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Technology

Fingerstall-type Tissue Oximetry Reduced Anxiety of Nurses in Postoperative Nursing Monitoring of Free Flaps

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Background: Postoperative free flap monitoring is essential for immediately detecting obstruction of anastomosed vessels with successive recovery surgery for salvaging flaps. We performed postoperative nursing monitoring using handheld Doppler sonography, but nurses reported feeling anxious with this approach and demanded a clear-cut evaluation method. Therefore, we implemented monitoring with the fingerstall-type tissue oximeter Toccare, a noninvasive device that enables easy flap checking by simply touching the flap with a probe.

Method: Handheld Doppler was used for nursing monitoring from April to October 2020, with anxiety associated with its use reported. We collected information via an anonymous questionnaire to determine the reason for the anxiety. Toccare was subsequently applied for postoperative free flap monitoring by nurses. The protocol involved measuring tissue oxygen saturation by touching the flap with a Toccare probe every 4 hours from 24 to 100 hours postoperatively. Seven months later, a second anonymous questionnaire was conducted, and results were compared.

Result: Free deep inferior epigastric artery perforator flaps and anterolateral thigh flaps (n = 5 each) were included. The average tissue oxygen saturation values in the deep inferior epigastric artery perforator and anterolateral thigh flaps were 52.0% and 52.4%, respectively. According to the second questionnaire about Toccare, 7% felt anxious, 62% felt slightly anxious, and 31% did not feel anxious. Toccare was preferred by 89% of nurses who had used both methods.

Conclusions: Flap monitoring using Toccare reduced nurses' anxiety. A numerical evaluation method with easy handling and clear doctor call criteria is essential for low-anxiety nursing monitoring. *(Plast Reconstr Surg Glob Open 2021;9:e3991; doi: 10.1097/GOX.0000000000003991; Published online 20 December 2021.)*

Free flap reconstruction carries a risk of flap loss caused by obstruction of microsurgically anastomosed vessels in the postoperative course. Immediately noticing flap ischemia or congestion and performing early surgical intervention, such as thrombosis removal and re-anastomosis, can result in flap salvage. However, frequently checking the flap by assessing its color, capillary refill, and bleeding after pinprick is too laborious for resident doctors.[1] Continuous tissue oximetry monitoring is becoming a reliable and labor-reducing method, but false positive alarms become frequent starting 24 hours postoperatively, being caused by factors as benign as a patient's body movements.[2]

To mitigate these false alarms, we implemented a nursing monitoring protocol using handheld Doppler sonography once patients began to leave their bed the day after surgery, but nurses reported feeling extremely anxious about using this approach and demanded a clear-cut evaluation method. Therefore, we revised our postoperative protocol to one using a Toccare device (ASTEM Co., Ltd., Kawasaki, Japan), a fingerstall-type tissue oximeter that we found to be useful for the quick intraoperative evaluation of flap viability in 2017 and 2018.[3,4] The Toccare has advantages in its noninvasiveness, compact size, and simplicity of measurement using

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numerical values, which matches postoperative flap monitoring to reduce anxiety of nurses. We herein report the changes with regard to nurses' anxious feelings associated with the implementation of this new approach to patient monitoring.

METHODS

This study was approved by the Kyoto University Medical Ethics Committee (R3087). Before the introduction of Toccare for postoperative monitoring, there was a period during which handheld Doppler sonography (ES-100V3; Hadeco Co., Ltd., Kawasaki, Japan) was used with marking the position to be checked from April to October 2020; however, nurses reported feeling anxious with this approach. We therefore collected information via an anonymous questionnaire to determine the reason for nurses' discomfort with using Doppler monitoring (Table 1).

Toccare was then applied for postoperative free flap monitoring. The light weight of the module (0.1 kg), mobility (battery-powered), and the short sampling time (0.5 seconds) are useful features of this device; furthermore, it is approved for oral measurements (Fig. 1). Our protocol of nursing monitoring was as follows: continuous tissue oximetry OXY-2 (ViOptix Inc., Fremont, Calif.) was performed in all cases until 24 hours after surgery. Flap monitoring using a Toccare device was then performed every 4 hours from 24 to 100 hours postoperatively. Nurses who belonged to general wards measured the tissue oxygen saturation (StO_2) values by touching the central part of flap with a Toccare probe. If the StO_2 value was less than 40%, nurses summoned a doctor. The cut-off of 40% was decided based on our previous report that an StO_2 of 41% coincided with the intraoperative indocyanine green fluorescence imaging border.[3,4] (**See Video [online],** which shows an intraoperative flap evaluation using Toccare.)

The device was used for 7 months, from December 2020 to June 2021, and a second anonymous questionnaire was conducted in July 2021, with the results compared (Table 1). All the questionnaires were performed without any previous announcements.

Takeaways

Question: We implemented monitoring with the fingerstall-type tissue oximeter Toccare, a noninvasive device that enables easy flap checking by simply touching the flap with a probe.

Findings: The average StO_2 values in the DIEP and ALT flaps were 52.0% and 52.4%, respectively. According to the questionnaire for nurses about Toccare, 7% felt anxious, 62% felt slightly anxious, and 31% did not feel anxious.

Meaning: A numerical evaluation method with easy handling and clear doctor call criteria is essential for low-anxiety nursing monitoring.

RESULTS

Postoperative nursing monitoring with Toccare was performed for five cases of free deep inferior epigastric artery perforator (DIEP) flap and five cases of free anterolateral thigh (ALT) flap. All the 10 flap surgeries were performed by the first author, who is a microsurgeon with more than 10 years of experience. All DIEP flaps were for breast reconstruction after total mastectomy and skin-sparing mastectomy of breast cancer with zone 1 area positioning at the skin defect, and all ALT flaps were for head and neck reconstruction, such as intracranial cancer, maxillary cancer, pharyngeal fistula, ear canal cancer, and tongue cancer. All 10 cases had exposed skin flaps that required monitoring and showed no postoperative complications associated with the free flaps. (**See figure, Supplemental Digital Content 1,** which shows the positions of monitoring flaps in each of the 10 cases. **http://links.lww.com/PRSGO/B860**.) (**See table, Supplemental Digital Content 2,** which shows the clinical information of 10 cases. **http://links.lww.com/PRSGO/B861**.) The StO_2 value in the DIEP flaps was 52.0% on average (Fig. 2, above), while that in the ALT flaps was 52.4% (Fig. 2, below). The cut-off for calling a doctor was set at less than 40% based on our previous study, but no cases with values of less than 40% were observed. (See

Table 1. First and Second Questionnaires concerning Nursing Monitoring Using Doppler and Toccare

First Questionnaire for Nurses about Doppler		Second Questionnaire for Nurses about Toccare	
Nursing monitoring period	2020.04–2020.10	Nursing monitoring period	2020.12–2021.06
Questionnaire timing	2020.11	Questionnaire timing	2021.07
No. responses	36/38 (95%)	No. responses	35/37 (95%)
Q1. Have you ever used Doppler for monitoring?		Q1. Have you ever used Toccare for monitoring?	
Yes	17/36 (47%)	Yes	29/35 (83%)
No	19/36 (53%)	No	6/35 (17%)
Q2. Do you feel anxious about the monitoring?		Q2. Do you feel anxious about the monitoring?	
Feel anxious	7/17 (41%)	Feel anxious	2/29 (7%)
Feel slightly anxious	9/17 (53%)	Feel slightly anxious	18/29 (62%)
Not feel anxious	1/17 (6%)	Not feel anxious	9/29 (31%)
Q3. Why do you feel anxious? (free description)		Q3. Why do you feel anxious? (free description)	
Difficulty evaluating small beating sounds	7	Changes in the value depending on the probe position	8
Changes in the sound depending on the probe position	4	Difficulty selecting values that should be recorded	3
Difficulty judging whether or not to call a doctor	4	Difficulty of pressure to apply to the flap with a probe	2
		Q4. Which method is better? (Question for both experienced nurses)	
		Toccare	16/18 (89%)
		Handheld Doppler	2/18 (11%)

Fig. 1. Postoperative flap monitoring of an ALT flap for tongue cancer reconstruction using a fingerstall-type tissue oximeter, the Toccare.

figure, Supplemental Digital Content 1. **http://links.lww.com/PRSGO/B860**.) (See **figure, Supplemental Digital Content 2**. **http://links.lww.com/PRSGO/B861**.)

According to the first questionnaire about handheld Doppler sonography, 41% felt anxious, 53% felt slightly anxious, and 6% did not feel anxious. According to the second questionnaire about Toccare, 7% felt anxious, 62% felt slightly anxious, and 31% did not feel anxious (Fig. 3). Toccare was preferred by 89% of nurses who had used both methods (Table 1).

DISCUSSION

The rate of take-back due to flap circulatory compromise is highest during the first day after surgery, dropping significantly by postoperative day 2 [5]; however, flap monitoring should be continued for 72 hours to improve the salvage rate by the early detection of vascular compromise.[6] There is no universal consensus concerning the ideal flap monitoring method, although such a method would be harmless, rapid, reliable, objective and simple to interpret.[7] Continuous tissue oximetry is useful, but the false positive rate increases significantly from 24 hours postoperatively due to probe malfunction/errors.[2]

To obtain the cooperation of nurses, the most important point is to reduce their anxiety and complaints concerning flap monitoring. Nursing education on free flap physiology and monitoring, such as capillary refill and venous congestion, improves confidence among nursing staff.[8,9] We also have annual nursing education lectures; however, a complete education is not always possible in larger hospitals, and the skill level of nursing staff is often varied. We therefore felt that a numerically evaluated method with easy handling and clear criteria for summoning a doctor was essential for nursing monitoring. We considered Toccare had appropriate usability for the first postoperative 24 hours, too.

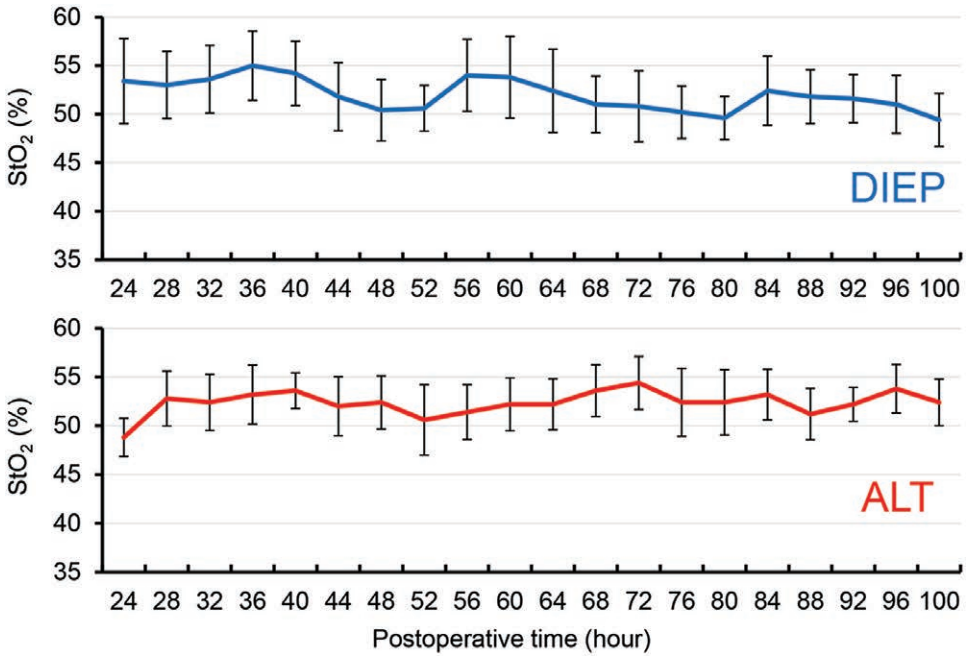

Fig. 2. The average StO_2 values in five free DIEP flaps and five free ALT flaps were 52.0% (above) and 52.4% (below), respectively. Error bar: standard error.

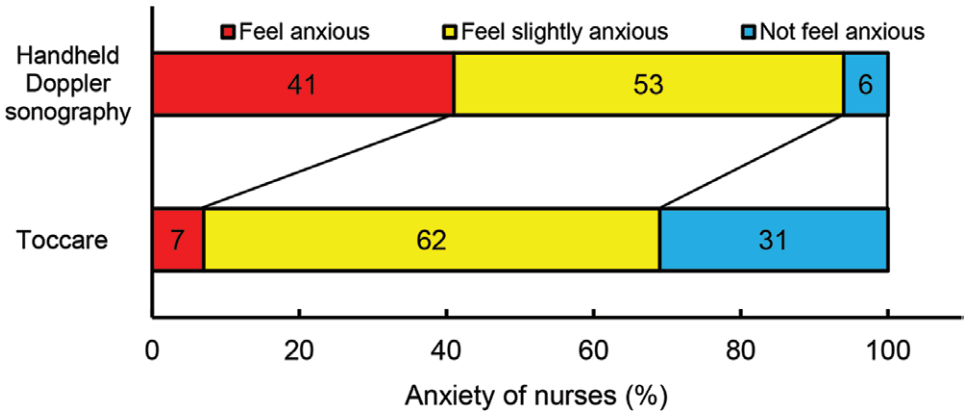

Fig. 3. Toccare reduced nurses' anxiety for the postoperative monitoring of free flaps.

The present study indicated that Toccare reduced the anxiety of nurses, although 62% of nurses still felt slightly anxious, even with the Toccare protocol. We analyzed the years of nursing experience and found that nurses with fewer than 5 years of experience felt slightly anxious (11/12, 92%) or generally anxious (1/12, 8%) for Toccare. The anxiety questionnaire for traditional Doppler monitoring did not show the differences of nursing experience. Broyles et al reported that nurses with under 5 years of experience were less comfortable with flap monitoring than their more experienced colleagues, especially when newer technologies were employed.[10]

Nursing monitoring using Toccare has two limitations that should be mentioned: the need to monitor skin islands on the body surface and the need for more clinical cases of compromise to decide the StO_2 value of alert. Also, limitations of this study are the relatively small number of flaps, the timing of questionnaires which may affect the behavior of nurses, and the differences of number of nurses included in the first and the second questionnaire.

CONCLUSIONS

Nursing monitoring using Toccare reduced the anxiety of nurses. We suspect that this device matches flap monitoring after patients get out of bed.

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