

Original Article

“Soleus muscle flap for the coverage of pre-tibial defect of middle third of leg”

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Abstract

Soft tissue defects of the lower limb are a challenge to the plastic surgeon but a soleus muscle flap often provides the solution. Early reconstruction by soft tissue to cover exposed bone significantly reduces the risk of infection, nonunion and subsequent amputation. A Prospective, observational study was carried out in the Department of Plastic Surgery & Burn Unit, Dhaka Medical College Hospital and Department of Plastic Surgery, National Institute of Traumatology and Orthopaedic Rehabilitation, Dhaka, from September 2011 to March 2013. 30 cases were selected by purposive continuous sampling who had soft tissue defect in front of the middle third of the legs only. Proximally based soleus muscle transposition flap was done by standard operative procedure under spinal anaesthesia or general anaesthesia and under tourniquet control. After 2 months of operation, final follow-up was done. Regarding the outcome of flap surgery, 18 (60%) cases were found excellent. 7 (23.33%) cases were good, 3 (10%) were fair and 2 (6.66%) were poor. In the final follow up, according to the preset criteria for evaluation of wound coverage by soleus muscle flap, the satisfactory result (excellent and good) was 83.33%. Unsatisfactory (fair and poor) result was in 16.67% cases. Effective coverage of pretibial defect of middle third of leg by soleus muscle flap with satisfactory outcome was seen in this study.

Key Word : Soleus muscle flap, tibial soft tissue defect, mid tibial coverage.

Introduction

Soft tissue defects of the lower limb are a challenge to the plastic surgeon but a soleus muscle flap often provides the solution. The challenge is due to closeness of the skin to bone and poor circulation in that area.¹ About one third of the tibial circumference and most of its length is subcutaneous. The unique anatomy of the tibia with its associated soft tissue and their vulnerability to severe injury produces most of the problem like limb salvage, problems with soft tissue cover, infection and nonunion which are all too common and result in severe disability.² Early reconstruction by soft tissue to cover exposed bone significantly reduces the risk of infection, nonunion and subsequent amputation.³ The management of lower extremity has evolved over the last two decades to the point that

many extremities that would require amputation are routinely salvaged.^{5,6,7} This is mainly because of better understanding of anatomy and vascular patterns of the areas, resulting in expansion of available choices to cover a wide range of defects. Local options available for soft tissue coverage of leg include muscle, fasciocutaneous and adipofascial flaps.⁶ Free tissue transfer has now become the gold standard option for the large complex defects of the lower limb.^{5,8} Amongst the local options, the soleus muscle flap is still a widely used option for coverage of defect of the middle third of the leg.⁹ The improved knowledge of blood supply to the soleus muscle flap allows the design safer, longer and solution for some challenging soft tissue problems.

Muscle and musculocutaneous flaps were preferred to cutaneous flaps because experimental evidence suggests that the immediate source of blood supply is from muscle adjacent to the wound. The operative procedures for soleus flap are technically easier, required less time for wound preparation, can be a good means for controlling infection without limiting leg function. Thus an early coverage of pretibial soft tissue defect with soleus muscle flap is preferable.

The objective of the current study is to evaluate the observations of effectiveness of the use of soleus muscle

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flap to cover the defect of soft tissue from the pretibial region of the middle third of the leg.

Methods and material

This was a prospective observational type of clinical study, carried out on patients with pretibial soft tissue defect over the middle third of leg treated in Dhaka Medical College & Hospital and National Institute of Traumatology, Orthopedic and Rehabilitation (NITOR) during the period of September 2011 to March 2013 in the Department of Plastic Surgery. A total of 30 patients with soft tissue loss from the middle third of the front of leg were included. Excluded patients were, soft tissue loss extending beyond middle third of leg, patients with co-existing known vascular problems, patients with damaged vascular pedicle of muscle, patients with severe systemic co-morbidities, i.e. uncontrolled DM, uncontrolled hypertension, poly trauma patient with immediate life threatening condition.

Surgical Procedure : Harvesting of proximally based soleus muscle transposition flap was done by standard operative procedure under spinal or general anesthesia and under tourniquet control. The muscle was approached either through the medial incision or through a lateral incision. The standard flap was exposed through the medial incision. Half or total soleus muscle was used depending on the size of the wound, measured beforehand. The flaps were transposed and sutured in place with adjacent soft tissue edge. Split skin graft was done over the flap in the same procedure. Limb was splinted with Plaster of Paris. Fractures when present were stabilized by external fixator before the flap procedure.

Results

A total of 30 patients were operated to reconstruct the defect using soleus muscle flap. All the patients with trauma

and burn were treated with initial resuscitation; surgical debridement of the wound followed by fracture stabilization wherever indicated or limb immobilization by long leg posterior cast, when the condition become favorable definitive surgery was done to resurface the soft tissue defect(s). In cases where soft tissue loss follows tumor or scar excision, flap coverage was done at the same stage of operation. Stitches removed on 14th POD and the patient discharged with the splint or fixators. Patient was followed up at the end of 4th week and splint removed, in case of fracture external fixator kept as required. Flap was evaluated at this time according to the preset criteria. After 2 months of operation, final follow-up was done. 07 patients were followed up for 5 month, 17 patients were followed up for 2 months, 05 patients for 1 month and 1 patient never reported for any follow-up. All 30 patients were included for data analysis. Post-operative outcome of flap were excellent in 22 (%) case, 06 (%) were good and 02 (%) were poor as per definition.

That the major cause of pre-tibial soft tissue loss was RTA 17 (56.66%). It is followed by infection in 07 (23.33%), burn in 3 (10%) cases. Soft tissue defects were also a result of scar excision in 2 (6.66%) and after tumor (SCC) excision from mid tibial region in 1 (3.33%) cases. Among the 3 burn cases, 2 were electric burn 1 was flame burn.

Regarding time interval between the date of injury or excision surgery and the date of flap surgery, most of the operations, 14 (46.66%), were done within 1-2 weeks of the injury. The maximum delay is 43 days and the earliest coverage was done soon after the wound was made after excision of scar and tumor.

Table - I
Relation between time intervals with outcome.

Interval time between Injury and surgery	Frequency (n)	Outcome				Satisfactory (Excellent + Good)	Unsatisfactory (Fair+Poor)
		Excellent	Good	Fair	Poor		
Within 1 week	5	4	1	0	0	5	0
1 – 2 Week	14	10	3	1	0	13	1
2 – 3 Week	7	2	3	1	1	5	2
More than 3 week	4	2	0	1	1	2	2
Total	30	18	7	3	2	25(83.33%)	5(16.67%)

About the outcome variable with time of intervention of surgery, 19 cases operated within 2 week showed 18 satisfactory outcomes. 11 cases were operated after 2 week, of which only 7 had satisfactory outcome.

Table-II*Result of Pre and Post-operative wound swab culture & organisms found.*

Organism found in culture	Pre-operative		Post Operative	
	Frequency(n)	Percentage	Frequency(n)	Percentage
Pseudomonus	8	26.66%	4	13.33%
E. Coli	5	16.66%	1	3.33%
Proteus	2	6.66%	0	0%
Mixed	3	10.0%	1	3.33%
Total culture positive	18	60%	6	20%
Total culture negative	12	40%	24	80%

Table-III*Relation between presence of infection and outcome.*

Pre-operative wound swab culture	Post-operative wound swab culture	Outcome				Satisfactory	Unsatisfactory
		Excellent	Good	Fair	Poor		
Positive(n-18)	Positive(N-5)	9	4	3	2	13	5
Negative(n-12)		9	3	0	0	12	0
Total		18	7	3	2	25(83.33%)	5(16.67%)

In all the cases, wound swab culture was done immediately before operation. Out of 18 (60%) pre-operative culture positive cases, 5 cases remained positive after operation. Post-operative wound swab culture was done in cases where there was clinical evidence of infection. There were no symptoms and signs of infection in post-operative period in the 12 cases where pre-operative wound swab culture were negative.

Table-IV*Follow-up at 14th post-operative day.*

Follow up at	Frequency	Percentage
14 th POD	(n)	(%)
Viable flap	26	86.66%
Satisfactory Flap Adhesion	25	83.33%
Complete Wound healing	23	76.66%
Discharge	10	33.33%
Infection	7	23.33%
Wound breakdown	4	13.33%

In 26 (86.66%) cases the total flap were found viable. The rest 4 out of 30 cases, one case with more than 50% flap loss detected at 5th POD was treated later with cross-leg flap. Another 3 cases of marginal flap loss were treated with debridement and flap advancement. Case with more than 50% flap loss was also associated with purulent discharge, infection, and wound breakdown. Other 3 cases of marginal or less than 50% flap necrosis were all associated with wound

breakdown and incomplete healing at these follow up stage. Out of 30 cases 25 (83.33%) had satisfactory flap adhesion. Among the rest 5 (16.67%) cases, 2 with unsatisfactory adhesion and 3 with no adhesion were observed. Among the 2 unsatisfactory adhesion, one had both discharge and infection and other had only flap necrosis (< 50%).

Table-V*Overall post-operative complications.*

Complications	Number (n)	Percentage (%)
Flap loss	04	13.33%
Infection	06	20.0%
Wound breakdown	04	13.33%
Skin graft loss	06	20.0%
Total	20	

4 (13.33%) flap loss of variable dimension mentioned in Table-5 also had associated skin graft loss of variable percentage. 6 (20.0%) patient had clinical evidence of infection (purulent discharge, red and oedematous wound, local pain etc.). 6 patients had skin graft loss, 4 of them were associated with flap necrosis rest 2 had skin loss without underlying flap necrosis. There were 4 cases (13.33%) of wound breakdown, of which 3 included dehiscence of flap margin from the adjacent wound margin and 1 had dehiscence of donor site wound. It is to be noted that an individual case may had more than one complication mentioned in the table.

Table-IV
Final Outcome of flap based on preset criteria.

Outcome of flap	Frequency (n)	Percentage (%)	Final outcome	Frequency (n)	Percentage (%)
Excellent	18	60.0%	Satisfactory	25	83.33%
Good	7	23.33%			
Fair	3	10.0%	Unsatisfactory	05	16.67%
Poor	2	6.66%			

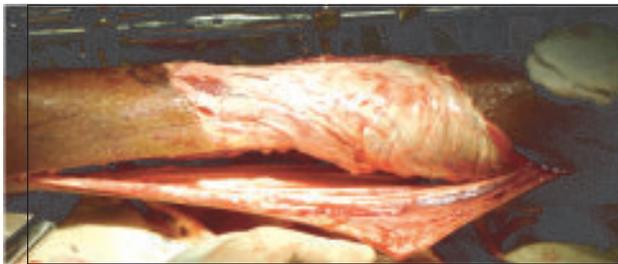
Excellent and good outcome were considered as satisfactory and fair and poor outcome were considered as unsatisfactory in the final outcome. Table shows 25 (83.33%) cases with satisfactory outcome and 5 (16.67%) cases with unsatisfactory outcome.



Pre-operative



Pre-operative



Wound is covered by the Soleus muscle flap



The Soleus muscle flap covered by the split thickness skin graft

Discussion

This study was designed to see the effectiveness the soleus muscle flap for coverage of pretibial soft tissue defect of middle third of leg. As a tertiary level hospital, significant number of patient came from different parts of the country for direct admission and from different hospital of the country as referred case to Dhaka Medical college Hospital or National Institute of Traumatology and Orthopaedic Rehabilitation, Dhaka.

The management of lower extremity trauma has evolved over the last two decades to the point that many extremities that would have required amputation are now routinely salvaged. Now a satisfactorily healed wound is not the only goal in lower extremity wound reconstruction, a good functional outcome for the patient is also of vital importance when planning reconstruction.¹¹ Since younger population is usually involved, the temptation is to save the limb at any cost. The evolving technology in trauma management today enable us to save the severest of injuries.¹² Out of 30 patients, age ranged from 8 years to 63 years, with a mean age 27.8 (SD±7.78). Among them, maximum 9 (30%) patients were between 31 years to 40 years of age. 31 to 40 years age population are the working group population of any society. They work outside and travel frequently and more susceptible to injury usually from road traffic accidents (RTA). This picture is similar to the study of Pu (2006) and Chowdhury et al. (2008), where mean age was 37 years and 37.5 years respectively.^{34,44} In the study of Caudle & Stern (1987), the age group ranged between 17years to 80 years.⁵

In the present study, two third of the affected cases were because of trauma (66.66%). Out of 20 trauma patients, 17 (56.66%) were the victim of RTA and among them 15 have associated open tibia or tibia-fibula fracture in addition to pretibial soft tissue loss. Other 3 trauma cases were due to deep burn injury. Next common cause of pretibial soft tissue defect was infection, which were 7 (23.33%) in number followed by scar excision 2 (6.66%) and tumor excision 1 (3.33%). Among the 7 infection cases, 4 were known diabetic, 1 was diagnosed as diabetes after admission in the hospital, rest 2 (6.66%) case of soft tissue defect were due to post

cellulites and was referred from other department for the coverage of exposed mid tibia. The indication of scar excision in 2 (6.66%) were unstable scar following initial burn injury. The only case of tumor excision was Squamous cell carcinoma (SCC) over the middle of pretibial area proved before excision by incision biopsy. In the study of Haq et al. (2000), one was injured from fire-arm injury, and remaining all from RTA.⁵ In the study of Small & Mollan (1992) and Pu (2000) most of the patients were the victim of RTA.

Out of total 30 cases fracture was present in 13 (43.33%) cases. All these cases were associated with RTA. All fractures were stabilized with external fixator prior to flap surgery.

The interval between injury and the flap coverage came out to be one of the most important factors regarding better outcome. 5 (16.66%) patient were operated within one week of injury, 14 (46.66%) were operated between 1-2 weeks, 7 (3.33%) between 2-3 weeks and 4 patients after 3 weeks. More of the flap surgery were done between 1-2 weeks. In the study of Pu (2006) and Shamsuzzaman et al. (2010), all flap surgery were done within 10 days and 5 days of initial trauma respectively.^{13,15} Pollak et al. (2000) reconstructed most of the flap within 7 days of surgery.¹⁶ In my series delayed intervention was performed in more cases compared to other series. In this series RTA was the major cause of soft tissue defect (56.66%). The treatments of these cases were initiated in different hospitals or different department of the same hospital which were referred later to the plastic surgery department. Other reasons of delay were patient overload and limited facilities.

In this series, wound swab for culture and sensitivity was performed in every case before and after the surgery. Initial swab was taken from the wound just before the antiseptic wash before surgery. No organism was found in the culture of 12 (40%) cases before operation. The rest 18 (60%) cases were culture positive. The common organism found in this study was *Pseudomonas*. All culture positive patients were treated with appropriate antibiotic according to sensitivity report.

In the study of Caudle & Stern (1987), *Pseudomonas* was the most common organism followed by *Enterococcus* and *Staphylococcus*.⁵ In the study of Uddin (2004), *Staphylococcus* was found in about half of the case series.¹⁷

In post operative wound swab, which was taken at 5th post operative day only in those cases where there were clinical evidence of infection. Here also the common organism was *Pseudomonas*.

In this study first follow up was done at 14th POD. Follow up regarding flap viability showed no flap necrosis in 26 (86.66%) cases. Marginal flap necrosis was present in 3 (10%) cases and more than 50% flap loss was found in one case. 3 patient with marginal necrosis were treated with minor procedures (debridement, flap advancement and STSG. One patient having more than 50% flap loss needed major procedure like cross-leg flap to cover the defect. In the study of Gopal et al. (2000), flap failure was 3.5%.³ In the study of Kaukmann et al. (2004) partial necrosis in one and flap failure in on patient (out of 12 patients), and that of Neale et al. (1982) were 8 and 5 respectively (out of 71 patients).^{18,19} In the study of Pu (2006), one patient developed flap necrosis (out of 14 patients) and was treated by debridement and flap advancement. Chittoria & Mishra (2000) reported 5% partial flap necrosis.^{13,20}

Regarding over all post-operative complications, this study shows 4 cases of flap loss of variable dimension. These 4 patients also had associated skin graft of variable percentage. 4 (13.33%) patients had clinical evidence of infection (purulent discharge, red, oedematous wound, local pain etc.). Out of total 6 patients with skin graft loss, 4 were associated with flap necrosis and rest 2 had infection. Shamsuzzaman et al. (2010) noticed no chronic infection or osteomyelitis in their study.¹⁵ In the study of Haq et al. (2009) & Hutson et al. (2010) one patient developed infection which was managed by drainage and antibiotic.^{5,21} Major procedures (cross-leg flap) was done in one patient, minor procedutres were done 7 (23.33%) patients. These were skin re-graft, flap advancement, drainage of seroma / hematoma, debridement of marginal flap necrosis. Other 9(30%) patients were treated conservatively in the form of regular dressing and appropriate antibiotics. There were 13 fracture cases and none of them showed any features of chronic osteomyelitis during the study period. There was no death during the period of study and follow up.

Regarding the final outcome of flap surgery, 18 (60%) cases were found excellent. 7 (23.33%) cases were good, 3 (10%) were fair and 2 (6.66%) were poor. In the final follow up, according to the preset criteria for evaluation of wound coverage by soleus muscle flap, the satisfactory result (excellent and good) was 83.33%. Unsatisfactory (fair and poor) result was in 16.67% cases. These finding was nearer to the result of Khundker and Kalam (1996), Ponten (1981) and Choudry et al. (2008) where success rate were 85%, 73% and 89% respectively.^{22,23,14}

Effective coverage of pretibial defect of middle third of leg by soleus muscle flap with satisfactory outcome was seen in this study.

Conclusion

Coverage of pretibial defect of middle third of leg in timely fashion following wound excision is a key component of lower limb reconstruction. The soleus muscle flap not only provides adequate soft tissue coverage of pretibial defect but also prevent infection by increasing vascularity to site of defect. This study clinically proved that outcome of early reconstruction of pretibial defect of middle third of leg with soleus muscle flap is satisfactory.

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