

Combined Non-Invasive Tissue Oxygen and Flow Monitoring in Fasciocutaneous Forearm Flaps

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Background / Objective

Tissue oxygenation and maintenance of microvascular blood flow of grafted tissue is crucial for flap viability. Therefore, monitoring of free tissue flaps is of great clinical interest^{1,2,3}.

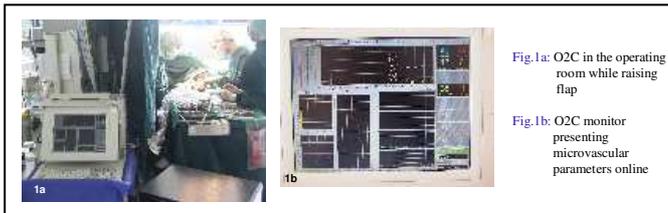
Early recognition of microvascular flap failure is therefore important for the outcome of the graft and for the decision on surgical revision in order to avoid the loss of the graft.

Aim of the study

To investigate the usefulness of the tissue oxygen analysis system O2C for monitoring patients undergoing maxillofacial reconstruction with fasciocutaneous forearm flaps

Methods / Patients

For our research, the tissue oxygen analysis system O2C (Oxygen-to-see, LEA, Gießen, Germany) was used permitting non-invasive measurements of blood flow, flow velocity, hemoglobin concentration (AU, Arbitrary Units) and hemoglobin oxygenation (%).



In 6 patients (2 men and 4 women, aged 49 to 76, mean: 60±10.1 years) who underwent successful microvascular reconstruction with fasciocutaneous forearm flaps, the indicated parameters were assessed before elevation, in the raised (A) and removed (B) flap, after anastomosis (C) and reconstruction (D) up to 3 days postoperatively (see Figure 2, upper panel).

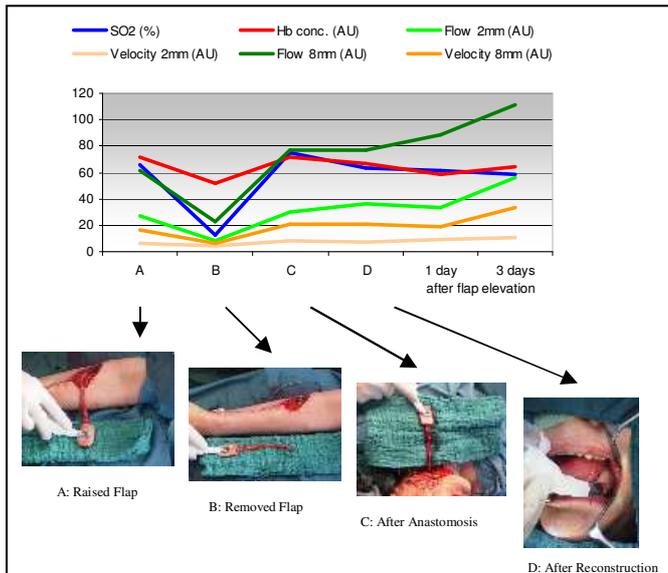


Figure 2: Time schedule for repetitive measurements of microvascular parameters in fasciocutaneous flaps using O2C.

Note hyperemic response after microvascular anastomosis (C) and significantly higher flow levels (P<0,05) in 2mm and 8mm depth and velocity values in 8mm depth after 3 days compared to A.

Results

- SO2:** Note the significant fall (p<0,05) after severance of flap pedicle (see Fig. 3). Higher oxygen values were found when compared to earlier studies⁴.
- Flow:** Blood flow in 2 and 8mm depth tended to be higher in the grafted forearm flaps than in the donor region (see Figs. 2 and 4).
- Velocity/Hbconc:** Blood velocity and hemoglobin concentration similarly parallel the microvascular changes encountered for blood flow and SO2 (Fig. 2).
- In one patient with a later on diagnosed sticky platelet syndrome (SPS), flap failure was already recognized with O2C intraoperatively (see Figs. 5 and 6).

Tissue Oxygenation and Microvascular Blood Flow in patients before, during and after Transfer of Fasciocutaneous Forearm Flaps

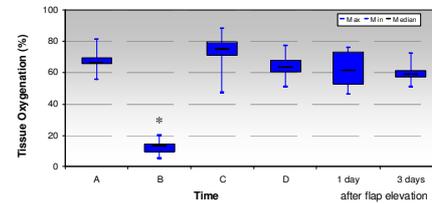


Fig. 3: Tissue oxygenation values measured by O2C (n=6, * P<0.05 vs. A, T-test). At C, an initial increase of SO2 is observed during the hyperemic response (see also Fig. 4).

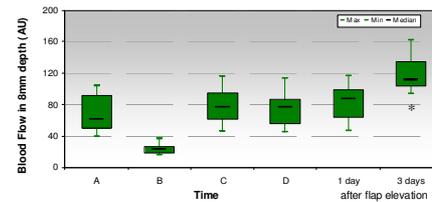


Fig. 4: Blood flow values measured by O2C (n=6, * P<0.05 vs. A, T-test). Note significantly higher values 3 days after flap elevation which persisted over 14 days (data not shown).

Clinical Case of a Patient with Flap Failure due to later on diagnosed Sticky-Platelet-Syndrome

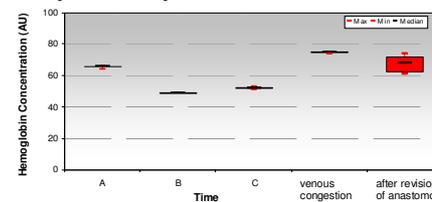


Fig. 5: Hemoglobin concentration in a patient with SPS. See rapid increase of hemoglobin concentration as an indicator of severe venous congestion.

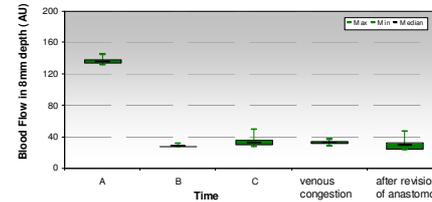


Fig. 6: Blood flow in a patient with SPS. Note the absence of recovery of blood flow indicated by O2C which is also paralleled by low hemoglobin oxygenation (data not shown).

Conclusion

- O2C permits objective and early recognition of flap failure prior to clinical assessment.
- Values of tissue oxygenation under 15% and of blood flow at 2mm tissue depth under 10 AU seem to be highly predictable to indicate start of flap failure.
- Therefore, O2C is a suitable and easy method for non-invasive monitoring of tissue oxygenation and blood flow in free tissue transplantation.

References

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