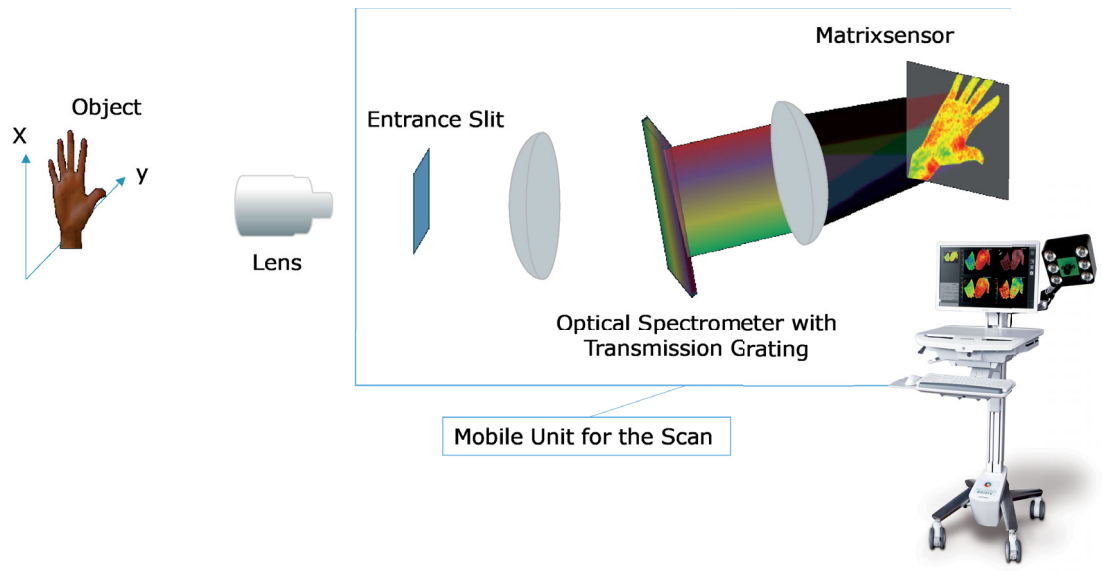
Is Hyperspectral Imaging Suitable for Assessing Collateral Circulation Prior Radial Forearm Free Flap Harvesting?

Comparison of Hyperspectral Imaging and Conventional Allen's Test

Diana Heimes[1], Philipp Becker[2], Daniel G. E. Thiem[1], Robert Kuchen[3], Solomiya Kyyak[1], Peer W. Kämmerer[1]

INTRODUCTION

The aim of this cross-sectional study was to compare a new and non-invasive approach using **hyperspectral imaging (HSI)** with the conventional modified **Allen's test** (MAT) for the assessment of **collateral perfusion** prior to **radial forearm free flap (RFFF)** harvest in healthy adults.



MATERIALS & METHODS

HSI of the right hand of 114 patients was recorded. Here, three recordings were carried out:

1. basic status (perfusion),
2. after occlusion of ulnar and radial artery (occlusion) and
3. After releasing the ulnar artery (reperfusion)

Measured values:

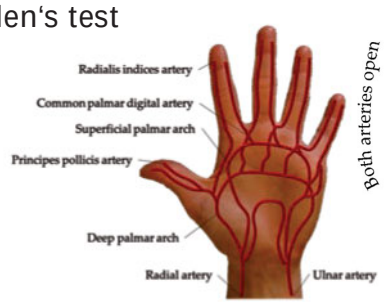
Superficial perfusion (StO_2 [0–100%]; 0–1 mm depth)

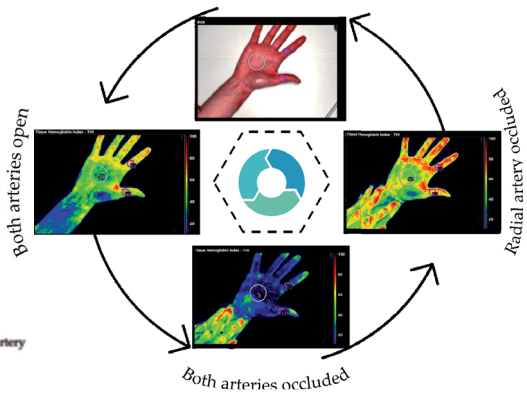
Tissue haemoglobin index (THI [0–100])

Near infrared perfusion index (NIR [0–100]; 0–4 mm depth)

Goldstandard (control):

Modified Allen's test





RESULTS

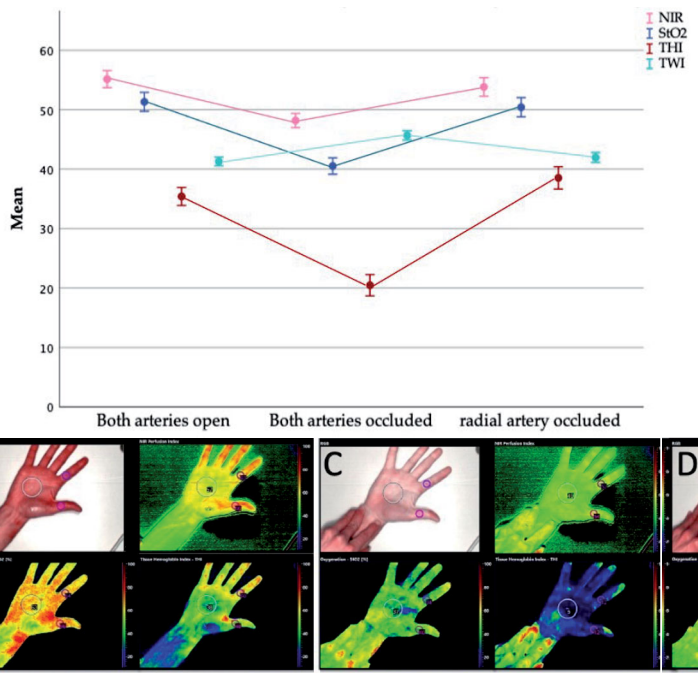


Fig. 1: Measurements of the hyperspectral analysis over the time course of the experiment. Statistically significant differences between **perfusion (I) and occlusion (II)** as well as between **occlusion (II) and reperfusion (III)** (p<0.001 each). There was a statistically significant correlation between the difference of **perfusion (I) and reperfusion (III)** and the time measured during the **Allen's tests** (p<0.05).

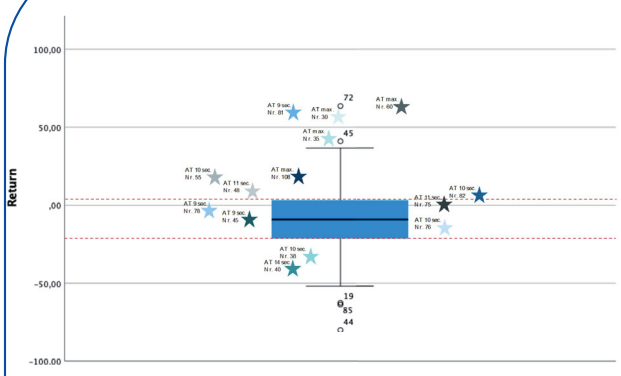
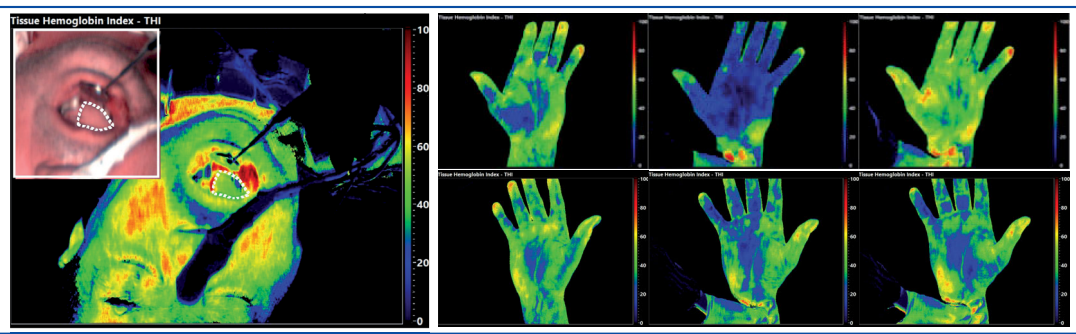


Fig. 2: Population with an **Allen's test >8 seconds.** An impairment **in reperfusion (III)** (p<0.05) and a strong correlation between **the difference of perfusion (I) and reperfusion (III)** and the time measured during the Allen's test (p<0.01).

Fig. 3: 63-year-old patient with oral squamous cell carcinoma.
Allen's test right arm: Reperfusion time **> 20 sec**.; confirmed by HSI
Allen's test left arm: Reperfusion time **11 sec**.; **adequate perfusion** with satisfactory RTP-value (HSI)
With constant monitoring of oxygen saturation, the RFFF could be harvested without complications. In the postoperative follow-up, the graft was adequately perfused and healed well.



CONCLUSIONS

The results indicate a reliable **differentiation between perfusion and occlusion** by HSI. Therefore, HSI could be a useful tool for verification of the correct performance of the MAT as well as to confirm the final diagnosis, as it provides an **objective, reproducible** method whose results strongly correlate with those obtained by MAT. What is more, it can be easily applied by **non-medical personnel**.

[1] Klinik und Poliklinik für Mund-, Kiefer- und Gesichtschirurgie der Universitätsmedizin Mainz, Augustusplatz 2, 55131 Mainz
[2] Klinik für Mund-, Kiefer- und Gesichtschirurgie, Bundeswehrzentralkrankenhaus Koblenz, Rübenacherstraße 170, 56072 Koblenz
[3] Institut für Medizinische Statistik, Epidemiologie und Informatik, Universitätsmedizin der Johannes Gutenberg-Universität Mainz, Obere Zahlbacher Str. 69, 55131 Mainz