Upsala J Med Sci 100: 165–168, 1995

A Pilot Study of the Effects of Abdominal Aortic Cross Clamping on Metabolic Gas Exchange

(Short communication)

L. Lind

Departments of Medicine, University Hospital, Uppsala, and Anaesthesia, Gävle County Hospital, Sweden

Cross-clamping of the abdominal aorta, as performed during surgery for abdominal aortic aneurysm, induces profound effects on the metabolic rate (1-3,5). However, in most of these studies, metabolic rate was estimated as oxygen consumption (VO_2), measured by the thermodilution technique. Today commercially available monitors are available for continuously measuring of metabolic gas exchange by indirect calorimetry (4), providing a new method for making on-line determinations of intra-operative changes in metabolic rate.

The present study included five subjects in whom scheduled reconstructions of the abdominal aorta were performed because of aneurysms. Four of the patients received aortic bifurcated grafts, while in one patient a straight graft was inserted above the iliac bifurcation. Mean age was 67±6 (SD) years, and all patients were males. Four of the patients were on regular antihypertensive medication. None of them had a history of coronary heart disease, except for mild angina pectoris in one subject.

All patients were premedicated with 0.1 mg/kg diazepam orally and 1 mg/kg pethidin i.m.. An epidural catheter was placed at the mid-thoracic level, and a bolus of 5-10 ml bupivacain (5mg/ml) was given, followed by continuous infusion at a rate of 5-10 ml/h. Five min prior to giving the induction dose an intravenous injection of 5-10 μg/kg fentanyl was given. Sleep was induced by an infusion of 2 mg/kg propofol administered by a syringe pump over 30 seconds. As soon as the patient had lost consciousness vercuronium, at a dose of 0.1 kg/

kg, was given for muscle relaxation, and a continuous infusion of propofol was started at a rate of 10 mg/kg/h during the first 10 min. The infusion rate was thereafter decreased to 8 mg/kg/h over the following 10 min, after which a maintenance dose of 6 mg/kg/h was given throughout the operation. Additional fentanyl and vercuronium were given throughout the operation, but not in connection with any of the clamping or declamping procedures. Neither nitrous oxide nor volatile agents were given in the study.

Metabolic gas exchange was continuously measured using the indirect colorimetry device Deltatrac (Datex Instr Corp, Helsinki, Finland), recently validated in a study using butane combustion (4).

Wilcoxon signed rank test was used for evaluating changes during surgery.

Forty-five min after induction of anaesthesia, but prior to surgery, VO_2 was 164± 32 (SD) ml/min. A rise in VO_2 was seen in all five patients 5-10 min after skin incision (mean increase 13 ± 4 %, $p<0.05$). The aorta was cross-clamped after a mean of 37 min after skin incision. After cross-clamping, VO_2 decreased by 20 ± 7 % ($p<0.05$), the decline being maximal after 5 - 7 min. VO_2 thereafter gradually increased in all patients ($p<0.05$) to pre-surgery levels. The cross-clamping period lasted for an average of 70 min.

The release of circulation to the first leg resulted in an increase in VO_2 of 32 ± 19 % ($p<0.05$) (70 % in the subject with the non-bifurcated graft). The VO_2 during this period reached its maximum after 6 - 11 min and thereafter declined to the level seen prior to cross-clamping. After a mean of 90 min after cross-clamping, the circulation was released to the second leg, and resulting in a maximal increase in VO_2 of 20 ± 4 %, which occurred within 3 - 5 min. Similar, but less pronounced, changes were also seen in carbon dioxide production (VCO_2).

During anaesthesia, just prior to skin incision, the systolic blood pressure (SBP) was 115±13 mm Hg (mean±SD) and heart rate 73±17 beats/min. Five min after clamping of the aorta, SBP increased by 23%,while the heart rate decreased by 12%. Blood pressure decreased during the period of aortic cross-clamping to 124±28 mmHg, while no major change in heart rate was seen. Release of

the circulation to the legs did not change SBP or heart rate. No relationships were found between the alterations in VO_2 induced by aortic clamping and declamping, on the one hand, and the changes in SBP or heart rate on the other. Thus, the present pilot study demonstrates that metabolic gas exchange measurements by indirect calorimetry provide a new method for evaluating VO_2 during aortic cross-clamping. Compared with thermodilution, this technique has the advantage of being non-invasive and provides continuous on-line measurements so that changes could be closely monitored. The maximal or minimal values in VO_2 induced by the clamping or declamping could be identified in a way that single measurements by the thermodilution technique are not able to do.

REFERENCES

1. Bowald, S., Eriksson, I. & Wiklund, L.: The influence of heparin on haemodynamics and blood gases during abdominal aortic surgery. Acta Chir Scand 146: 333-341,1980.

2. Damask, M.C., Weissman, C., Rodriguez, J., Askanazi, J., Rosenbaum, S.H. & Hyman, A.I.: Abdominal aortic cross-clamping. Arch Surg 119: 1332-1337,1984.

3. Degoute, C.S., Ray, M.J., Manchon, M., Claustrat, B. & Banssillon, V.: Intra-operative glucose infusion and blood lactate: Endocrine and metabolic relationships during abdominal aortic surgery. Anesthesiology 71: 355-361, 1989.

4. Makita, K., Nunn, J.F. & Royston, B.: Evaluation of metabolic measuring instruments for use in critically ill patients. Crit Care Med 18: 638-642,1990.

5. Reinhart, K.,Foehring, U., Kersting, T., Schaeffer, M., Bredle, D., Hirner, A. & Eyrich, K.: Effects of thoracic epidural anesthsia on systemic hemodynamic function and systemic oxygen supply-demand relationship. Anesth Analg 69: 360-369, 1989.

Address for reprints:

Lars Lind, MD

Department of Medicine, University Hospital, S-751 85 Uppsala,Sweden.