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Microdialysis: characterisation of haematomas in myocutaneous flaps by use of biochemical agents

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Abstract

Metabolic markers are measured by microdialysis to detect postoperative ischaemia after reconstructive surgery with myocutaneous flaps. If a haematoma develops around the microdialysis catheter, it can result in misinterpretation of the measurements. The aim of the present study was to investigate whether a haematoma in a flap can be identified and dissociated from ischaemia, or a well-perfused flap, by a characteristic chemical profile.

In 7 pigs, the pedicled rectus abdominal muscle flap was mobilised on both sides. A haematoma was made in each flap and two microdialysis catheters were placed, one in the haematoma, and the other in normal tissue. One flap was made ischaemic by ligation of the pedicle. For 6 hours, the metabolism was monitored by measurement every half-an-hour of the concentrations of glucose, lactate, pyruvate, and glycerol from all 4 catheters. After 3 hours of monitoring, intravenous glucose was given as a challenge test to identify ischaemia.

The non-ischaemic flap could be differentiated from the ischaemic flap by low glucose, and high lactate, concentrations. It was possible to identify a catheter surrounded by a haematoma in ischaemic as well as non-ischaemic muscle from a low or decreasing concentration of glucose together with a low concentration of lactate. All four sites could be completely dissociated when the concentrations of glucose and lactate were evaluated and combined with the lactate:glucose ratio and a flow chart. The challenge test was useful for differentiating between haematomas in ischaemic and non-ischaemic tissue.

Keywords: Microdialysis; Free flap; Ischaemia; Haematoma; Monitoring

Introduction

A serious complication after reconstructive surgery using free flaps is total necrosis of the flap as a result of insufficient perfusion of blood. When perfusion is too low, the patient should be reoperated on within a few hours to prevent permanent damage.[1] It is, therefore, of great importance that the flap is monitored closely for signs of ischaemia after operation. Simple clinical tests together with other techniques are used to detect ischaemia at an early stage, all with advantages and disadvantages.[2]

When a monitoring technique is chosen, it is important to consider the risk of failure. The higher the risk of primary failures, the more important it is that the technique has good sensitivity, and the lower the risk of primary failures, the more important is the specificity of the chosen technique. Microdialysis is a reliable tool when it comes to the detection of metabolic changes in tissue.[3–5] In reconstructive surgery,

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it has proved to be valuable for the monitoring of ischaemia in pedicled and free flaps.[6–13] It may be of utmost importance when monitoring buried flaps, which are difficult to monitor because it is not possible to observe them clinically,[14,15] and the technique has been described as being both sensitive and specific in these cases.[12,16]

The technique has been described in detail elsewhere.[9,17,18] A double lumen catheter with a semipermeable membrane in the distal end is placed in the tissue. The catheter is perfused with an isotonic buffer. The membrane allows low-molecular-weight substances to diffuse along the concentration gradient between the extracellular fluid and the buffer. The dialysate is collected and analysed.

There is a risk of development of a haematoma in any operation. If a microdialysis catheter is accidentally placed in a haematoma or a haematoma develops around the catheter, the results may be skewed. Misinterpretation of the results could lead to either unnecessary surgery or necrosis of the flap. A haematoma around the catheter can be identified by ultrasound, but continuous screening is time-consuming. The identification of a characteristic profile of metabolic agents in a haematoma, therefore, would be of great value clinically. A study of 1195 breast reconstructions indicated that 1.6% of free flaps had a postoperative haematoma that required intervention.[19] Another study of 408 patients found a bleeding haematoma in 25 of 427 flaps (6%).[20] We know of no studies that have described the metabolic conditions inside a haematoma using microdialysis.

The aim of this study was to investigate whether haematomas have a certain characteristic metabolic profile that differs from that of the tissue outside the haematoma.

Materials and methods

The experiment was approved by the Danish Ministry of Justice, the Animal Experimentation Inspectorate (No. 2006-561-1138).

Seven female Danish Landrace pigs weighing 34–39 kg were used. The animals were premedicated with midazolam 20 mg and ketamine 200 mg intramuscularly. Anaesthesia was induced by injection of pentobarbital 500 mg into an ear vein. The animals were intubated and ventilated on a Datex Ohmeda S/5 Avance (GE Healthcare) medical respirator with a mixture of 65% air and 35% oxygen. To maintain anaesthesia, pentobarbital 500 mg/hour was infused. At the end of the experiment, the pigs were killed with an overdose of pentobarbital.

Two symmetrical myocutaneous rectus abdominis flaps (6 cm × 25 cm) were mobilised, one on each side of the upper abdomen of each pig. Two CMA 63 microdialysis catheters (CMA Microdialysis, Solna, Sweden) were inserted intramuscularly in each flap. One microdialysis catheter (the reference catheter) was inserted in the central part of the flap with a splitable introducer SI-2 (CMA Microdialysis). A second catheter was placed distal to the reference catheter in a haematoma using the following technique: a 3-lumen BD Careflow™ central venous catheter (BD medical Systems, Singapore) was shortened to let the distal end of a CMA 63 microdialysis catheter be exposed when it was placed in the middle lumen. With the aid of a cannula and a guide wire, the shortened central venous catheter was placed in the muscle of the flap. A CMA 63 catheter was placed in the middle lumen and fixed with sutures (Fig. 1). A haematoma was generated around the microdialysis catheter by injecting arterial blood 5 ml through the 3-lumen catheter. The blood had been aspirated through a carotid artery catheter. The positions of the catheters in the haematomas were verified using an 8 MHz linear probe connected to a Vivid *i* ultrasound machine (GE Healthcare, Horten, Norway).

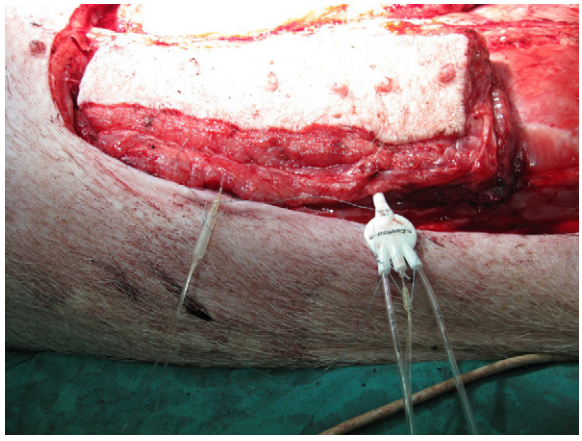

Fig. 1. The placement of the microdialysis catheters in the flap. The reference catheter was placed in the proximal part of the flap, and a microdialysis catheter in a shortened central venous catheter was placed in the distal part as described in the text. The haematoma was created by injecting blood through the central venous catheter.

One of the two myocutaneous rectus abdominis flaps was randomised to be made ischaemic by clamping the vascular pedicle to the flap. Taken together, there were four possible sites of a catheter: non-ischaemic reference tissue (NIR), non-ischaemic tissue with haematoma (NIH), ischaemic reference tissue (IR), and ischaemic tissue with haematoma (IH). The catheters were perfused with perfusion fluid T1 (CMA Microdialysis) at a flow rate of 0.3 μl/minute using a CMA 106 microdialysis infusion pump (CMA Microdialysis). At this rate, the relation between the concentration of solutes in the extracellular fluid and the buffer is close to 100%.[21]

Every 30 minutes for the next 6 hours concentrations of glucose, lactate, pyruvate, and glycerol were measured in the dialysate from all 4 microdialysis catheters using a CMA 600 microdialysis analyser (CMA Microdialysis). The lactate/pyruvate ratio and the lactate/glucose ratio were calculated. After three hours of monitoring, a challenge test was given by intravenous infusion of 50 mg/ml glucose 500 ml (Fresenius Kabi AB, Uppsala, Sweden) over 20 minutes.