SMARTPHONE PHOTOGRAPHY AND WIRELESS INTERNET FOR FREE FLAP MONITORING

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ABSTRACT

BACKGROUND

Fate of the microvascular free flaps (MFF) is directly related to the surgeon's skill and experience, diligent postoperative monitoring, and re-exploration at the earliest to salvage the failing flap. In keeping with the times, smartphone photography and wireless technologies may have a role to play alongside the other methods to monitor MFFs.

MATERIALS AND METHODS

In this pilot study, we assessed the feasibility of utilizing smartphone and wireless Internet technologies for postoperative monitoring of MFFs (with a visible skin paddle) for the oral cancer post-extirpation defects. Post-operative photographs of MFFs were sent to two surgeons using smartphones and wireless Internet technology every six hours for 120 hours. Clinical and photographic methods of monitoring were compared between the findings of three surgeons. The operating surgeon (OPS) and the observing surgeon-2 (ObS-2) had access to clinical monitoring records, while the photographs were available to the OPS and the observing surgeon-1 (ObS-1). Indications to re-explore and salvage rates were compared using standard statistical methods.

RESULTS

30 MFFs were studied, with 100% survival rate at 120 hours. 5 patients were re-explored and salvaged completely. Re-exploration was indicated for the neck hematoma of 4 patients, and post-anastomotic venous thrombosis of 1 patient in whom the venous congestion was identified on a photograph. The accuracy rate with the use of photographs was 100%**.**

CONCLUSION

Smartphone photography with wireless Internet technology has proven to be a useful adjunct in free flap monitoring with a success rate of 100% in identifying a venous thrombosis and salvaging the flap. Incorporating this technique in the current protocols of free flap monitoring may help in identifying impending flap failures.

KEY WORDS

Oral Cancer, Free Flap Monitoring, Wireless Internet, Microvascular Free Flap.

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BACKGROUND

Dealing with large complex defects following excision in patients with oral cancers is a challenge. A vital component in the management of these patients is the use of microvascular free flaps (MFF) in reconstructive surgery [1]. The fate of the MFF is directly related to the surgeon's skill and experience, diligent postoperative monitoring, and re-exploration at the earliest to salvage the failing flap[2–4]. In the era of real time communication in health care, smartphone photography and wireless technologies may have a role to play alongside the other methods to monitor MFFs.

Objective

To study the role of Smartphone photography and wireless Internet technology in free flap monitoring.

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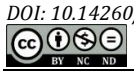

MATERIALS AND METHODS

Permission for this pilot study was obtained from the Institutional review board at Christian Medical College, Vellore. Informed written consent was obtained from each patient preoperatively. 30 patients who underwent microvascular free flap (MFF) reconstruction for post excisional defects of oral cavity with a visible skin paddle were subjected to a pilot study from November 2012 to October 2016.

The primary observer was a final year general surgical resident. The microvascular free flaps were monitored by clinical assessment and a handheld Doppler examination for 120 hours postoperatively. During the same period, clinical photographs of the MFF using a Sony Xperia® Smartphone (with no external flash or macro lens) were taken with a standardized color card in the frame, Figures 1-3. The clinical photographs taken at 6 hourly intervals were transmitted via wireless Internet connection to the Operating Surgeon (OPS) and another independent surgeon, the Observing Surgeon 1 (ObS1). The clinical details at these points of time were revealed to OPS and another surgeon, the Observing Surgeon 2 (ObS2).

The microvascular free flaps were independently assessed (studied) using the '**HAVUS'** assessment criteria as follows: pink and full as **H**-healthy, pale and wrinkled skin as **A**- "arterial insufficiency, " dusky skin as **V**- "venous insufficiency,

" blurred picture, loss of focus or poor exposure value as **U**- uninterpretable and a localized swelling in neck as **S**- swelling, Figure 4. The findings were then analyzed. The decision for re-exploration of the MFF was made by OPS, although input from the other two surgeons (ObS1 & ObS2) was provided when the free flap viability was questionable. Survival of the microvascular free flaps, salvage of failing flaps, if any, and the accuracy of Smartphone photography and wireless Internet in picking up complications were assessed at the end of the study.

RESULTS

Thirty microvascular free flaps, which included 15 radial artery free flaps, 11 anterolateral thigh flaps, and 4 Fibula osteomyocutaneous free flap were studied. There was a 100% survival rate of the MFF at 120 hours. All the MFF were used to reconstruct defects in patients undergoing excision for oral squamous cell carcinoma. There were 19 patients with lesions involving the tongue, 6 with buccal mucosa lesions, 4 with lower alveolar lesion, and 1 with a lesion on the lower lip. Based on the smartphone photography and wireless internet, five MFF were re-explored and the flaps were salvaged completely leading to a salvage rate of 100%. Of the 5 who were re-explored, 4 patients (13.33%) were for neck hematomas and 1 patient (3.33%) for a post-anastomotic venous thrombosis. Accuracy rate of complication pick-up with the use of wireless Internet was 100% as in all the 5 patients it corroborated with the identification of flap compromise by clinical assessment.

Figure 1

Figure 2

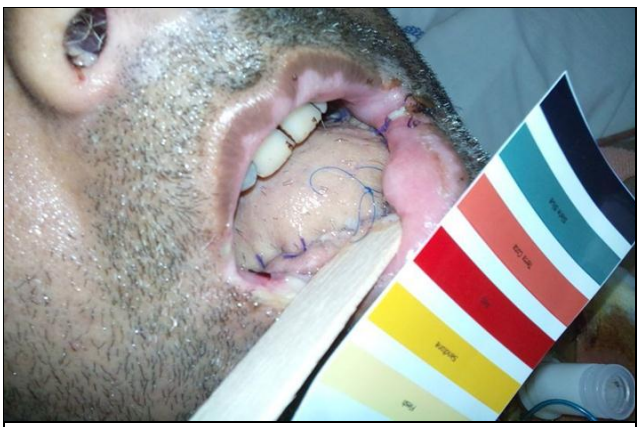

Figure 3

Post-operative days 1 (Figure 1), 3 (Figure 2) and 5 (Figure 3 of free flap monitoring in an uneventful flap.

Photographic assessment of free flaps: the **'HAVUS'** criteria	
H	Healthy: Pink, full
A	Arterial insufficiency: Pale & wrinkled skin
V	Venous insufficiency: Dusky skin
U	Un-interpretable: Blurred picture, loss of focus, poor exposure value.
S	Swelling in the neck

Figure 4

Figure 5

Figure 6

Figure 7

Photographs of flap showing compromise, before (Figure 5 and 6) and after salvage (Figure 7).

DISCUSSION

Postoperative monitoring is crucial for the successful salvage of microvascular free flaps[5]. To this end, the role of both early detection of vascular thrombosis and early intervention cannot be overemphasized[6]. Non-invasive and invasive methods have been described to monitor MFF. Clinical assessment remains the gold standard in the assessment of free flap status[7,8]. With experience and dedicated nursing, free flap monitoring is now more systematic, reliable, and effective in identifying failing flaps with timely interventions and overall successful salvage rates[9]. Smartphone photography and communication of data using wireless Internet, has been used and proven to be a newer, easier and more efficient method of free flap monitoring[8]. The reduction in flap failure rates was proven to be comparable to in-person assessments in many large volume centers[8,10]. In this study, clinical photographs of the free flap were transmitted postoperatively to the surgeons concerned, using wireless Internet, based on the premise- 'a picture speaks a thousand words'; thus, allowing the operating surgeon to make a virtual bedside visual assessment obviating the need for actually being beside the patient during this time. Although, the wireless Internet was used as an adjunct to clinical monitoring of free flaps, in one instance, the ObS2, while being out of country, identified a venous congestion and an impending flap failure even before the OPS could be contacted (Due to a local network congestion!) and suggested the emergency exploration and that was successfully salvaged by the OPS, Figures 5-7. Thus, this technique did play a crucial role in diagnosing a failing flap even as an adjunct to the clinical monitoring with an advantage of being non-invasive, easy, quick, reliable, and user-friendly as well as patient-friendly. Analysis of photographs and agreement amongst the surgeons was uniform with minimal ambiguity; thus, proving the effectiveness of the wireless Internet in communicating the clinical pictures of free flaps for objective assessment and monitoring.

CONCLUSION

Smartphone photography with wireless Internet technology is a useful adjunct to the clinical monitoring of free flaps with a success rate of 100%. The technique was useful in identifying potential venous thrombosis which helped in the decision to re-explore and revise the venous anastomosis. The incorporation of this technique in the current protocols of free flap monitoring may help in identifying impending flap failures even before the arrival of the senior team member.

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