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Microdialysis monitoring of ischemic metabolism in splanchnic organs: Liver and intestine

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**Background.** Monitoring vascular complications in the liver and the intestine is of great importance. Ischemia in these organs is life threatening and may cause organ dysfunction, sepsis and multiple organ failure.

**Aim.** The present thesis explores the use of microdialysis as a monitoring technique in the liver and the intestine. The first aim was to describe the changes in glucose, lactate, lactate/pyruvate ratio and glycerol during hepatic and intestinal ischemia. The effect of ischemia was studied in porcine models in order to determine ischemic and organ specific changes. The second aim was to apply the microdialysis technique to human liver transplant patients and patients that had undergone right-sided hemicolectomy in order to describe the normal course early after surgery as well as changes that may occur in conjunction with postoperative complications. In addition, techniques for the introduction of microdialysis catheters into specific organs were developed to enable safe monitoring in a clinical setting. The third aim was to search for other ischemia markers related to organ function and patient outcome.

**Materials and methods.** Total ischemia of the small bowel was studied after occlusion of the superior mesenteric artery in 6 pigs and local intestinal ischemia after occlusion of the supplying vessels in the mesentery of a 30cm long small bowel section in 8 pigs. The microdialysis catheters were placed intraperitoneally among the intestine, in the same way as a normal drain, in order to reduce the invasiveness of the monitoring method. In the local ischemia study, intraperitoneal microdialysis (IPM) catheters were placed next to the ischemic area and another catheter 10cm caudally. Liver ischemia was studied by occluding either the hepatic artery or the portal vein in 18 pigs divided in three groups (arterial, portal, and control group).

A clinical study using IPM monitoring was conducted on 8 patients who had undergone right-sided hemicolectomy. They were monitored 46 h postoperatively by catheters placed next to the ileocolic anastomosis. Ten orthotopic liver transplanted (OLT) patients were studied for 3 days in a clinical study of the liver. The intrahepatic microdialysis catheter was introduced in segment IV, in the direction of segment VIII and secured by a thin suture to the falciform ligament.

Glucose, lactate, pyruvate and glycerol were measured and the lactate/pyruvate ratio calculated at 20 min intervals in the preclinical studies and at one to two hour intervals...
in the clinical studies. In the search for new markers of ischemia, 17 OLT patients monitored with intrahepatic microdialysis were analysed for amino acids by HPLC.

**Results.** Both total and local intestinal ischemia resulted in significant increases in lactate, lactate/pyruvate ratio and glycerol, with a decrease in glucose. However, only the catheter located in the ischemic area was able to detect significant changes in the ischemic markers. Hepatic arterial occlusion resulted in increased lactate, lactate/pyruvate ratio, glycerol, and glucose, whereas occlusion of the portal vein did not result in any major changes.

The clinical studies showed no major complications due to introduction of the microdialysis catheter. One hemicolecotmy patient developed increasing levels of lactate, lactate/pyruvate ratio and decreasing glucose 5 h before the onset of clinical symptoms due to low oxygen saturation.

The early postoperative levels of intrahepatic amino acids showed significant changes during the first postoperative days with amino acids that increased, decreased or were stable. The arginine/citrulline line ratio was significantly lower in patients who had major complications after OLT.

**Conclusions.** It is possible to detect intestinal ischemia by intraperitoneal microdialysis (IPM). IPM reveals intestinal ischemia by the increase in lactate, lactate/pyruvate ratio and glycerol and decrease in glucose. IPM also enables local intestinal monitoring when the catheter is placed close to the area of interest. This opens new possibilities for postoperative monitoring of the viability of intestinal anastomosis and transplanted bowel. No major complications were found due to the introduction of the catheter intraperitoneally. A clinical case study indicated that IPM is a sensitive monitoring technique and that pathological events may be detected before the onset of clinical symptoms.

No major complications were found due to the introduction of the catheter into the liver. The liver was markedly affected by arterial occlusion, with increasing levels of lactate, lactate/pyruvate ratio, glycerol and glucose, whereas portal venous occlusion resulted in no major changes. This indicates that microdialysis may detect arterial vascular complications after liver surgery and that impaired arterial flow may be more harmful to the liver than impaired portal flow. Human intrahepatic amino acids were monitored for the first time. The analysis revealed that a low arginine/citrulline ratio, indicating a large NO production, correlates to the development of major complications and poor outcome.

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