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Transcutaneous pO₂ measurement during tourniquet-induced venous occlusion using dynamic phosphorescence imaging

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Abstract:

A sufficient oxygen supply in skin grafts requires a functioning microcirculation. Venous occlusion impairs the microcirculation and is therefore a major threat of healing. Luminescence life time imaging (LLI) enables the non-invasive and two-dimensional assessment of the transcutaneous oxygen partial pressure (p_{tc}O₂). In the current trial this new device was applied for monitoring of venous congestion. A tourniquet on the upper arm was inflated up to 40 – 50 mmHg and released after 10 min in eight healthy volunteers. The p_{tc}O₂ was measured at the lower arm every minute prior to, during and up to 10 min after cuff occlusion (40 °C applied skin temperature) using LLI of platinum(II)-octaethyl-porphyrin immobilized in a polystyrene matrix. For validation the polarographic Clark electrode technique was applied in close proximity and measurement was performed simultaneously. p_{tc}O₂ measurements prior to (Clark: 50.68 ± 5.69 mmHg vs. LLI: 50.89 ± 4.96 mmHg) and at the end of the venous congestion (Clark: 16.41 ± 4.54 mmHg vs. LLI: 23.82 ± 3.23 mmHg) did not differ significantly using the Clark electrode vs. LLI. At the initial congestion respectively reperfusion phase the Clark electrode measured faster decreases respectively increase of p_{tc}O₂ due to oxygen consumption of this method.

This experimental trial demonstrates the applicability of LLI to quantify the p_{tc}O₂ under changing venous blood flow. The use of planar transparent sensors allows the non-invasive generation of two-dimensional maps of surface pO₂ what makes this method particularly suitable for monitoring of skin grafts.

Key-words: Transcutaneous pO₂, luminescence life time imaging, Clark electrode, planar sensor, microcirculation