

## Original Research Article

# Flap and finger-tip blood glucose level monitoring to predict venous thrombosis in free flaps: a simple and effective method

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### ABSTRACT

**Background:** Rapid detection and early re-exploration is the key to salvage congested flap. Various methods have been described in literature to monitor flaps in post operative period. We evaluate the efficacy of measurement of flap and fingertip blood glucose level and its role in predicting the flap congestion and salvage.

**Methods:** prospective observational study conducted in a tertiary care centre in North India between December 2020 to December 2022. A total of patients 500 underwent 507 free tissue transfer were included in this study. Flap congestion was noted clinically in 41 flaps. In these 41 flaps, flap and fingertip blood glucose level were measured.

**Results:** Congested appearing flaps divided into 2 groups. Group A consist of 8 flaps out of 41. The difference in flap and fingertip blood glucose level is less than 10%. Out of 8, 5 does not required re-exploration and were successfully salvaged. In 3 flaps, difference in flap and fingertip glucose level rises with time and were taken for re-exploration. Out of these 3, 2 were successful salvaged. Group B consist of 31 flaps. In these 31 flaps, 41. the difference in flap and fingertip blood glucose level is more than 10%. All these flaps were re-explored and 21 were salvaged.

**Conclusions:** Flap and body glucose level monitoring is a simple and reliable method for flap monitoring and it can be performed by residents as well as nursing staff.

**Keywords:** Flaps monitoring, Blood glucose level monitoring, Flap salvage

### INTRODUCTION

Free flaps have become the most reliable method for reconstruction of defects following trauma and oncological resection. The success rate of free flap reconstruction is 95% or higher.<sup>1</sup>

The main adverse event of free flap reconstruction is vascular compromise leading to flap failure. Vascular compromise may occur as a result of arterial insufficiency, venous thrombosis or hematoma. Out of these, venous thrombosis is the most common cause of flap failure.<sup>2-5</sup> Free-flap failure due to vascular compromise range from 2 to 5% in several large case series.<sup>6-8</sup> However meticulous monitoring help in early detection of signs of vascular compromise. Flap salvage

rate decline as the duration between the onset of vascular compromise and its detection increases. With early detection and early re-exploration flap salvage range from 30 to more than 70%.<sup>3,9-11</sup>

Various methods have been described for flap monitoring.<sup>12</sup> Clinical assessment (flap colour, capillary refill, temperature, turgor and pin prick/ dermal scratch) remains the mainstay for flap assessment however it requires clinical expertise for early detection of signs of vascular compromise.

Here we evaluate the simple and effective method of flap monitoring by measuring flap blood glucose level. It is based on the principles of micro-dialysis where capillary glucose levels in free flaps is measured using glucometer.

Flap blood glucose level is compared with fingertip blood glucose level. This method is simple, cheap and effective for early detection of vascular compromise especially venous thrombosis.

**METHODS**

*Patients*

This is a prospective observational study conducted in a tertiary care centre in North India between December 2020 to December 2022. A total of patients 500 underwent 507 free tissue transfer were included in this study. There were 423 male and 84 female patients. Patient’s age ranged from 9 to 79 years, with a mean age of 47.4 years. Flap characteristics are listed in Table 1.

**Table 1: Types of free flap performed.**

Flap type	N
Anterolateral thigh free flap	290
Osteocutaneous free flap	98
Radial artery forearm free flap	101
Gracilis free flap	8
Superficial circumflex iliac artery perforator flap	5
Anteromedial thigh free flap	3
Omental free flap	1
Tensor fascia lata free flap	1
Total flaps	507

*Flap monitoring and blood glucose level measurement*

All flaps were monitored clinically by their physical condition: colour, warmth, turgor and pin-prick examination. If flap appeared congested on physical appearance, blood glucose level of flap was measured. A pin prick/dermal scratch was made with 24 G needle over the flap. After skin prick/scratch, blood glucose level in flap was measured with glucometer (No coding 1 plus, model-GM01BAA) as shown in Figure 1. Flap glucose level was compared with fingertip blood glucose level. Difference of 10% between flap and fingertip glucose level were consider normal.

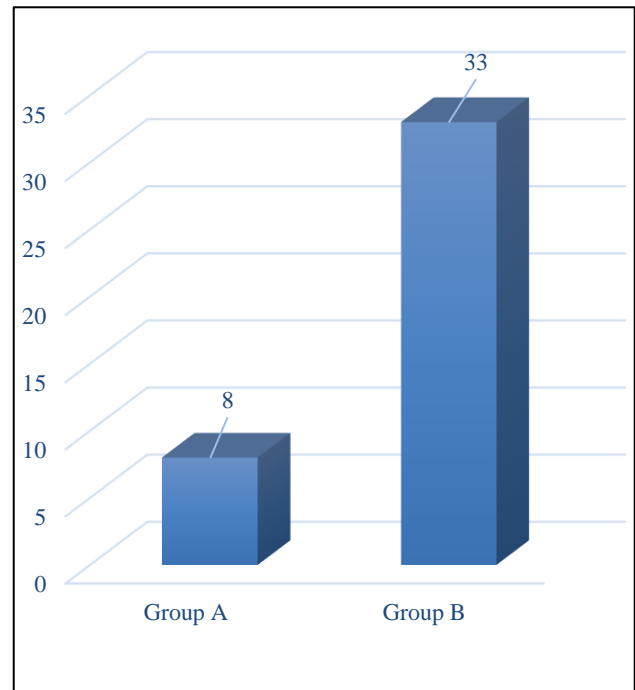


**Figure 1: No coding 1 plus glucometer with glucose level monitoring strips.**

We suspect venous congestion if difference in flap and fingertip glucose level is more than 10% in combination with physical findings. Countermeasures such as removing tight dressing, removing few sutures and correcting the position of neck/limb was done. Flap and fingertip blood glucose levels were checked again. If the appearance or blood glucose level of flaps improved after the countermeasures, we continue to measure 2 hourly flap and fingertip blood glucose level for next 24 hours followed by 4 hourly for next 24 hours. If there is no improvement or worsening in the gross appearance and blood glucose level of flaps despite such countermeasures, venous thrombus was suspected, and re-exploration was performed.

**RESULTS**

Out of 507 flaps, 41 flaps (8.1%) showed signs of congestion. These 41 flaps were divided into 2 groups (Figure 2).

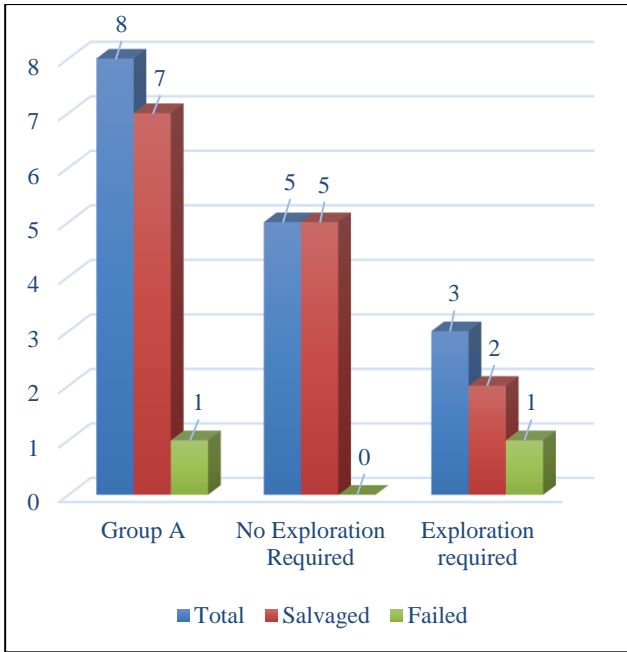


**Figure 2: Number of congested flaps.**

*Group A*

It consists of 8 flaps (19.5%) out of 41. In these 8 flaps difference in flap and fingertip blood glucose levels were less than 10%. In these 8 flaps blood glucose level were monitored 2 hourly for next 24 hourly then 4 hourly for next 24 hour.

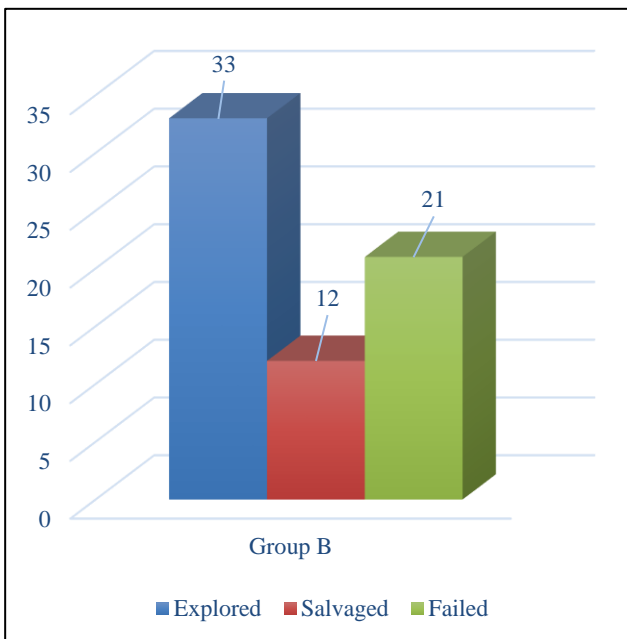
Out of these 8, 5 flaps were salvaged without re-exploration. In 3 flaps, difference in flap and fingertip blood glucose level rises gradually and were taken for re-exploration. Out of these 3, 2 flaps were successfully salvaged (Figure 3).



**Figure 3: Number of flaps salvaged and failed in group A.**

**Group B**

It consists of 33 flaps out of 41 (80.5%). In this group, the difference in flap and fingertip blood glucose level was more than 10% at the time of detection of congestion and these flaps were immediately taken for re-exploration. Out of 33, 12 flaps were salvaged by venous thrombectomy and re-anastomosis. Post re-exploration flap and fingertip glucose level were found to be within normal limit in these 12 salvaged flaps (Figure 4).



**Figure 4: Number of flaps salvaged and failed in group A.**

**DISCUSSION**

Rapid detection and early re-exploration play an important role in salvage of a congestive flap.<sup>7,13</sup> The results of our study show that the difference in blood glucose level of flap and fingertip is more than 10% in congested flaps. This is a simple and effective measure for monitoring flaps and also help in predicting the need for re-exploration of congested flap.

Reduction in the blood glucose levels in congested flaps has been reported in several studies. Setalare et al found that the blood glucose level in flaps is reduced in ischemic or congestive conditions by using microdialysis measurements.<sup>14</sup> In 2010, Sakakibara et al reported the first use of a blood glucose meter for flap monitoring in diabetic patients and a lower blood glucose level in congestive flaps in clinical case.<sup>15</sup> In 2011, Hara et al described blood glucose measurement for flap monitoring and reported that the blood glucose level of 62 mg/dl is the best cut-off value for detecting venous thrombosis.<sup>16</sup> Cut off value of 62 mg/dl lack sensitivity and specificity. We noted that in diabetic patient, flap glucose is low when patient is on insulin infusion, so the difference in flap and fingertip blood glucose level as well as continuously falling glucose level is more important to predict re exploration rather than single cut off value. Karakawa et al in 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.<sup>17</sup> But they excluded diabetic patients, we included them too.

**Limitations**

The study is a prospective observational study. No randomization has been done and also there is a no control group to which the results can be compared.

**CONCLUSION**

Flap and fingertip glucose level monitoring is a simple and reliable method for flap monitoring and it can be performed by residents as well as nursing staff. The combination of glucose level monitoring with the classical methods of flap monitoring is likely to improve the flap salvage following venous thrombosis.

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