrospective	87	36.7	74\13
Maazil [15]	Retrospective	22	17	16\6

Table [2]: Lesion characteristics

Author	Etiologies	Site of the defect	size\cm	Surgery time\min	follow up\mo.
Shtutin *et al.* [12]	High-energy mechanical injuries [n=8, 38.1%], gunshot explosive wounds [n=9, 42.9%], complications after osteosynthesis [n=2, 9.5%], complications of Achilles tendon suture [n=2, 9.5%]. Injury following high-energy trauma was observed in 17 [81%]	distal leg, ankle joint, Achilles tendon, heel area, middle and forefoot	87±6.7	127±18	6
Rihan *et al.* [10]	Diabetic neuropathy and ischemia	The heel in 15 cases [75%], the ankle in 3 cases [15%] and the distal third leg in 2 cases [10%].			12
Sahu *et al.* [11]	Traumatic, chronic, nonhealing ulcers				
Saaiq and Zimri [7]		Hind foot [n=17; 50%], ankles [n=6; 17.64%], heel [n=5; 14.70%], distal third of leg [n=4; 11.76%] and dorsum of proximal third of foot [n=2; 5.88%].	82.11±5 1.54		
Cui *et al.* [13]	Car accident, heat stress				
Raza *et al.* [14]	Trauma, Diabetic ulcers, Trophic ulcers				
Maazil [15]	trauma in 15 patients, post-surgical excision in 2 patients and unstable scar and burn in 5 patients	Distal leg, Ankle and tendo-achilles, Sole of foot, Dorsum of foot, Heal			36

Table [3]: Outcome and complications

		Outcome				Complications			
Author		**No.**	**Healed**	**Partial necrosis**	**Complete flap necrosis**	**Total No.**	**Venous insufficiency**	**Wound dehiscence**	**Desquamation**
Shtutin *et al.* [12]	Single Staged	9	8	0	1	10	4	3	2
	Two Staged	12	12	0	0	4	2	2	0
Rihan *et al.* [10]	Single Staged	10	8	4	3	17	7	3	0
	Two Staged	10	9	2	1	5	2	0	0
Sahu *et al.* [11]	Single Staged	6	3	3	0	3	0	0	0
	Two Staged	6	5	1	0	1	0	0	0
Saaiq and Zimri [7]	Single Staged	17	14	3	3	12		0	6
	Two Staged	17	16	0	1	1	0	0	0
Cui *et al.* [13]	Single Staged	10	8	0	2	2	0	0	0
	Two Staged	10	10	0	0	0	0	0	0
Raza *et al.* [14]	Single Staged	46	46	12	0	33	0	0	21
	Two Staged	41	41	3	0	12	0	0	9
Maazil [15]	Single Staged	15	15	0	0	0	0	0	0
	Two Staged	7	7	0	0	0	0	0	0

Table [4]: Long term outcome

Author		No.	Secondary procedures	Pedicle morbidity	Donor site morbidity	Time to failure\days	Hospital-stay\days
Shtutin *et al.* [12]	Single staged	9	0	0	0	2.5	36.8±4.2
	Two staged	12	0	0	0		23.2±3.7
Rihan *et al.* [10]	Single staged	10	2	2	2		
	Two staged	10	0	1	1		
Sahu *et al.* [11]	Single staged	6	0	0	0	3	
	Two staged	6	0	0	0		
Saaiq and Zimri [7]	Single staged	17	13	0	0		14.61±1.93
	Two staged	17	1	0	0		14.61±1.93
Cui *et al.* [13]	Single staged	10	0	0	0		
	Two staged	10	0	0	0		
Raza *et al.* [14]	Single staged	46	0	0	0		43.1 ±3.6
	Two staged	41	0	0	0		27.9 ±2.1
Maazil [15]	Single staged	15	0	0	0		
	Two staged	7	0	0	0		

Table [5]: Meta-analysis for healed

Study	Single staged		Two staged		RR	95% CI
	Total	Event	Total	Event		
Shtutin *et al.* [12]	9	8	12	12	0.884	0.667 to 1.172
Rihan *et al.* [10]	10	8	10	9	0.889	0.612 to 1.290
Sahu *et al.* [11]	6	3	6	5	0.600	0.250 to 1.442
Saaiq and Zimri [7]	17	14	17	16	0.875	0.681 to 1.124
Cui *et al.* [13]	10	8	10	10	0.810	0.573 to 1.144
Raza *et al.* [14]	46	46	41	41	–	–
Maazil [15]	15	15	7	7	–	–
Total [fixed effects]					0.839	0.717 to 0.982
Total [random effects]					0.858	0.740 to 0.995
Test for heterogeneity						
Q	0.934					
DF	4					
Significance level	0.9196					
I^2 [inconsistency]	0.00%					
95% CI for I^2	0.00 – 16.16					

Q: Total variance for heterogeneity; RR: Relative Risk; I^2: Observed variance for heterogeneity; CI: Confidence interval [LL: Lower limit –UL: Upper Limit].

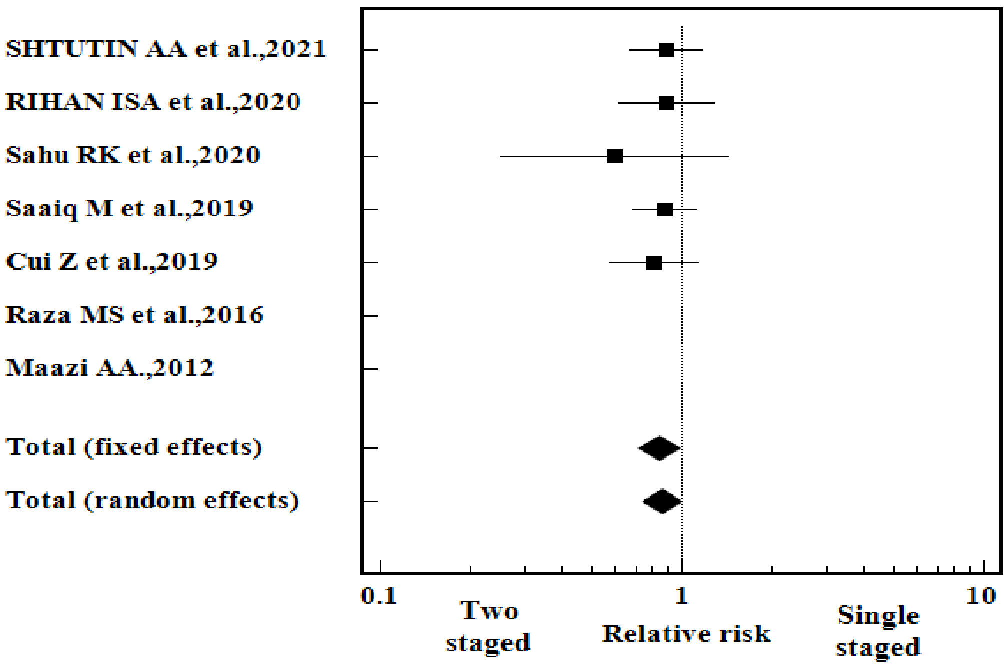

Figure [2]: Forest plot for healed

Table [6]: Meta-analysis for venous insufficiency

Study	Single staged		Two staged		RR	95% CI
	Total	Event	Total	Event		
Shtutin *et al.* [12]	9	4	12	2	2.667	0.619 to 11.493
Rihan *et al.* [10]	10	7	10	2	3.500	0.950 to 12.898
Sahu *et al.* [11]	6	0	6	0	–	–
Saaiq and Zimri [7]	17	0	17	0	–	–
Cui *et al.* [13]	10	0	10	0	–	–
Raza *et al.* [14]	46	0	41	0	–	–
Maazil [15]	15	0	7	0	–	–
Total [fixed effects]					3.115	1.180 to 8.228
Total [random effects]					3.102	1.173 to 8.208
Test for heterogeneity						
Q	0.07414					
DF	1					
Significance level	0.7854					
I^2 [inconsistency]	0.00%					
95% CI for I^2	0.00 to 0.00					

Q: Total variance for heterogeneity; RR: Relative Risk; I^2: Observed variance for heterogeneity; CI: Confidence interval [LL: Lower limit –UL: Upper Limit].

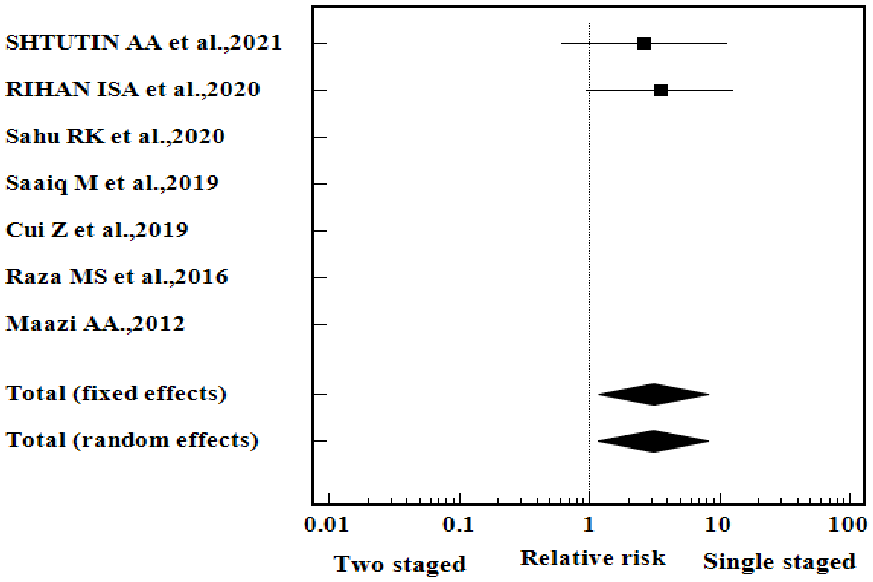

Figure [3]: Forest plot for venous insufficiency

Table [7]: Meta-analysis for wound dehiscence

Study	Single staged		Two staged		RR	95% CI
	Total	Event	Total	Event		
Shtutin *et al.* [12]	9	3	12	2	2.000	0.417 to 9.581
Rihan *et al.* [10]	10	3	10	0	7.000	0.408 to 120.164
Sahu *et al.* [11]	6	0	6	0	–	–
Saaiq and Zimri [7]	17	0	17	0	–	–
Cui *et al.* [13]	10	0	10	0	–	–
Raza *et al.* [14]	46	0	41	0	–	–
Maazil [15]	15	0	7	0	–	–
Total [fixed effects]					3.129	0.799 to 12.248
Total [random effects]					2.678	0.679 to 10.560
Test for heterogeneity						
Q	0.6217					
DF	1					
Significance level	0.4304					
I^2 [inconsistency]	0.00%					
95% CI for I^2	0.00 to 0.00					

Q: Total variance for heterogeneity; RR: Relative Risk; I^2: Observed variance for heterogeneity; CI: Confidence interval [LL: Lower limit –UL: Upper Limit].

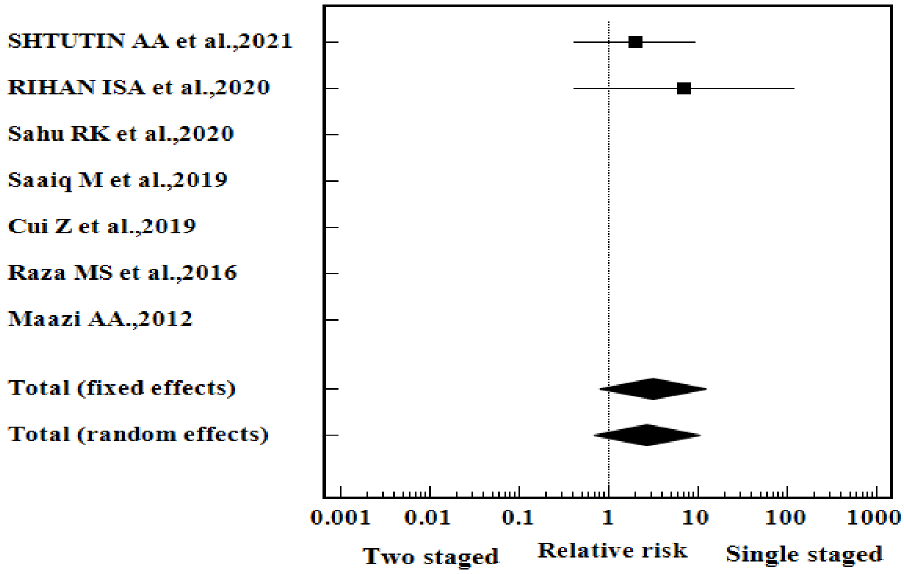

Figure [4]: Forest plot for wound dehiscence

Table [8]: Meta-analysis for desquamation

Study	Single staged		Two staged		RR	95% CI
	Total	Event	Total	Event		
Shtutin *et al.* [12]	9	2	12	0	6.5	0.350 to 120.803
Rihan *et al.* [10]	10	0	10	0	–	
Sahu *et al.* [11]	6	0	6	0	–	
Saaiq and Zimri [7]	17	6	17	0	13	0.789 to 214.062
Cui *et al.* [13]	10	0	10	0	–	
Raza *et al.* [14]	46	21	41	9	2.08	1.077 to 4.015
Maazil [15]	15	0	7	0	–	
Total [fixed effects]					2.786	1.497 to 5.186
Total [random effects]					2.732	1.122 to 6.656
Test for heterogeneity						
Q	2.2435					
DF	2					
Significance level	0.3257					
I^2 [inconsistency]	10.86%					
95% CI for I^2	0.00 to 97.01					

Q: Total variance for heterogeneity; RR: Relative Risk; I^2: Observed variance for heterogeneity; CI: Confidence interval [LL: Lower limit –UL: Upper Limit].

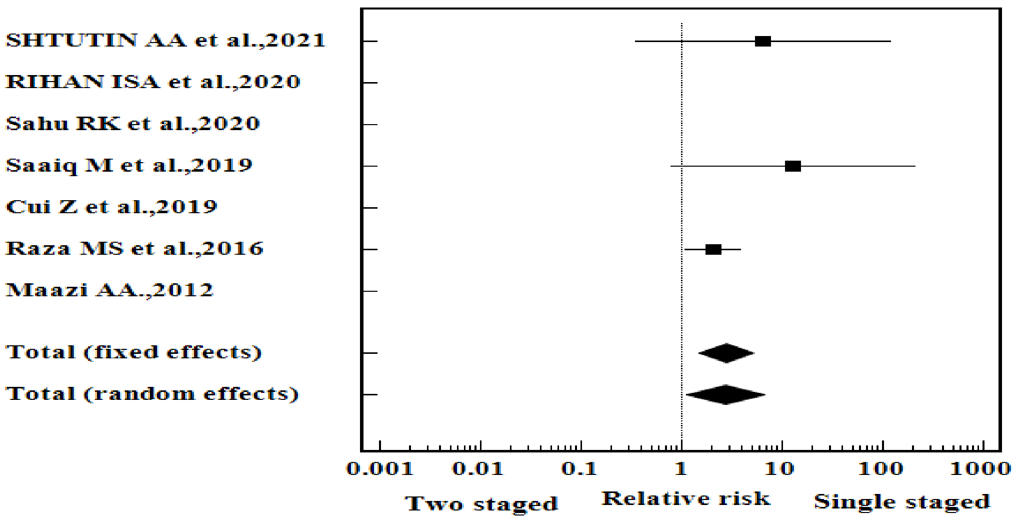

Figure [5]: Forest plot for desquamation

Table [9]: Meta-analysis for Partial necrosis

Study	Single staged		Two staged		RR	95% CI
	Total	Event	Total	Event		
Shtutin *et al.* [12]	9	0	12	0	–	–
Rihan *et al.* [10]	10	4	10	2	2	0.467 to 8.557
Sahu *et al.* [11]	6	3	6	1	3	0.423 to 21.298
Saaiq and Zimri [7]	17	3	17	0	7	0.389 to 125.994
Cui *et al.* [13]	10	0	10	0	–	–
Raza *et al.* [14]	46	12	41	3	3.565	1.081 to 11.755
Maazil [15]	15	0	7	0	–	–
Total [fixed effects]					3.269	1.463 to 7.305
Total [random effects]					3.06	1.373 to 6.822
Test for heterogeneity						
Q	0.7332					
DF	3					
Significance level	0.8654					
I^2 [inconsistency]	0.00%					
95% CI for I^2	0.00 – 47.17					

Q: Total variance for heterogeneity; RR: Relative Risk; I^2: Observed variance for heterogeneity; CI: Confidence interval [LL: Lower limit –UL: Upper Limit].

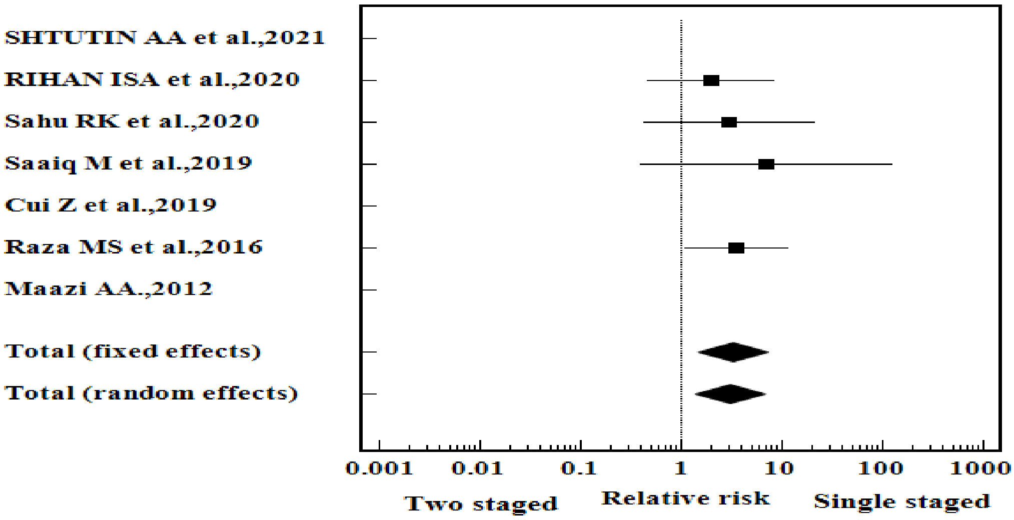

Figure [6]: Forest plot for Partial necrosis

Table [10]: Meta-analysis for complete flap necrosis

Study	Single staged		Two staged		RR	95% CI
	Total	Event	Total	Event		
Shtutin *et al.* [12]	9	1	12	0	3.900	0.177 to 85.940
Rihan *et al.* [10]	10	3	10	1	3.000	0.372 to 24.172
Sahu *et al.* [11]	6	0	6	0	–	–
Saaiq and Zimri [7]	17	3	17	1	3.000	0.346 to 26.041
Cui *et al.* [13]	10	2	10	0	5.000	0.270 to 92.627
Raza *et al.* [14]	46	0	41	0	–	–
Maazil [15]	15	0	7	0	–	–
Total [fixed effects]					3.474	1.022 to 11.806
Total [random effects]					3.421	1.004 to 11.652
Test for heterogeneity						
Q	0.1018					
DF	3					
Significance level	0.9916					
I^2 [inconsistency]	0.00%					
95% CI for I^2	0.00 to 0.00					

Q: Total variance for heterogeneity; RR: Relative Risk; I^2: Observed variance for heterogeneity; CI: Confidence interval [LL: Lower limit –UL: Upper Limit].

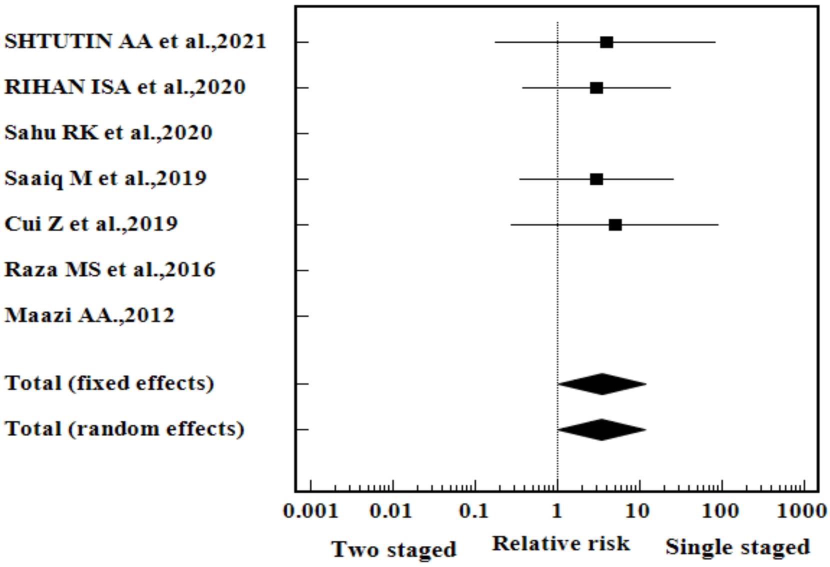

Figure [7]: Forest plot for complete flap necrosis

Table [11]: Meta-analysis for secondary procedures

Study	Single staged		Two staged		RR	95% CI
	Total	Event	Total	Event		
Shtutin *et al.* [12]	9	0	12	0	–	–
Rihan *et al.* [10]	10	2	10	0	5	0.270 to 92.627
Sahu *et al.* [11]	6	0	6	0	–	–
Saaiq and Zimri [7]	17	13	17	1	13	1.907 to 88.644
Cui *et al.* [13]	10	0	10	0	–	–
Raza *et al.* [14]	46	0	41	0	–	–
Maazil [15]	15	0	7	0	–	–
Total [fixed effects]					10.33	2.114 to 50.522
Total [random effects]					9.742	1.959 to 48.444
Test for heterogeneity						
Q	0.2925					
DF	1					
Significance level	0.5886					
I^2 [inconsistency]	0.00%					
95% CI for I^2	0.00 to 0.00					

Q: Total variance for heterogeneity; RR: Relative Risk; I^2: Observed variance for heterogeneity; CI: Confidence interval [LL: Lower limit –UL: Upper Limit].

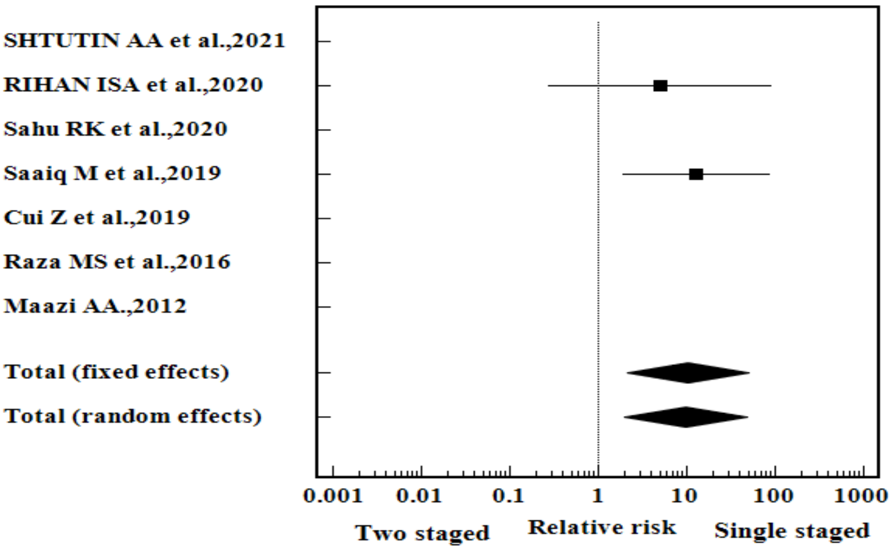

Figure [8]: Forest plot for secondary procedures

Table [12]: Meta-analysis for hospital-stay\days

Study	Single staged		Two staged		SMD	SE	95% CI
	No.	Mean ± SD.	No.	Mean ± SD.			
Shtutin *et al.* [12]	9	36.8 ± 4.2	12	23.2 ± 3.7			
Saaiq and Zimri [7]	17	14.61 ± 1.93	17	14.61 ± 1.93			
Raza *et al.* [14]	46	43.1 ± 3.6	41	27.9 ± 2.1			
Total [fixed effects]							
Total [random effects]							
Test for heterogeneity							
Q							
DF							
Significance level							
I^2 [inconsistency]							
95% CI for I^2							

Q: Total variance for heterogeneity; RR: Relative Risk; I^2: Observed variance for heterogeneity; CI: Confidence interval [LL: Lower limit –UL: Upper Limit].

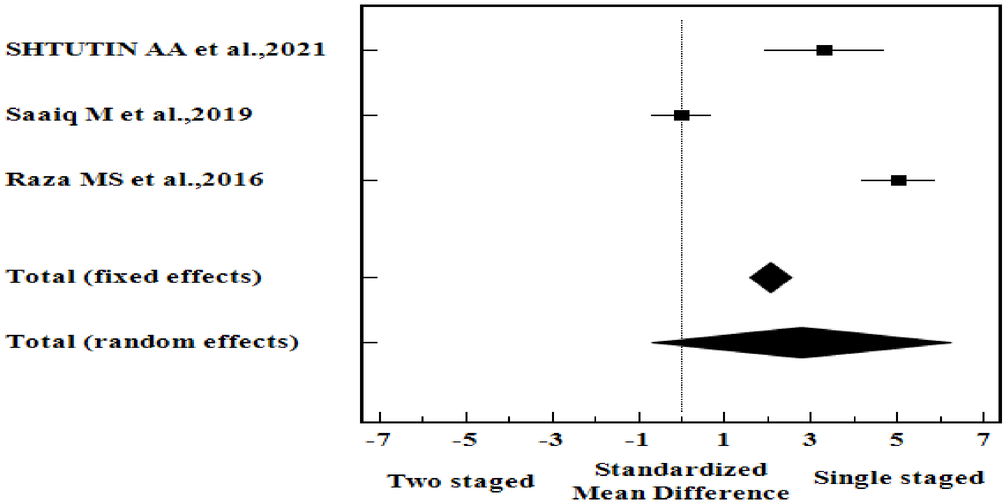

Figure [9]: Forest plot for hospital-stay\day

DISCUSSION

This meta-analysis included the recent updates as we retrieved 77 references to studies. After examination of the titles and abstracts of these references, we eliminated all of those which did not match our inclusion criteria and those which were clearly ineligible from the review. We obtained full text copies of the remaining 7 potentially eligible trials for further evaluation.

As regard demographic data; Patient's characteristics; 206 cases were included with mean age 34.6 years. The majority of them were males.

Our results were supported by study of **Cui *et al.*** [13] as they reported that ten patients were treated with the same surgical plan for wound repair. The patients comprised seven males and three females ranging in age from 18 to 65 years. Also, in the study of **Raza *et al.*** [14], distally based sural artery flaps in 87 patients requiring coverage of distal lower limb were studied, retrospectively. They were divided into two groups. G1 included 46 cases in which distally based sural artery flap was islanded. G2 included 41 cases in which flap was not islanded and pedicle was raised. The mean age of patients was 38.4 ±16.2 years in G1 and 35.1 ±18.6 years in G2. The majority of both groups were males.

The present study showed that as regard etiology most commonly were High-energy mechanical injuries, gunshot explosive wounds, complications after osteosynthesis, Injury following high-energy trauma, diabetes neuropathy and ischemia, traumatic, chronic, non-healing ulcers, car accident, heat stress. Regarding site were distal leg, ankle joint, Achilles tendon, heel area, middle and forefoot, distal third leg, Hind foot dorsum of proximal third of foot. Mean size of defect was 84.5 cm, mean surgical time was 127±18 minutes and mean follow up was 18 months.

Our results were supported by study of **Sahu *et al.*** [11] as they reported that wounds of diverse etiologies [traumatic, chronic, non-healing ulcers] were reviewed. Trauma was the most common etiology with eight out of twelve patients [66.7%].

In the study of **Saaiq and Zimri** [7] the flap size ranged from 5×5 cm [25 cm2] to 15×15 cm [225 cm2] with a mean size of 82.11±51.54 cm2. The wound locations were as follows: Hind foot [n=17; 50%], ankles [n=6; 17.64%], heel [n=5; 14.70%], distal third of leg [n=4; 11.76%] and dorsum of proximal third of foot [n=2; 5.88%].

Furthermore, **Rihan *et al.*** [10] revealed that main etiological factor was diabetes with additional factor like neuropathy in 11 cases and ischemia in 9 cases. Different sites of defect had encountered: The heel in 15 cases [75%], the ankle in 3 cases [15%] and the distal third leg in 2 cases [10%]. Average size of flaps drawn ranged from [5 X 6 cm] to [10 X 14 cm] with mean [7.5 X 10 cm].

The lower third of the leg and around the heel poses a demanding reconstructive scenario. The paucity of soft tissue in this region decreases the local flap reconstructive options. Lack of adequate recipient vessels in the trauma zone, scarcity of qualified expertise and operating microscope in low-resource settings make microsurgical reconstruction an arduous possibility [16].

The distally based RSF is considered an ideal alternative in such reconstructive dilemmas. The classic technique of flap harvest is a single-staged cutaneous islanded reverse sural flap [SS-RSF] method where the cutaneous part of flap is islanded and the pedicle is subcutaneously tunneled to reach the wound defect. However, partial and total flap necrosis is variably seen with this method. The most common reason for flap necrosis is venous congestion due to extrinsic compression by the tight overlying skin bridge [17].

One way to prevent subcutaneous tunnel is to make a skin incision between pedicle base and the flap margin. The flap pedicle is then covered with a split thickness skin graft [SSG]. Nevertheless, there always exists the possibility of pedicle compression due to graft tension. Various modifications have been suggested to avoid this complication. Supercharged sural flap is one such modification. However, this procedure requires microsurgical expertise and is technically demanding [18].

The current study showed that as regard outcome healed was in 102\113 in single tagged vs 100\103 in two staged; Partial necrosis founded in 22\113 in single staged vs 6\103 in two staged and complete flap necrosis in 9\113 in single staged vs 2\103 in two staged. As regard long-term outcome; Secondary procedure in 15\113 single staged vs 1\103 two staged, pedicle morbidity in 2\113 single staged vs 1\103 two staged, donor site morbidity in 2\113 single staged vs 1\103 two staged, mean time to failure was 2.7 days and mean hospital stay was 26.7 days.

Seven studies assessing rate of healing among two groups showing that there were insignificant differences. Seven studies assessing rate of venous insufficiency among two groups showing that there were insignificant differences. Seven studies assessing rate of wound dehiscence among two groups showing that there were insignificant differences.

In the study of **Sahu *et al.*** [11], five out of six [83.3%] of the flaps operated by two-stage reverse sural flap [TS-RSF] healed uneventfully. The remaining one patient was a diabetic patient who had partial flap necrosis in the distal part. Flap necrosis was noted on the third postoperative day of the stage one of the procedures. It was managed with debridement of the necrosed area and secondary healing with regular dressings. In the SS-RSF group, three out of six [50%] had partial flap necrosis. The necrosed part in these flaps was managed by debridement followed by skin grafting in two patients and regular dressing in the remaining one patient. All complicated flaps healed well subsequently.

In a study conducted by **Cui *et al.*** [13], the duration of tibial exposure ranged from 5 to 20 days [mean, 14 ± 7.3 days]. After reverse sural fasciocutaneous flap [RSFF] surgery, local skin flap necrosis occurred in two patients, and all wounds in the remaining eight patients healed. These necrotic sites were located at the extreme or marginal parts of the flap. The necrotic sites were not located on the previously exposed surface of the tibia and were repaired using split-thickness skin grafts during the repeated RSFF procedure. In all 10 patients, the repeated RSFF survived without local necrosis. The wounds of all 10 patients healed; 7 patients underwent two operations, two patients underwent three operations, and one patient underwent four operations.

Calf injuries with resultant pretibial skin defects and tibial exposure are very common in the clinical setting and are often associated with fracture and nerve vascular injury. It is relatively easy to manage a small area of tibial exposure with a local skin flap; however, large areas of tibial exposure, especially areas longer than 20 cm, are difficult to completely cover using this strategy. Local flap transfer is not a good choice in these cases because the tibial exposure is often accompanied by extensive anterior and peripheral skin defects. When the length-to-width ratio of the skin flap is too large, the patient is more susceptible to blood flow disorders or even necrosis. When free flap transplantation is performed, great damage at the donor site may occur when the tibia is exposed by more than 20 cm, and the operation is often complicated and time-consuming; furthermore, poor blood circulation can lead to necrosis and increase the surgical risk [19].

Cross-leg skin flaps have also been used to repair such injuries, but patients with cross-leg skin flaps have difficulties in activities of daily living and require nursing care during the postoperative fixation period. For small areas of bone exposure, such as those less than 3 cm in diameter or after a tibial periosteal retention procedure, granulation tissue formation can be induced by drilling the cortical bone or using tissue-engineered dermal materials; the wound can then be covered using split-thickness skin grafts. However, when the wound is too large, especially in cases accompanied by periosteal loss, granulation tissue does not readily form on the surface of cortical bone. Moreover, flaps are always recommended for the repair of large anterior tibial skin defects to avoid subsequent repeated collapse. Therefore, cultivation of granulation tissue followed by application of split-thickness skin grafts is not recommended for large areas of tibial exposure [20].

Sural fasciocutaneous flaps include sural nerve flaps, sural neurovascular flaps, sural flaps, and sural fasciocutaneous flaps. These flaps can be used either in the forward or reverse direction; when used in reverse, they are termed RSFFs. RSFFs are widely used in the clinical repair of soft tissue defects of the calf or foot. However, because of their width limitations, it is difficult to cover exposed tibial surfaces of more than 20 cm in length. If the flap covers the distal end of the tibia, the proximal wound is still exposed. If the proximal wound is covered, the distal wound is still exposed [21].

Moreover, **Raza *et al.*** [14] revealed that the mean number of surgeries in G1 was 3 ±1 while that in G2 was 2 ±1. The highest number of surgeries in a single patient in G1 was 5, and 3 in G2 [p < 0.001]. In G2, division and in setting was required as a second procedure in 34 cases; 5 did not require division and in setting while the remaining 2 did not opt for a secondary procedure. The difference in mean hospital stay was also significant [p < 0.001] with mean stay in G1 of 43.1 ±3.6 days with the longest stay in any one patient being 78 days and the shortest being 13 days. The mean hospital stay in G2 was 27.9 ±2.1 days with longest stay of 59 days and the shortest of 13 days. Return to work was also significantly early in G2 [p=0.0127]. In G1, the mean time for return to work was 17.5 ±3.1 weeks while in G2 it was 16.2 ±1.1 weeks. The longest stay off work was 32 weeks in a patient from G2 and was attributed to the patient developing myocardial infarction while recovering from the ankle injury.

Furthermore, **Rihan *et al.*** [10] stated that in Group [A] patients with super drainage technique: In the second day postoperatively, two cases [20%] had venous congestion [cases no. 5 and no. 8]. This congestion was not relived by local subcutaneous injection of heparin and ended with partial flap necrosis at the fifth day, then one of the two flaps [no. 8] had complete flap necrosis and flap loss [another flap reconstruction was done]. This case also showed wound dehiscence, and graft loss at the pedicle and the donor site areas. All other flaps showed complete healing without complications. In Group [B] patients with standard technique: Venous congestion occurred in seven cases [70%] which ended in partial flap necrosis in four cases [40%] cases [no. 2, 3, 6 and 8] and complete flap necrosis in three cases [30%] cases [no. 1, 5 and 9]. Also, wound dehiscence was reported in the three cases with complete flap loss that underwent secondary surgery for re-stitching. Skin re-grafting was performed in 2 [20%] cases at the pedicle and the donor site area. Comparison between these groups was statistically significance for the above-mentioned differences [p<0.005].

Our results showed that complications founded in 77\113 of single staged vs 23\103 in two staged in form of venous insufficiency 11\113 single staged vs 4\103, wound dehiscence in 6\113 in single staged vs 2\103 in two staged, desquamation in 29\113 single staged vs 9 \103 two staged.

Seven studies assessing rate of desquamation among two groups showing that there were insignificant differences. Seven studies assessing rate of Partial necrosis among two groups showing that there were insignificant differences. Seven studies assessing rate of complete flap necrosis among two groups showing that there were insignificant differences. Seven studies assessing rate of secondary procedures among two groups showing that there were insignificant differences. 3 studies assessing rate of hospital-stay\days among two groups showing significant longer stay among single staged group.

In the study of **Sahu *et al.*** **[11]** all complicated flaps healed well subsequently. No donor site complication was found in any of their patients.

According to **Cui *et al.*** **[13]**, all 10 patients were followed for 6 months, and the wounds healed without infection or ulceration and with good limb function. All patients returned to their previous occupation and daily activities. There were no cases of pain or numbness at the wound site or at the end of the limb. The general condition of each limb was good. The doctors evaluated the results as satisfactory. Although scar hyperplasia developed in the area of the skin grafts and the edge of the flap, the limb function was minimally affected because the hyperplasia was not located at the joint. The overall outcomes were satisfactory.

In addition, **Raza *et al.*** **[14]** reported that the most important and significant differences were in the early flap related complications. None of the flaps in either group developed complete flap necrosis. There was epidermolysis in 21 [46%] out of 46 islanded reverse sural artery flaps [G1] while 9 [22%] out of 41 non-islanded flaps [G2] developed this complication [p=0.020]. Partial necrosis occurred in 12 [26%] of flaps in G1 and in only 3 [7%] of the G2 flaps [p= 0.024]. The hospital stay was 13-19 days with a mean stay of 14.61±1.93 days.

Furthermore, in the study of **Saaiq and Zimri** **[7]**, thirty-four patients were enrolled, while half randomly underwent interpolated flap design [group A] and for half, islanded flap design [group B]. In group B, the complications included epidermolysis [n=6; 35.29%], flap tip necrosis [n=3; 17.64%] and partial flap necrosis [n=3; 17.64%]. In group A, they encountered one case [5.88%] of tip necrosis. In group B, a total of 13 [76.47%] secondary procedures were carried out to address the various flap related complications; whereas in group A, one additional procedure was required for addressing the complication of flap tip necrosis [n=1; 5.88%].

Moreover, **Rihan *et al.*** **[10]** demonstrated that rate of complication in cases super-drainage technique was fewer than cases reconstructed with standard flap technique, there were only two cases that had slight venous congestion This congestion was not relived by local subcutaneous injection of heparin and ended with partial flap necrosis at the fifth day, then one of the two flaps had complete flap necrosis and flap loss [another flap reconstruction was done]. All other flaps showed complete healing without complications. In contrary to cases reconstructed with standard flap technique, venous congestion occurred in seven cases which ended in partial flap necrosis in four of them and complete flap necrosis in three cases. Wound dehiscence reported in three cases that underwent secondary surgery for re-stitching and skin re-grafting was performed in two cases at the pedicle and the donor site area.

Conflict of Interest and Financial Disclosure: None.

REFERENCES

1. Parrett BM, Pribaz JJ, Matros E, Przylecki W, Sampson CE, Orgill DP. Risk analysis for the reverse sural fasciocutaneous flap in distal leg reconstruction. Plast Reconstr Surg. 2009 May;123[5]:1499-1504. doi: 10.1097/PRS.0b013-e3181a07723.
2. Korompilias A, Gkiatas I, Korompilia M, Kosmas D, Kostas-Agnantis I. Reverse sural artery flap: a reliable alternative for foot and ankle soft tissue reconstruction. Eur J Orthop Surg Traumatol. 2019; 29[2]:367-372. doi: 10.1007/s00590-018-2330-8.
3. Dhamangaonkar AC, Patankar HS. Reverse sural fasciocutaneous flap with a cutaneous pedicle to cover distal lower limb soft tissue defects: experience of 109 clinical cases. J Orthop Traumatol. 2014 Sep;15[3]:225-9. doi: 10.1007/ s10195-014-0304-0.
4. Ciofu RN, Zamfirescu DG, Popescu SA, Lascar I. Reverse sural flap for ankle and heel soft tissues reconstruction. J Med Life. 2017 Jan-Mar;10[1]:94-98. PMID: 28255387.

5. He JY, Chen SH, Kumar KK, Fan ZH, Lao J, Tien H. Anatomical study of anterior supramalleolar artery and its potential application to design a bi-foliate fasciocutaneous flap. Indian J Plast Surg. 2015 Jan-Apr;48[1]:17-21. doi: 10.4103/0970-0358.155262.

6. Follmar KE, Baccarani A, Baumeister SP, Levin LS, Erdmann D. The distally based sural flap. Plast Reconstr Surg. 2007 May;119[6]:138e-148e. doi: 10.1097/01.prs.0000259203.79909.7e.

7. Saaiq M, Zimri FUK. Reverse Flow Superficial Sural Artery Fasciocutaneous Flap: A Comparison of Outcome between Interpolated Flap Design versus Islanded Flap Design. World J Plast Surg. 2019;8[3]:316-323. doi: 10.29252/wjps.8.3.316.

8. Goil P, Sharma AK, Gupta P, Srivastava S. Comparison of the outcomes of adipofascial and two-staged fasciocutaneous reverse sural flap in patients with lower leg trauma. J Clin Orthop Trauma. 2020 Jul 31;14:113-120. doi: 10.1016/j. jcot.2020.07.025.

9. Chang SM, Li XH, Gu YD. Distally based perforator sural flaps for foot and ankle reconstruction. World J Orthop. 2015 Apr 18; 6[3]:322-30. doi: 10.5312/wjo.v6.i3.322.

10. Rihan AA, Ali AA, Hifny MA, Said SA. Superdrainage reverse-flow sural flap for distal leg and foot reconstruction: a method to overcome venous congestion in diabetic patients. The Egypt J Plast Reconstr Surg. 2020 Jan 1;44[1]:137-43. doi: 10.21608/ejprs.2020.88934.

11. Sahu RK, Kala PC, Midya M. Two-staged reverse sural flap: a versatile flap with consistent results in the soft tissue reconstruction of distal leg and heel defects-an institutional experience. Eur J Orthop Surg Traumatol. 2020 Feb;30[2]:337-341. doi: 10. 1007/s00590-019-02544-x.

12. Shtutin AA, Mikhailichenko VYu, Shtutin IA, Samarin SA. Closure of distal defects of the lower extremity with a sural flap. Plast Surg Aesthetic Med. 2021;1:52-7. doi: 10.17116/plast.hirurgia-202101152.

13. Cui Z, Zhang X, Shou J, Yin G. Repeated reverse sural fasciocutaneous flap is an effective surgical strategy for repairing long segmental soft tissue defects of the tibia. J Int Med Res. 2019 Oct;47[10]: 5003-5009. doi: 10.1177/0300060519874154.

14. Raza MS, Nazir U, Ansari HH, Khan FA. Non-Islanded Distally Based Sural Artery Flap: A Reliable Solution for an Unreliable Flap. J Coll Physicians Surg Pak. 2016 Apr;26[4]:310-4. PMID: 27097704.

15. Maazill AA. Distally Based Sural Fascio-cutaneous Flap for Soft Tissue Reconstruction of The Distal Leg, Ankle and Foot Defects. Kufa Med J. 2012;15[1]:232-8.

16. Olawoye OA, Ademola SA, Iyun K, Michael A, Oluwatosin O. The reverse sural artery flap for the reconstruction of distal third of the leg and foot. Int Wound J. 2014 Apr;11[2]:210-4. doi: 10.1111/j. 1742-481X.2012.01075.x.

17. de Rezende MR, Saito M, Paulos RG, Ribak S, Abarca Herrera AK, Cho ÁB, Mattar R Jr. Reduction of Morbidity With a Reverse-Flow Sural Flap: A Two-Stage Technique. J Foot Ankle Surg. 2018 Jul-Aug;57[4]:821-825. doi: 10.1053/j.jfas. 2017.11.020.

18. Herlin C, Bekara F, Bertheuil N, Carloni R, Dast S, Sinna R, Chaput B. Venous Supercharging Reduces Complications and Improves Outcomes of Distally Based Sural Flaps. J Reconstr Microsurg. 2017 Jun;33[5]:343-351. doi: 10.1055/s-0037-1598620.

19. Opara KO, Nwagbara IC. Reconstruction of complex soft-tissue defects around the knee using the proximally based sural Island fasciocutaneous flap. Niger J Clin Pract. 2018 Jun;21[6]:726-730. doi: 10.4103/njcp.njcp_174_17.

20. Yousaf MA, Abidin ZU, Khalid K, Haq AU, Khalid FA, Tarar FA, Asif MU, Tarar MN. Extended Islanded Reverse Sural Artery flap for Staged Reconstruction of Foot Defects Proximal to Toes. J Coll Physicians Surg Pak. 2018 Feb;28[2]: 126-128. doi: 10.29271/jcpsp.2018.02.126.

21. Lou X, Xue H, Li G, Wang K, Zhou P, Li B, Chen J. One-stage Pelnac Reconstruction in Full-thickness Skin Defects with Bone or Tendon Exposure. Plast Reconstr Surg Glob Open. 2018 Mar 21;6[3]:e1709. doi: 10.1097/GOX.000000000-0001709.

International Journal

https://ijma.journals.ekb.eg/

Print ISSN: 2636-4174
Online ISSN: 2682-3780

# of Medical Arts