Viability of Flaps: intra- and postoperative Monitoring for Increase of Transplantation Success Rate

Although the success rate of flap transplants increased to 91-99%[1] in the last thirty years since their introduction, due to advancement of microsurgical methods, the loss of transplanted tissue is associated with such high costs, effort and strain for the patient, that the fight for each single transplant is tremendously important and beneficial[2]. Most important is the early diagnosis of perfusion impairments (because of arterial and venous occlusion) caused by thromboses that are the main reason for the loss of flaps. With early enough diagnosis most flaps can be revised [7]. Over the last years the laser doppler has been proven to be a reliable, non invasive, continous, exact and simply applicable diagnostic device to identify undersupply earlier than it can be identified by experienced staff. The preservation of vulnerable transplants could be increased to 50-100% [3].
For judgment of viability of tissue, however, it is not only necessary to observe the delivery of blood, but also the metabolic condition of the tissue. A differentiated monitoring of the perfusion and oxygen utilisation is possible with the newly developed O2C.

Intraoperative Monitoring

The transplantation of a flap from the forearm to the heel is an examplification [4]. The dynamic of the tissue supply parameters oxygen saturation, blood flow and blood quantity was monitored and is shown in the following diagram. It was measured at five measurement points in the middle of the flap always from distal to proximal.

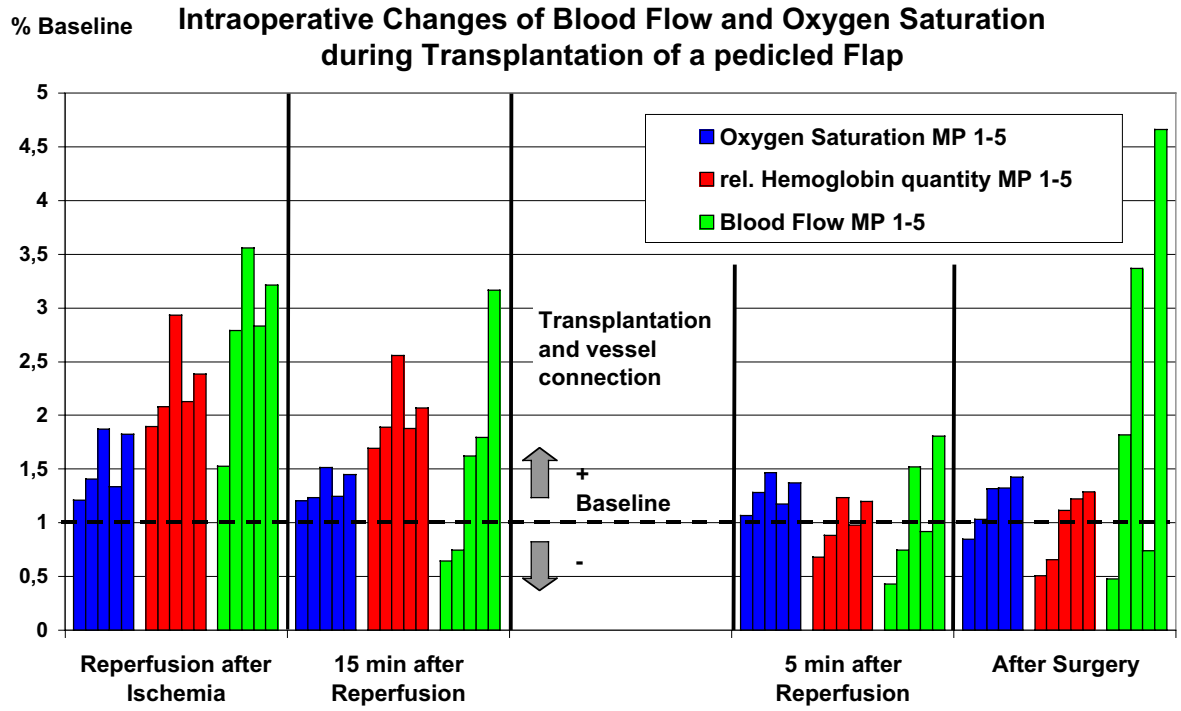

Figure 1: Intraoperative changes of blood flow and oxygen saturation

After preparation of the pedicled flap at the forearm it was kept ischemic for two hours and then reperfused. As shown in Figure 1, the oxygen saturation and blood flow increased during the reperfusion period, due to reactive hyperemia, that decreases after 15 minutes. The oxygen saturation increases less than the blood flow, as there is an oxygen dept in the tissue after ischemia, and therefore oxygen extraction increases in the reperfusion period. After transplantation of the flap to the area of the heel and after connection of the vessels you can see a low perfusion at the same measurement points that also reacted less hyperemic during the first reperfusion. Measurement point three and five show in contrast a highly increased blood flow with slightly increased oxygen saturation. That indicates a high cell metabolism after transplantation and therefore viable tissue.

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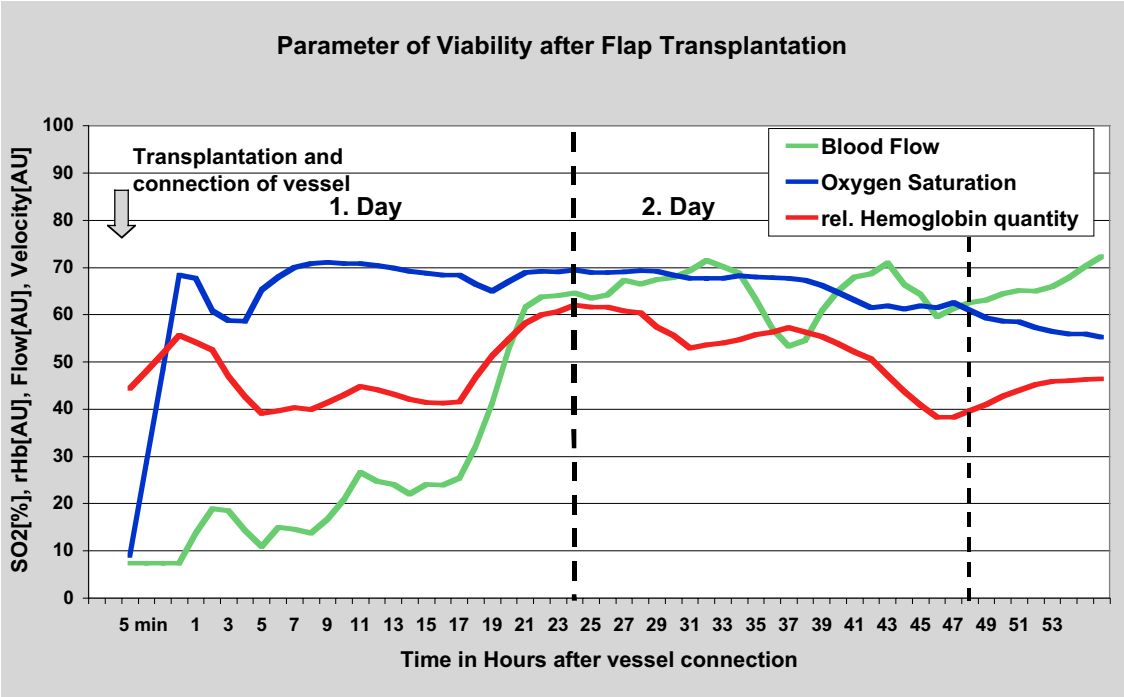
Postoperative Long-term Monitoring

After the transplantation of a musculocutaneous flap from the forearm to the ball of the thumb the transplanted tissue was observed for about 50 hours and the parameters of viability oxygen saturation, blood flow and blood quantity continously recorded.

During the first 24 hours after surgery the blood flow increases up to sevenfold compared to the baseline values. This increase of the blood flow is an important criterion for the outcome of the transplants as has been shown by laser doppler measurements [3]. With higher temporal resolution you can also see the pulse and beginning of vasomotion as a sign for physiologic reactivity [5].

An increase of the blood flow or the oxygen saturation after days up to a week was also described in different other studies [6] [7].

However the viability of tissue is only identifiable, if the delivered oxygen is also utilized by the tissue. The constant or even decreasing oxygen saturation over 48 hours shows a stable oxygen extraction of the tissue and in connection with the increasing blood flow even an increasing oxygen consumption.
Venous occlusions, the main reason for decreased perfusion of transplants, could be differentiated by increase of the hemoblobin quantity with concomitant decreasing flow.



O2C allows the determination of blood flow and oxygen saturation in tissue by combination of laser doppler and tissue spectrophotometry and therefore provides information about critical blood supply and oxygen utilisation in tissue.

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