

How to Cite:

Hawas, E. M. S., Emad, A., Abdelbaset, M. S. E., Fathelbab, A. M. A., Sakr, W., & Abdelazem, K. M. (2022). Comparative study between early and delayed perforator flaps for reconstruction of soft tissue defects over distal third tibia. *International Journal of Health Sciences*, 6(S8), 4669–4679. <https://doi.org/10.53730/ijhs.v6nS8.13271>

Comparative study between early and delayed perforator flaps for reconstruction of soft tissue defects over distal third tibia

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Abstract---Background: Flap is tissue(s) with its own vascular supply, allowing transfer from one site to another. Flaps come in various forms. The purpose of classification is to understand the anatomy and the features that each flap provides; it also allows communication not only with peers but with the patients as well to achieve the common goal of reconstruction. Objective: The aim of this study was to compare the outcome of perforator flaps whether being early in timing in the first 48 hours of trauma or later than 48 hours. Methods: This study was conducted in the period between March 2019 to March 2021 on 40 patients with soft tissue defects in distal third tibia from the outpatient clinic, Emergency department of Plastic Surgery faculty of medicine, Beni-suef University also Surgical and Emergency

departments, Agouza Police Authority hospital, Algizah, Egypt. Results: Dehiscence was more frequent in delayed as compared with early group (2 vs. 1 case in both groups respectively); but with no statistically significant difference. Healing complications were more frequent among early vs. delayed group; however, this difference had none statistically significant value. Patients in the early group showed higher post-operative satisfaction as compared with patients in the delayed group with a statistically significant p-value Conclusion: perforator flaps in reconstructive surgery is now one of surgical technique in addition of other conventional flaps. Initially, the perforator flap based on a perforating vessel, or 'perforator' was viewed as being new and distinct from the older concept of the conventional flap.

Keywords---perforating vessel, flap, reconstructive surgery, plastic surgery.

Introduction

Trauma injuries are variable in type and severity, but most commonly are burns, lacerations, fractures, and crush injuries, patients are presented with such conditions suffering of skin loss (partial or total) forming one of the major challenges facing the plastic surgeon as reconstruction of the area of trauma covering the defect giving both the best functional and cosmetic results using flaps. (1) Flap is tissue(s) with its own vascular supply, allowing transfer from one site to another. Flaps come in various forms; it also allows communication not only with peers but with the patients as well to achieve the common goal of reconstruction. A flap is a tissue that is transferred on the basis of its vascular anatomy. Flaps can be composed of skin (including subcutaneous fat), skin and fascia, skin and muscle, or skin, muscle and bone, or various compositions of tissues. Because the circulation to the tissue to be mobilized is important for survival of flap, the development of flap techniques has depended on defining the vascular anatomy of the skin and underlying soft tissue. (2)

During the first half of the last century, skin flaps was limited to random flaps, which were raised without known blood supply other than the sub dermal plexus and were thus restricted to rigid length-to-width ratios to ensure viability (3). These flaps were differentiated according to how they were constructed, including the type of movement (e.g., advancement or rotation), conformation (e.g., direct or tubed), and origin of flap (e.g., local or distant). This situation changed forever when McGregor and Morgan discovered discrete, large, subcutaneous vessels with a predictable orientation that could ensure the viability of huge cutaneous or "axial" flaps, soon thereafter flaps were instrumental in proselytizing the use of muscle, not only as a soft-tissue flap itself but also with overlying skin to create even larger musculocutaneous flaps (2)

Patients and Methods

This study was conducted in the period between March 2019 to March 2021 on 40 patients with soft tissue defects over distal third tibia from the outpatient clinic, Emergency department of Plastic Surgery faculty of medicine, Beni-suef University also Surgical and Emergency departments, Agouza Police Authority hospital, Algizah, Egypt. The patients was classified randomly into 2 groups each involve 20 patients. Group (A) early perforator flaps (first 48 hours) and group (B) delayed perforator flaps (later than 48 hours).

Ethics

The study was performed in accordance to Helsinki Declaration, after approval of the local ethical committee of Beni-suef University hospital. A written consent was obtained from all patients.

Inclusion criteria

Both sexes (male and female) patients, age from 15 to 55 years, patients are presented with skin, subcutaneous and muscle loss due to trauma, recurrent cases in order to avoid severe fibrosis and poor blood supply in such cases, patients was required to understand and accept to participate in the trial and be able to comply with the scheduled visits and follow-up regime.

Exclusion criteria

Patients with skin diseases (psoriasis, skin infections, xeroderma pigmentosa, etc.), patients with soft tissue defect over osteomyelitic bone, immunocompromised patients (malignancy, corticosteroid therapy & AIDS), presence of one or more medical problems including renal, hepatic, hematologic, active autoimmune or immune diseases and uncontrolled diabetes mellitus (HBA1c > 10 percent).

Management protocol

History

Admission information were collected concerning the type, magnitude, extent of injury and the time of injury, also the mode of trauma, history of concomitant medical and surgical disorders and history of previous surgical procedures.

Primary management in the emergency department

Initial evaluation of the airway, breathing and circulation according to ATLS (Advanced Trauma Life Support) principles. Antibiotics prophylaxis (ampicillin sulbactam) and anti-tetanus measures were provided in the emergency room. Examination of the local condition of the wound was done. Foreign bodies and gross contamination were removed if possible, coverage of the wound with sterile, moist (saline) dressing.

Preoperative preparation

Clinical laboratory investigations including CBC, INR for all patients, other laboratory investigations including liver enzymes, kidney functions for all patients above 20 years old and pregnancy test for all females in childbearing age, Plain X-ray to detect presence of fissures, fractures or osteomyelitis, Arterial Duplex and Angiography were used in suspected vascular problems. Biopsy if the soft tissue defect is more than three months to exclude malignancy.

Debridement

After induction of anesthesia, general, spinal or regional anesthesia, the wound is cleaned using as a soap solution for removal of particulate debris, the wound is prepped and draped in the standard manner with an antiseptic chlorhexidine skin preparation solution applied over the entire wound region. Non-viable skin, fat, muscle and bone are excised, with irrigation of the wound with large amount of saline.

Flap design and surgical technique

The vascular axes and the distribution of the perforators which could sustain them were taken into consideration. A hand-held Ultrasound Doppler was done pre-operatively. And intraoperatively to detect perforator vessels in the donor site area. Selection of Perforator before flap harvesting is depended on vessel size and distance between the defect and the perforators.



Fig (1): A perforator flap is designed according to the defect

A tourniquet was inflated without exsanguination. This maneuver facilitates identification of perforators as the perforator becomes more engorged with blood. An exploratory incision along the margin of flap was made keeping the position of marked perforator in mind. The incision is made through the skin, subcutaneous tissue, deep fascia (sub-fascial approach) and fixation of the skin to the fascia is done to avoid shering movement. The perforator vessel is directly visualized. The incision is initially always made from one side of the flap only to properly identify and assess the caliber of the perforator.

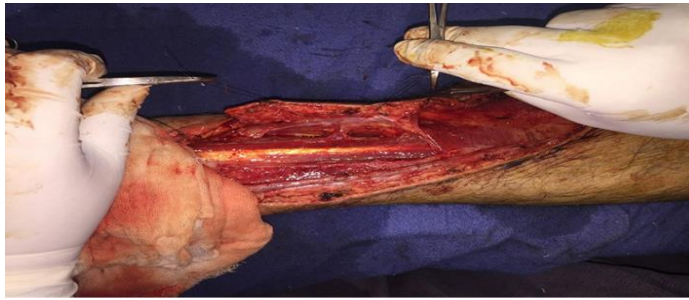


Fig (2) Dissection of the flap is done subfascially

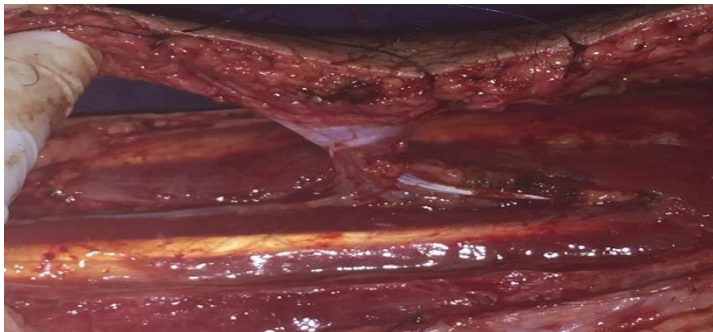


Fig (3): Dissection with adequate hemostasis until reaching the marked perforator

Adequate release of all fascial strands around the perforator and proper dissection around the perforator (intermuscular or intramuscular) to gain adequate length were then carried out. This facilitates rotation of flap without kinking the perforator, hemostasis was performed after deflation of the tourniquet, and viability of flap was evaluated. Perfusion was checked before flap rotation by waiting a few minutes and irrigating with lukewarm saline solution to improve microcirculation recovery. A window was left uncovered for observe the color and temperature without bandage removal. The donor sites were closed (primary or grafted). Post-operative the flaps were monitored. The parameters monitored included color, temperature, margins, congestion, epidermal shrinking, or blistering. The second defect of the donor site can be covered immediately with a split-skin graft or closed by direct sutures.



Fig (4): The flap was then rotated on its perforators.

Post-operative care

Close monitoring of the flap in the first 48 hours, to observe the edema and the vascularity of the flap. Stitches which caused tightness and stretching of the flap were removed. Monitoring of any complications: complete or partial flap failure, flap tip necrosis, infection, hematoma or donor site problems in cases of venous congestion and edema, anticoagulants, antiplatelet and antiedematous drugs were used. Skin graft has been used over the donor site, the graft take was inspected after 5-7 days and if this is satisfactory then mobilization of the patient is recommended. Patients with lower limbs flaps were mobilized by using crutches and not bear weight especially when the defect was in the foot. Weight bearing should only be encouraged once the flap is stable and it should be gradual. After discharge, patient was followed up weekly until complete healing, after that another follow up after one month. Comparison criteria was assessed and collected according to both research team and the patients.

Evaluations

Photos were taken pre, intra and post-operative and were processed by AutoCAD program that estimate percentage of the area of flap survival and area of flap necrosis. The aesthetic outcome was assessed using the Likert scale for evaluation of aesthetic outcome in free flaps, in which four main factors are evaluated on a numerical scale: general appearance, shape, color, and texture. The combined numerical score of the Likert scale (min, 4; max, 20) was classified as follows: 4 to 6, poor; 7 to 9, bad; 10 to 13, regular; 14 to 16, good; and 17 to 20, very good. This evaluation was performed for each patient by three lectures of plastic and reconstructive surgeon not involved in the research.

Statistical analysis

Data was collected from the patients in the form of written questionnaire and pre and post reconstruction (photos). Data was processed by SPSS program. Mann Whitney test was used to test the differences between patients in two groups. P-values less than 0.05 were considered significant.

Results

Majority of the studied patients were males (70%). Ages were ranged from (17) to (40) with an average age of 27.40 ± 7.6 (SD) years old. There were none statistically significant differences between early and delayed groups regarding gender and age. The defect size was ranged from (3.40) to (8.40) with an average size of (5.48 ± 1.3) There was none statistically significant difference between early and delayed groups regarding causes of defect size. Table (2) Time interval between the onset of injury and reconstruction was significantly lower among studied cases in the early group. In the late group the time interval was ranged from (4) to (65) days after the onset of injury with an average time of 21.90 ± 18.3 (SD) days. Figure (5) The duration of hospital stay in the post-operative period was significantly shorter among studied cases in the early group as compared with the late group (p-value= 0.30). Table (3)

Dehiscence was more frequent in delayed as compared with early group (2 vs. 1 case in both groups respectively); but with no statistically significant difference. Table (4) Healing complications were more frequent among early vs. delayed group; however, this difference had none statistically significant value. Table (5) Patients in the early group showed higher post-operative satisfaction as compared with patients in the delayed group with a statistically significant p-value (0.003). Table (6)

Table (1): Gender and Age Distribution among studied patients:

		Group		Total N= 40	p-value
		Early N= 20	Delayed N= 20		
Gender	Male	15 (75.0)	13 (65.0)	28 (70.0)	0.731
	Female	5 (25.0)	7 (35.0)	12 (30.0)	
Age (years)	Mean $\pm$ SD	28.10 $\pm$ 8.1	26.70 $\pm$ 7.2	27.40 $\pm$ 7.6	0.566
	Minimum	18.00	17.00	17.00	
	Maximum	45.00	40.00	40.00	

*p-value ≤ 0.05 was considered statistically significant

Statistical analysis was carried out by Mann-Whitney-test

Statistical analysis was carried out by Chi square test

Table (2): Comparison of the studied patients regarding Defect Size (Length-to-width ratio)

		Group		Total N= 40	p-value
		Early N= 20	Delayed N= 20		
Defect Size (Length-to-width ratio)	Mean $\pm$ SD	5.42 $\pm$ 1.2	5.54 $\pm$ 1.3	5.48 $\pm$ 1.3	0.566
	Minimum	3.40	8.40	3.40	
	Maximum	3.50	8.40	8.40	

*p-value ≤ 0.05 was considered statistically significant

Statistical analysis was carried out by Mann-Whitney-test

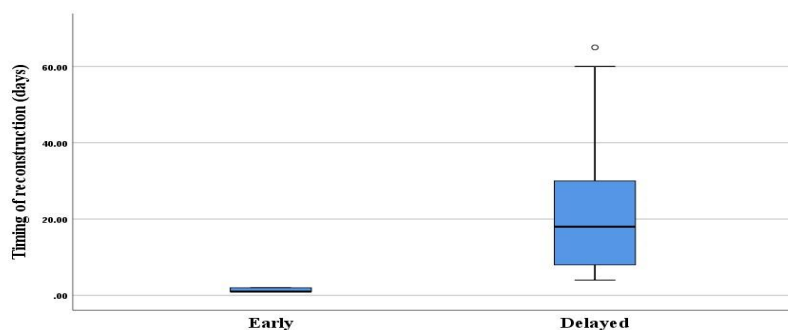


Figure (5): Comparison of the studied patients regarding timing of reconstruction

Table (3): Comparison of the studied patients regarding Hospital Stay (days) post-operative:

		Group		Total N= 40	p-value
		Early N= 20	Delayed N= 20		
hospitalization (days)	Mean $\pm$ SD	12.65 $\pm$ 3.7	16.15 $\pm$ 5.8	7.75 $\pm$ 3.6	0.030*
	Minimum	8.00	7.00	7.00	
	Maximum	20.00	28.00	20.00	

Statistical analysis was carried out by Mann-Whitney-test

Table (4): Frequency of Dehiscence among Studied population:

		Group		Total N= 40	p-value
		Early N= 20	Delayed N= 20		
Dehiscence	No	19 (95.0)	18 (90.0)	37 (92.5)	0.500
	Yes	1 (5.0)	2 (10.0)	3 (7.5)	

*p-value ≤ 0.05 was considered statistically significant

Statistical analysis was carried out by Chi square test

Table (5): Comparison regarding Healing Complications between the two groups

		Group		Total N= 40	p-value
		Early N= 20	Delayed N= 20		
Healing Complications	No	17 (85.0)	18 (90.0)	35 (87.5)	0.500
	Yes	3 (15.0)	2 (10.0)	5 (12.5)	

*p-value ≤ 0.05 was considered statistically significant

Statistical analysis was carried out by Chi square test

Table (6): Comparison regarding Patient satisfaction postoperative

		Group		Total N= 40	p-value
		Early N= 20	Delayed N= 20		
Patient Satisfaction	Poor	1 (5.0)	11 (55.0)	12 (30.0)	0.003*
	Bad	4 (20.0)	4 (20.0)	8 (20.0)	
	Regular	13 (65.0)	5 (25.0)	18 (45.0)	
	Good	2 (10.0)	0 (0.0)	2 (5.0)	
	Very Good	0 (0.00)	0 (0.00)	0 (0.00)	

*p-value ≤ 0.05 was considered statistically significant

Statistical analysis was carried out by Chi square test

Discussion

It is important that the bone and soft tissue defects are reconstructed as early as possible after proper debridement, the defect of the lower leg is reconstructed with vascularized soft tissue; any dead space must be filled with vascularized soft tissue. Many flaps to repair these defects have been described, and each flap has its respective characteristics and indications (4). Traditional flap transplantation provides superficial wound coverage without fill the dead space that leads to increase the rates of complications, such as with infection and hematoma (5). Musculocutaneous flaps may use to fill dead space and cover the wound surface; however, because of the lack of freedom between the skin flap and the muscle segment, this option may fail to effectively fill the dead space and may lead to a swollen, bad cosmetically postoperative appearance (6).

Our study aims to evaluate the operation timing difference whether in early (first 48 hours) or delayed (after 48 hours) perforator flaps for covering soft tissue defects aiming to restore both function, aesthetic outcome and with the least possible complications. Fortunately, microsurgical reconstruction has evolved and now offers diverse chimeric flap options to reconstruct the complex tissue defects (7). Chimeric flaps have been used for reconstructing three-dimensional (3D) defects, in which the skin flap covers the superficial wound, and a separate, mobile muscle segment fills the dead space. While this is an improvement compared with traditional skin and musculocutaneous flaps, donor site morbidity, operative complexity, and size challenges are areas requiring improvement (8).

The first finding in our study is that men are the majority gender susceptible of trauma especially motor car accidents and of middle age group from 17 to 40 years old considering our inclusion criteria for age from 15 to 55 years old both genders. The second finding in our study that there is a significant difference not only in the duration in the operation room for dissection and reconstruction of the perforator flap this was in complete accordance with the study Xiaojun Zheng et al (9) as they demonstrated that all cases dealt with as emergency in the same day or the day after required less time in operation room than the cases postponed after that for week or more later. The explanation of similar findings in that study as well as the present study may be because early management and debridement would be easier with less adhesion formed by the long time after the trauma.

The third finding in the present study is that there's a significant difference in postoperative hospital stay length and patient overall satisfaction in early cases this was in complete accordance with the study Jochen-Frederick Hernekamp et al (10) as they demonstrated that all cases dealt with in early days of trauma are recovering better, less hospital stay and have overall satisfaction more than late cases. Our results weren't far from the results of Jiqiang He et al, (11) who found that the hospital stay and overall satisfaction of the patients are higher in early cases as the present study however they found that the rate of seroma and infection is significant high in early perforator flaps a case which was different from our study.

Louer CR, et al, (12) early perforator flaps Complex soft tissue defect of the knee was reconstructed with anteriorlateral thigh perforator (ALTP) flap in 5 cases, modified ALTP flap in 2 cases, chimeric ALTP flap in 4 cases, dual skin paddles ALTP flap in 2 cases and chimeric thoracodorsal artery perforator flap in 2 cases. Multiple perforator flaps and vascularized fascia lata in combination were performed in one case. All flaps survived postoperative. No vascular problem was observed. Only one case suffered partial necrosis. Primary closure of donor site was performed for all patients. This is in complete accordance of our study as we also have two cases suffered partial necrosis one in early group and one in the delayed group with no statistical significance.

Marco Innocenti, et al, (13) disagree with our study as in their study for early cases twenty-eight of 66 flaps (42%) had complications such as Venous congestion (11 of 66, 17%) and superficial necrosis (seven of 66, 11%) occurred most frequently. Eighteen of the 28 complications (64%) healed with no further treatment; eight patients (29%) underwent skin grafting and one patient each experienced total flap failure (2%) and partial flap failure (2%). In those patients, a free anterolateral thigh flap was used as the salvage procedure. In our study we find that 3 cases of the early group and 2 cases of the delayed group suffered healing complications, severe infection in early cases was the cause ,long term course of antibiotics as medical treatment were used and two cases of the delayed group needed skin grafting. Zhaobiao Luo et al (4) believed that the rate of seroma and infection was insignificant in both early and delayed perforator flaps cases which were in complete accordance with the present study.

Conclusion

Perforator flaps in reconstruction of distal third tibia is one of important surgical technique when compared to the use of conventional flaps. early surgical procedure (first 48h) is better than delayed surgical procedure(after 48h) as easily dissection and short time intra operative and short time of hospitalization and good patient satisfaction

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