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Department of Anesthesiology and Intensive Care Medicine
University Hospital of Cologne

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Digital Thermal Monitoring: Non-Invasive Assessment of Perioperative Microvascular Function

Robert Schier, M.D., Ph.D.[1]; Reza Mehran, M.D.[2]; Jagtar Heir, D.O.[2]; Mike Hernandez, M.S.[2]; Bernhard Riedel, M.D., Ph.D.[3]

[1]University Hospital of Cologne, Germany; [2]The University of Texas M. D. Anderson Cancer Center, Houston, TX, USA; [3]Vanderbilt University, Nashville, TN, USA

Background and Goal of Study

- Systemic inflammation may impair microvascular and more specifically endothelial cell (EC) function (1-3).
- Quantifying preoperative (1°, related to comorbidities) and perioperative (2°, related to the surgical inflammatory response) microvascular function may improve our understanding of the pathophysiology related to postoperative morbidity.
- Digital Thermal Monitoring (DTM; Endothelix, Houston, TX, USA), a novel non-invasive method of assessing microvascular and EC function, measures temperature (T) change at the fingertip in response to forearm induced ischemia and hyperaemia. Importantly, DTM lends itself to repetitive point-of-care testing, thereby facilitating cardiovascular (4) and perioperative risk assessment.
- We set out to characterize the reactive hyperaemic response to acute exercise and that during the perioperative period.

Materials and Methods

- Following IRB approval, 40 patients scheduled for major thoracic surgery were studied prospectively.
- Fingertip probes measured T [° C] prior to (TS, starting temperature), during (T_{min}, lowest temperature during ischemia), and following (T_{max}, highest temperature during reactive hyperaemia) 2-minutes of upper arm cuff occlusion.
- Three variables were derived: temperature rebound (TR = T_{max} - TS); TR% (= TR / TS); and adjusted TR (aTR = peak TR - T_{min}). These variables were measured preoperatively (baseline and 10 minutes after maximal voluntary exercise using a cycle ergometer) and postoperatively (Day 1, 2, and 5).
- The Kruskal-Wallis test, with post-test using Dunn's Multiple Comparisons Test, analyzed the temperature response variables over the measured time points.

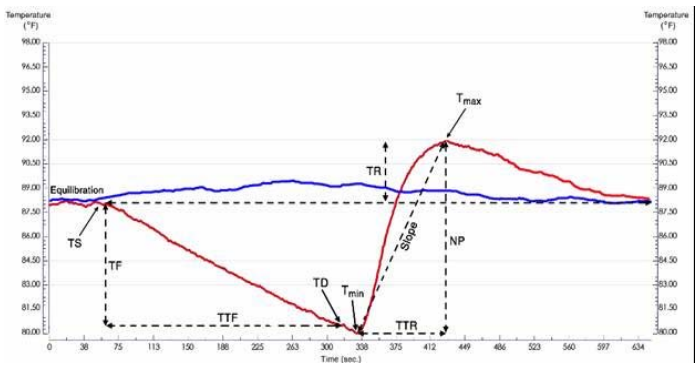

Figure 1. Temperature measured in right (red) and left (blue=control) fingertip

PRIMARY PARAMETERS	
TS	Starting fingertip temperature at cuff inflation
T_{min}	Lowest temperature (nadir) observed after cuff inflation
T_{max}	Highest temperature observed after cuff deflation
DERIVED PARAMETERS	
TF	Temperature Fall = TS – T_{min}
TR	Temperature Rebound (T_{max} - TS)
aTR	Peak TR - T_{min}
TS	Starting Temperature
TD	Deflation Temperature
TTF	Time taken to reach Temperature
TTR	Time taken to reach Temperature rebound (TR)
NP	Nadir to Peak Temperature Gain (T_{max} - TMP_{min})
SLP	Slope (NP/Time to Reach TR)

Figure 2. Digital Thermal Monitoring Parameters

Results and Discussion:

- The hyperaemic response (TR ° C, %TR and aTR) was lowest at the preoperative baseline, with increased response seen after surgery, and greatest response seen after acute maximal exercise.
- Postoperatively, the maximal hyperaemic response occurred on postoperative Day 2. Data are summarized in the table. P-values <0.05 were regarded as significant

Table. Perioperative Temperature Rebound Variables (TR, %TR, aTR)

Mean (± SD)	**Baseline**	**Exercise**	**Postop Day 1**	**Postop Day 2**	**Postop Day 5**	**P-value***
TR [° C]	0.03 (± 0.4)a	0.50 (± 0.9)a	0.21 (± 0.6)	0.31 (± 0.5)	0.24 (± 0.3)	0.046
%TR	0.11 (± 1.3)a	1.65 (± 3.2)a	0.69 (± 1.9)	1.00 (± 1.5)	0.75 (± 1.1)	0.049
aTR [° C]	0.59 (± 0.4)	0.87 (± 0.8)	0.52 (± 0.5)	0.69 (± 0.4)	0.69 (± 0.3)	0.141

*P-value based on Kruskal-Wallis test; a- significantly different using Dunn's Multiple Comparisons Test.

Conclusion

- **These data characterize the microvascular response to exercise and to surgical trauma. Since endothelium-dependent microvascular dysfunction is increasingly recognized as a component central to postoperative morbidity the clinical relevance of this physiologic signal warrants further study.**
- **Our future investigations will explore whether impaired microvascular response to surgical trauma correlates with adverse surgical outcome.**
- **An impaired response to acute exercise may identify patients unable to mount an adequate physiologic surgical stress response, thereby allowing timely preoperative intervention and optimization in an attempt to reduce postoperative morbidity.**

References

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