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Thromboelastometry: A contribution to perioperative free-flap management

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ABSTRACT

Background: Microvascular tissue transfer is a fundamental part of reconstructive surgery.

Different perioperative anticoagulation regimens exist, influencing hemostatic parameters. Since bleeding and thrombosis are major reasons for revision procedures and flap loss, current practice regarding anticoagulative treatment needs further refinement.

Thromboelastometry has been demonstrated as worthwhile in the determination of alterations of the anticoagulation cascade. We evaluated this aspect of thromboelastometry for free flap surgery.

Methods: Thirty-five patients undergoing free-flap surgery were enrolled in this study. Blood samples were obtained at three time points: at the beginning of surgery, at time of anastomosis and after 24 h. At each time point, thromboelastometry with special regard to clotting times for the intrinsic and extrinsic paths of coagulation was immediately performed. Global coagulation markers and clinical parameters were collected simultaneously.

Results: Hemostatic changes were deducible using thromboelastometry perioperatively. Measured parameters differed significantly over time ($p < 0.05$). Heparin therapy showed a significant effect on the measured slope of INTEM-clotting times ($p < 0.001$). Altered values of thromboelastometry suggested non-inferiority to standard testing. Neither standard testing nor thromboelastometry were capable of predicting adverse events such as thrombosis, bleeding or flap loss ($p > 0.05$).

Conclusions: Thromboelastometry monitors hemostatic effects almost in real-time and could serve as a supplementary tool in microvascular tissue transfer once its use has been standardized. The utilization of thromboelastometry allows for assessment of the anticoagulation needs of individual patients undergoing free flap surgery, which is frequently accompanied by hemostatic changes in the perioperative setting. Our findings implicate further validation of thromboelastometry in free-flap surgery.

1. Introduction

Bleeding and thrombosis are major causes for additional surgical intervention in microvascular tissue transfer, with reported flap loss rates around 5% (Davison et al., 2004; Gardiner and Nanchahal, 2010; Brinkman et al., 2013). Since no standardized protocol in perioperative management exists, special regard has been given to anticoagulation therapy (Salgado et al., 2009; Pattani et al., 2010). In an attempt to decrease thrombotic incidents anticoagulant agents are applied. Commonly, low molecular weight heparin (LMWH) and unfractionated heparin are utilized (Khouri et al., 1998; Ashjian et al., 2007). The administration of the latter has been debated controversially in recent years (Pan et al., 2014). The critical phase, when salvage procedures are a frequent necessity, is assumed to last for several days (Chang et al., 2014).

Perioperatively, for each patient, the ongoing assessment of the induced effects on coagulation is essential. Detecting impairments in coagulation and estimating the capacity to withstand

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iatrogenic adjustments are decisive in preventing undesirable incidents. The introduction of rotational thromboelastometry substantially enhanced options to overcome the limitations of conventional testing in anticoagulant therapy (ROTEM, Tem Innovations GmbH, Munich, Germany) and is already successfully established (Ebinger et al., 2010; Fries, 2011). The technique objectifies the dynamics and efficiency of coagulation influenced by plasmatic coagulation, platelet-function, fibrinolysis, and medication/fluids applied, among others (Franz, 2009). Thromboelastometry has proven its usefulness in the critically ill and in trauma patients (Stancheva et al., 2011; Tauber et al., 2011). Only limited data exist on microvascular tissue transfer. Kolbenschlag et al. (2014) found the method useful as a screening tool in the prediction of thrombosis in reconstructive surgery. The aim of this study was to evaluate the systematic use of thrombolestometry in the perioperative course in cranio-maxillofacial free-flap patients in comparison to standard testing and prove its value prospectively, outlining alterations for clinical applicability in hospitals using antithrombotic agents.

2. Materials and methods

2.1. Patient cohort

The prospective, exploratory cohort study was conducted in accordance with the WMA Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects and was previously given approval by the local Medical Ethical Committee (Reference no.: **PV4540**).

All 35 participants with evaluable data sets provided their written consent to participate after being meticulously informed about the scope of the study. A single specialist (JW) examined the patients prior to surgery and collected the medical history including current medication and general illnesses. In this context, patients who had previously received radiotherapy or prior surgery to the surgical site of anastomosis resulting in, for example, vessel depleted necks, were primarily excluded from further participation in this study. A total of 134 patients underwent free flap surgery in the department of oral and maxillofacial surgery of the University Hospital of Hamburg-Eppendorf in 2014. The number of non-irradiated patients within the reference time frame was 118 in total. The retrospectively calculated annual loss rate in this group was found to be 5.1%.

Accessibility of the device, absence of trained staff and logistic obstacles led to further exclusion of patients.

2.2. Rotational thromboelastometry (ROTEM)

Thromboelastometry represents a viscoelastic technique for the detailed presentation of hemostatic properties. A rotating sensor shaft suspended in a small whole-blood sample (300 μl, anticoagulated with citrate) slowly oscillates back and forth. A signal is transmitted via an optical detector system after starting the test by adding appropriate reagents. As long as no clotting is registered, the movement of this pin remains unimpeded. The evolving coagulum hinders the motion. The device measures alterations over time and graphically displays the changes in elasticity at all stages of the developing and resolving clot; this curve is called a temogram (TEM). Various clinical conditions give rise to characteristic TEM curves. Moreover, the system provides numerous parameters (Fig. 1). The rheologic conditions mimic a sluggish venous blood flow. The system provides the option to assess up to four channels simultaneously. The TEMs as surrogates for the intrinsic pathway (INTEM) and extrinsic pathway (EXTEM) can be measured and calculated along with others, for example, emphasizing fibrinogen via FIBTEM.

2.3. Study protocol

Laboratory parameters comprised prothrombin time (PT), partial thromboplastin time (pTT), thrombin time (TT) and platelet count (PC). Measurements were promptly determined in the central laboratory. Clinical routine parameters also included a full blood count, markers of inflammation and electrolytes.

For assessments of thromboelastometry two trained staff members of the anesthetic department performed the immediate processing of the blood samples via ROTEM (Tem Innovations GmbH, Munich, Germany). Conventional parameters and values

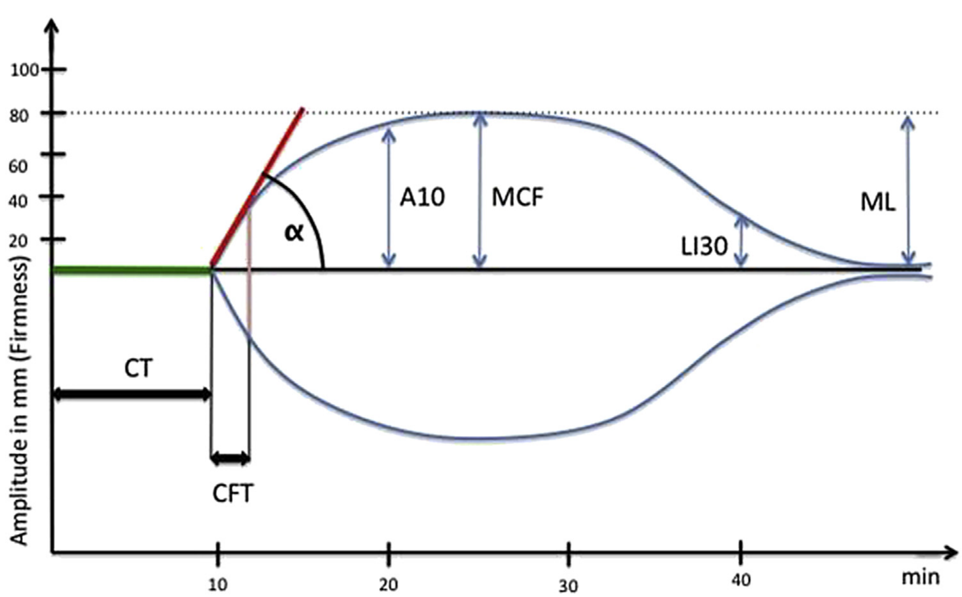

Fig. 1. Exemplary measurement graph of specimens in ROTEM α: alpha angle; A10: amplitude 10 min after CT; CT: clotting time; clot formation time/clot 20 mm; L30: lysis index 30 min after CT; MCF: maximum clot firmness; ML: maximum lysis.