

Efficacy of Scratch Test in Free Flap Monitoring

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Abstract

Introduction: Re-exploration of the failing free flap at the earliest provides the best chance for successful salvage. We describe our experience with scratch test as an adjunct to clinical monitoring that provides quick and reliable results at near negligible cost to monitor the viability of the free flap in the early post operative period.

Materials and methods: A prospective, observational study was conducted from January 2018 to December 2020 on patients undergoing free flaps where skin paddle was available for monitoring. Scratch test was performed by making a 2-3 mm horizontal scratch up to the dermis using a 28 gauge needle on the distal aspect of the flap. Bright red coloured blood (appearing between 3-12 seconds) was considered normal, while dark coloured blood (appearing within 3 seconds) or no blood appearing till 12 seconds were considered suggestive of vascular compromise. The scratch test commenced on the operating table immediately after completion of flap inset, and continued till 72 hours post-operatively.

Results: 122 patients were enrolled in the study over the period of 02 years. Scratch test was normal in 111 cases (91%) for initial 72 hours following the surgery. Eleven patients overall (11/122) exhibited features of vascular compromise on scratch test when the clinical examination was either normal or equivocal at that instant. Eight out of these eleven patients (8/11) exhibited features of venous congestion, whereas three patients (3/11) exhibited arterial blockage. All these patients underwent prompt re-exploration where the vascular compromise was corrected. Early identification helped in complete salvage of six out of eleven compromised flaps.

Conclusion: Scratch test has the potential to alert at the earliest for development of vascular compromise preceding the other clinical signs. This may enable re-exploration at the earliest for the higher rates of successful salvage of the failing flaps.

Keywords: Free flaps; Microvascular tissue transfer; Flap monitoring; Scratch test

Introduction

Free autologous tissue transfer is a versatile treatment modality for managing complex defects and difficult wounds. Initially used widely for post-traumatic reconstruction, free flap transfer has revolutionized the reconstruction of complex defects following cancer resection [1]. Success rate of free flaps has been reported to be in the range of 94-99% in most of the high volume institutions across the world [2]. The failure rate of up to 5% that has been reported, though acceptable, is felt to impose great effort, morbidity and cost due to requirement of another surgery to achieve the successful outcome [3]. Monitoring of a free flap during the initial post operative period is vital for keeping a close watch on flap viability and any need for early re exploration [4]. Earlier re-exploration of the free flap (ideally within couple of hours of detecting vascular compromise) translates consistently into higher rates of successful salvage of the flap [5,6]. Commonly, the free flap monitoring is performed by clinical examination supplemented with other adjuncts, both non-invasive and invasive [7]. In our experience, scratch test, as an adjunct to clinical monitoring, provides quick and reliable results at near negligible cost to monitor the viability of the free flap in the early post operative period. We present here our study to assess the role of scratch test as a primary flap monitoring adjunct in free micro vascular transfers.

Materials and Methods

This prospective, observational study was conducted from January 2018 to December 2020 in a tertiary level teaching hospital. All the consecutive patients undergoing free micro vascular tissue transfer for their respective diagnoses where skin paddle was available for the monitoring were included in the study. The patients who needed buried muscle or bone free flaps with no skin paddle available for monitoring were excluded from the study. Informed consent for post-operative flap monitoring using scratch test as an adjunct to clinical examination was taken prior to the surgery. The monitoring with clinical examination was performed with the well described parameters namely, flap colour, temperature, flap skin turgor and capillary refill time [7,8]. Scratch test was performed by making a 2-3 mm horizontal scratch up to the dermis, using a 28 gauge needle on the distal aspect of the flap. The time required

for blood to appear was then noted along with the colour of the blood. Bright red coloured blood that appeared between 3-12 seconds was considered normal, signifying satisfactory perfusion of the flap. Dark coloured blood that appeared in less than 3 seconds was considered to be suggestive of problem in the venous outflow, even if there was no discoloration of the flap skin at the time of examination. If blood did not appear till 12 seconds after the scratch, it was considered to be suggestive of compromise of arterial inflow to the flap. The scratch test commenced on the operating table immediately after completion of flap inset, and continued 2 hourly for the first 08 hours, 4 hourly for next 16 hours, and 6 hourly till 72 hours post operatively (total 16 scratches). After 72 hours flap monitoring was completely based on clinical assessment. Based on the

results noted after the scratch test, a decision of flap viability was made and appropriate surgical decision taken.

Results

The study accrued 122 patients over the period of 02 years. Male to female ratio was 3.2:1. The youngest patient in the series was 3 years of age and the oldest one was of 88 years. Co morbidities were present in 34 patients, of which 11 patients had two or more co-morbidities, with diabetes and hypertension being the most common (Table 1).

Table 1: Demographic data of the patients.

Number of patients	122	% of patients
Male	93	76.22
Female	29	23.77
Male to female ratio	3.2:1	-
Mean age	48.04	-
Smokers	69	56.55
Co-morbidities	34 (11 with two or more co-morbidities)	27.86
Hypertension	22	
Diabetes mellitus	19	
Coronary artery disease	11	
Hypothyroidism	5	
Collagen vascular disorders	3	

Free flaps were performed for various indications, the most common being reconstruction after cancer resection (74%). It was followed by trauma (14%), gunshot wounds, secondary reconstruction of burns, non healing chronic wounds, electric burns and radionecrosis of mandible (Table 2). Free osteo

cutaneous fibula flap was used in 58 cases (48%) followed by free anterolateral thigh flap (21%) and free radial artery forearm flap (11%) respectively (Table 3).

Table 2: Indication of free flap reconstruction.

Indication	Number of patients	% of patients
Post oncologic reconstruction	89	74.16
Trauma	17	13.93
Gunshot wound	5	4.09
Post burn Contracture	4	3.27
Chronic wounds	3	2.45
Electrical Burns	2	1.63
Radio necrosis of mandible	2	1.63
Total	122	100

Table 3: Type of free flaps performed.

Type of free flap	Number of patients	% of patients
Fibula osteocutaneous	58	47.54
Anterolateral thigh	26	21.31
Radial artery forearm	14	11.47
Gracilis muscle	8	6.55
Latissimus dorsi	5	4.09
Medial sural artery perforator	3	2.45
Thoracodorsal artery perforator	3	2.45
Parascapular	3	2.45
Toe pulp transfer	2	1.63
Total	122	100

The early post operative monitoring of the free flap was done with clinical examination using the scratch test used as an adjunct. Scratch test was normal in 111 cases (91%) for initial 72 hours following the surgery (Figures 1-3). Eleven patients (9%) exhibited features of vascular compromise, detected and interpreted as per the defining criteria for the scratch test, while the clinical examination was either normal or equivocal at that instant. Eight patients out of these 11 (8/11) exhibited features of venous congestion with scratch test showing brisk flow (less than 3 seconds) of dark coloured blood (Figure 4). In this cohort, seven (7/8) had normal appearing clinical parameters (colour, temperature, turgor, capillary refill time). In one patient of this cohort (1/8), while the scratch test was suggestive of venous obstruction, the concurrent clinical examination was equivocal. Re-exploration was performed in all these 8 patients and venous compromise were found in all of them. Six patients (6/8) had a soft clot at the anastomosis line that necessitated evacuation of clot and redo anastomosis. One patient (1/8) had a well formed clot and it needed evacuation and re-anastomosis using a vein graft. In one patient (1/8), a hematoma was found compressing the anastomosis and hematoma evacuation promptly improved the venous return. Three patients out eleven in whom scratch test was deemed abnormal (3/11), had features of arterial blockage (Figure 5). In all of these three patients, scratch test showed no blood while the other clinical parameters were equivocal at that instant. Arterial blockage was confirmed on

prompt re-exploration and revision of arterial anastomosis was performed. The abnormal scratch tests in these 11 patients were elicited within the initial 72 hours following the free flap surgery. Early identification helped in complete salvage of six (out of eleven compromised) flaps, while five flaps (4.09%) could not be salvaged (Table 4).

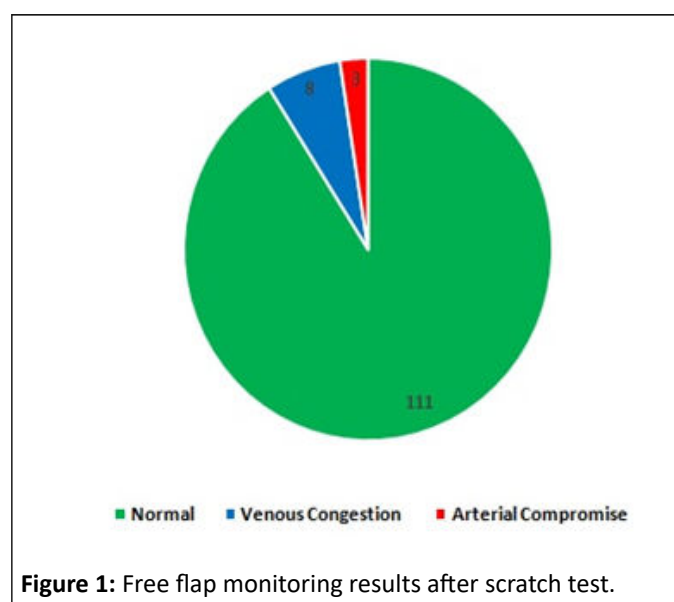
**Figure 1:** Free flap monitoring results after scratch test.



Figure 2 (a,b,c,d): Radial artery forearm flap reconstruction for floor of the mouth. Serial scratch test shows presence of bright red slow dermal bleed signifying normal perfusion. No marks can be seen after full recovery of the patient.



Figure 4: Absent blood on scratch test, an early indicator of arterial compromise.



Figure 3 (a,b,c,d): Scratch test on various patients demonstrating normal, bright dermal bleed suggestive of a viable flap.



Figure 5: Dark blood on scratch test indicative of venous congestion. The colour of the skin flap is appearing within normal limits at this stage.

Table 4: Final outcome of flaps.

Total flaps	122
Uneventful	111 (91%)
Re exploration required	11 (9%) (8-Venous compromise, 3-Arterial compromise)
Venous compromise (n=8)	4
Flaps salvaged	4
Flaps could not be salvaged	
Arterial compromise (n=3)	2
Flaps salvaged	1
Flaps could not be salvaged	
Overall flap survival	117 (95.9%)
Overall flap loss	5 (4.1%)

We noted that invariably all the scratch marks over the flaps in the patients with successful outcome healed well without any infection or prominent scarring in the long run even if they appeared somewhat unsightly during the initial few days following the surgery.

Discussion

Free flap reconstruction has changed the face of post oncologic and post trauma reconstruction. It is a very versatile modality owing to its ability to provide ample amount of tissue for reconstruction. Post operative monitoring of free flaps is of utmost importance for timely and early identification of vascular compromise so that re-exploration can be done with an aim to salvage the compromised flap. The salvage rates in the literature are reported from 30% to more than 70% [9].

The traditional modality of flap monitoring is periodic, frequent clinical flap examination which takes into consideration flap colour, temperature, turgor and capillary refill time. This is still considered to be the gold standard for monitoring of free flaps [8]. Clinical monitoring is efficient and found to be predictive in 85-95% of cases [8,9]. While assessing the flap color, the color of the flap should be similar to the donor site. Pale colour is suggestive of arterial compromise while dark purplish colour is indicative of venous compromise. It is well recognized that flap color monitoring is very difficult in dark skinned people, thus hindering accurate judgment of flap viability [10]. Normal capillary refill time is 2-3 seconds. Brisk or delayed capillary refill times indicate venous and arterial compromise respectively. Temperature and turgor should be compared with that of adjoining non-flap tissue, but these can be difficult to assess in case of post operative edema of the adjoining areas. The surface temperature could be fallacious in cases patient is running fever. Thus, clinical examination of the

flap has to be performed in a holistic fashion keeping in mind the various pitfalls that may vitiate the judgment.

Of the other available flap monitoring options, hand held acoustic doppler is a useful tool especially for the flaps where skin paddle is not available for monitoring [7]. This method was not assessed in this study. Similarly, duplex ultrasound is informative to find the arterial inflow and venous outflow. However, duplex ultrasound is operator dependent and additional cost of the equipment is associated with it [2,7].

Amongst the other used numerous methods, implantable doppler probes near the anastomoses and Indocyanine Green (ICG) near infrared angiography have shown fairly reliable and high rates of detecting early vascular compromise [11]. The implantable dopplers (Cook-Schwartz device) are expensive and are not widely available especially in low and middle income countries. ICG near infrared angiography with pinprick test need the availability of the dye as well as ICG camera that may not be widely available especially in LMIC [12].

In many centers, pin prick test solely as an adjunct is also used for early flap monitoring [7]. However, there is always a risk of injuring an underlying perforator or an axial vessel especially if done by someone who was not a part of the operative team.

Scratch test is a simple, informative and useful adjunct to clinical examination. This test retains accuracy irrespective of skin color and allows early identification of flap failure in dark and fair skin colours alike, thus allowing early intervention. As evident by the results (ten out of eleven patients, it precedes other clinical signs in early identification of the vascular compromise. It enabled us to intervene early and six flaps out of eleven could be salvaged completely. Overall, the scratch test, as described, is simple to learn and perform, and, easy to interpret.

Conclusion

Physical examination still remains the gold standard for monitoring of free flaps. Scratch test is a simple and effective adjunct to clinical monitoring. It has the potential to alert the surgical team with first sign of vascular compromise and may precede the other clinical signs of flap monitoring.

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