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MEASUREMENT OF BLOOD GLUCOSE LEVEL RATIO FOR MICROVASCULAR FLAP MONITORING

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Abstract
Microsurgical post operative vascularity of flap-finger is a difficult issue. No ideal method is available till date. By studying ratio of flap to fingertip blood glucose level we can reach to a conclusion for salvage of congested flap whether non surgical or surgical intervention is required.
We present a study based on this method in 31 cases and found promising results.
Keywords: Microsurgery, Free flaps, Blood glucose level.

Introduction:

These days microsurgery is the cutting edge technology. Improving with time with better operating microscopes, surgical skills, detailed anatomy, various methods are available in preoperative planning for best results. But post operative monitoring of flaps/replantation vascularity is still a challenge it is difficult to decide whether to and when to explore a congestive flap. Early timely definitive intervention can save congested flap. Venous thrombosis or external pressure/kink is the common cause of flap congestion. There are several methods described in literature flap monitoring but no one is near ideal method.

An ideal monitoring method should be harmless to patient and the flap, accurate, reliable, able to give rapid results/interpretation, reproducible inexpensive portable, capable of being done by all personnel.

Few studies in past have used flap capillary blood glucose level estimation and then compared with simultaneous blood glucose level. They all have measured absolute values and studied correlation of flaps viability with flap's glucose level. But this doesn't work properly in diabetic patients and in patients on parenteral glucose infusion in postoperative period. So I present new method of study of ratio of flaps versus fingertip blood glucose level at the same time give much productive results. Early timely intervention saved flaps.

Material and Method:

Patients:

A prospective study done from 2018 to 2019 for 31 patients underwent microvascular surgeries. 29 pts of free flap and 2 pts of finger replantation included to assess reliability of this new flap monitoring method. Various types of flaps for post malignancy and post traumatic composite tissue defects were done. Two patients were of type II insulin dependent diabetics. Type of flap and data are listed in table 1, 2, 3, 4. Age ranged from 22 years to 68 years with mean age of 46 years. Four patients were female and 27 were male.

Blood glucose measurements:

Needle prick with 26 G needle is done in flap and finger. Glucose level is measured with Accucheck instant instruments which utilize very small quantity of blood (≈10 µl only).

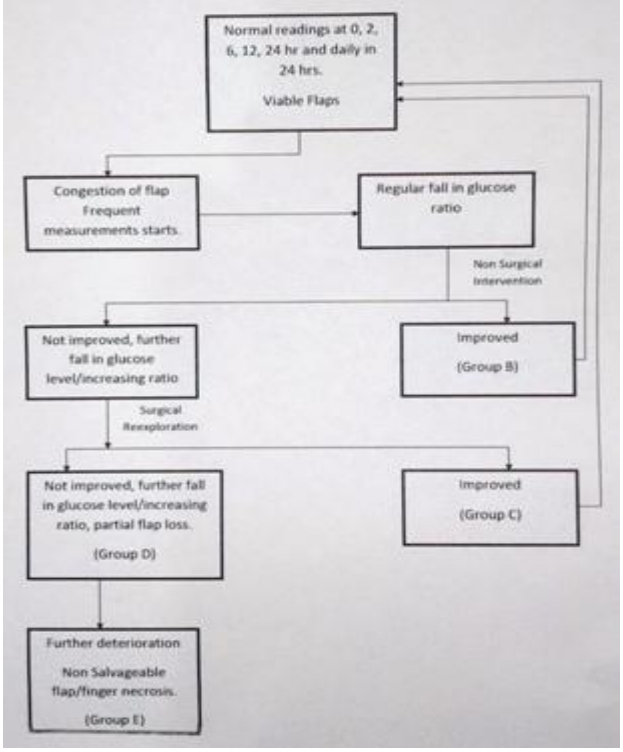
Fingertip prick blood glucose level is preferred over routine method of blood glucose measurements to use the same instrument for both glucose level estimation rather than venous blood glucose level estimated with different machine and flap's glucose level with different instruments/machines.

A standard protocol is followed and post operative readings noted at 0 hour (immediate post operative period), 2 hour, 6 hour, 12 hour then every 24 hrs in normal cases.

If there was evidence of congestion then this blood glucose measurement was done as per need e.g. every 1-2 hourly in progressive congested flaps.

Readings were interpreted. We relied more on ratio of blood glucose level rather than actual values.

Flow Chart of Protocol



Results:

For ease of interpretation and to simplify we put patients/flaps in four categories:-

A. No intervention required and flap survived well with ratio ≥ 85%

B. Flaps required non operative measures for salvage/ viability with ratio 75%-85% .

C. Flaps required some operative measured e.g. release of pressure on pedicle/re exploration of anastomosis, etc with ratio 60% - 75%.

D. Flap salvaged partially with patchy necrosis with ratio 50%- 60%.

E. Flaps and finger with full necrosis in spite of all measures with ratio ≤ 50%.

In our study total 23 flaps-finger survived well without any significant complications. So these patients came under group A.

Out of 31 flaps-finger 8 showed post operative congestion and we started 1-2 hourly measurement of blood glucose level ratio.

Three flaps were salvaged well with non surgical interventions. So these came in group B.

Out of 8 congested flaps 2 flaps were salvaged fully with surgical interventions. So came in group C.

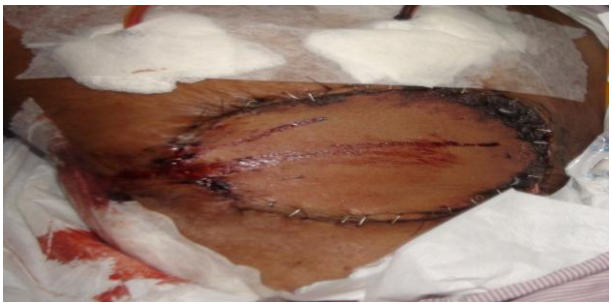
One TFL (tensor fascia lata) flap was salvaged with surgical interventions but there was distal marginal loss. So included in group D.

One fibula osteocutaneous flap for post commando reconstruction and one finger replantation were necrosed fully in spite of all surgical interventions. So included in group E.

Group A -free ALT flap survived well without any intervention.

Group B - free RAFAF flap survived well with non surgical interventions.

Group C - free RAFAF flap survived well with surgical interventions.



Group D - free TFL flap survived with distal flap loss with surgical interventions.

Group E - finger necrosed fully even with surgical interventions.

Discussion:

The salvage of congested flap depends upon early detection of congestion and timely intervention / re exploration. But issue is when to do or when not to do the re exploration?

There are various methods have been described for monitoring transplanted tissues including physical assessment of flap, color, turger, capillary refill, temperature, laser Doppler flowmetery, hand held acoustic Doppler, non invasive ultrasound Doppler, implantable Doppler system, near infra red spectroscopy, microdialysis, hydrogen clearance, pH measurement, trancutaneous oxygen tension , photoplethysmography, Infra red thermography scan and so on. But still lacking an ideal method for the same.

This study shows falling flap's blood glucose level in spite of nonsurgical measures is the strong indication of re exploration before flap enters in non salvageable stage.

Earlier studies stressed level of blood glucose in flap only but did not took due consideration of variation in overall blood glucose level due to intravenous infusion of glucose or in diabetic patients.

We have given stress to blood glucose level from finger of tip over that of venous blood glucose level and compared with that of flap's and ratio is calculated for better results. Even in selected cases we have compared glucose level within the flap from various points.

Sakakibara et al reported the first use of blood glucose meter for flap monitoring in diabetic patients and a lower blood glucose level in congestive flaps in clinical cases.

Table 1: Patient Demographics

Item	n
No. of Patients	31
No. of Flaps	29
No. of Fingers	**2**
Age in yrs, mean (range)	46(22-68)

Table 2: Flap-Finger Characteristics

Item	n = 31
Post Cancer reconstruction	25
Post Traumatic Flap reconstruction	4
Post Traumatic Finger/Hand	2

Table 3: Flap Types

Item	n = 31
ALT	7
RAFAF	12
Fibula OC	8
LD	1
Finger/Hand Replantation	2
TFL	1

Table 4: Group wise Flap's Fate

Item	A	B	C	D	E
ALT	6	1	0	0	0
RAFAF	10	1	1	0	0
Fibula OC	5	1	1	0	1
LD	1	0	0	0	0
Finger/Hand Replantation	1	0	0	0	1
TFL	0	0	0	1	0

Hara et al in 2011 described blood glucose measurement for flap monitoring and reported that the blood glucose level of 62 mg/dl in flap is the cutoff value for detecting venous thrombosis.

But this alone reading does not give proper information for re exploration. Surgeons have noticed that flaps with blood glucose level of 62 mg/dl survived sometimes and on contrary flaps necrosed with glucose level more than 62 mg/dl.

So it is not one time recording of glucose level rather continuously falling glucose level in flap is more important to predict re exploration. Karakawa et al in 2018 reported in their study that fall of flap glucose level by - 4.5 mg/dl per hour is the alarming sign for re exploration to salvage flap. But they excluded diabetic patients, we included them too.

In our study we took due consideration of ratio of fingertip to that of flap's glucose level to predict flap congestion or ischemia to be re explored.

To simplify this for better reproducibility we have proposed ratio and grouped in five categories as

GROUP A:

It is interpreted that ratio of glucose level above 85% signified good flap viability

GROUP B:

It is interpreted that ratio of glucose level between 75% to 85% without further drop signified flap viability with non surgical interventions like change in position, relieving external pressure on pedicle, decongestive medication, avoiding hypothermia, hypovolumia, hypotension, proper anticoagulation, etc.

GROUP C:

It is interpreted that ratio of glucose level between 60 % to 75% signified flap viability with surgical intervention like taking out sutures above the pedicle, relieving kink in vessels, hematoma evacuation, re exploration of micro anastomosis, etc.

GROUP D:

It is interpreted that ratio of glucose level between 50% to 60% signified partial flap viability in spite of all measures taken in group C. in this group we have seen change in glucose level within the flap from different sites. Part of flap necrosed with further low ratio.

GROUP E:

It is interpreted that ratio of glucose level below 50% signified total loss of flap or finger in spite of all measures taken in group C.

Practically glucose level ratio below 60% is very dangerous for flap viability.

In this study we have observed that flap glucose level below 60mg/dl was associated with total flap/finger necrosis.

Conclusions:

Multiple sequential measurement of ratio of fingertip to flap glucose level is a very good indicator of venous thrombosis in clinical cases.

This method is simple, reliable, accurate, inexpensive and highly reproducible.

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