

## Effects of desflurane and isoflurane on splanchnic microcirculation during major surgery

J. O'RIORDAN, H. A. O'BEIRNE, Y. YOUNG AND M. C. BELLAMY

### Summary

Isoflurane has been considered the agent of choice where preservation of splanchnic blood flow is required. Liver blood flow and the hepatic artery buffer response are maintained better in the presence of isoflurane than with other volatile anaesthetic agents. The effects of desflurane have not been assessed in humans. Therefore, we have compared the effects of isoflurane and desflurane anaesthesia on small bowel and hepatic microcirculatory flow during major surgery using laser Doppler flowmetry in a prospective, randomized, single-blind, crossover study. Patients were allocated randomly to receive desflurane or isoflurane (1 MAC) in oxygen-enriched air. Steady-state jejunal and liver blood flow in segment III were assessed by laser Doppler flowmetry. Volatile anaesthetics were then interchanged, and measurements repeated at steady state. Desflurane anaesthesia at 1 MAC was associated with significantly greater gut blood flow than 1 MAC of isoflurane. These differences could not be explained by systemic haemodynamic differences. The similarity in total hepatic flow between groups implies an intact hepatic artery buffer response with desflurane and isoflurane. (*Br. J. Anaesth.* 1997; 78: 95–96)

### Key words

Anaesthetics volatile, desflurane. Anaesthetics volatile, isoflurane. Liver, blood flow.

Surgery and anaesthesia are known to compromise hepatic blood flow. Patients with pre-existing hepatic dysfunction have a high morbidity and mortality rate. Liver function is compromised when splanchnic blood flow is reduced; major surgery is associated with a significant increase in serum concentrations of liver enzymes.<sup>1</sup>

Inhalation agents affect splanchnic vascular tone to varying degrees. Increased splanchnic vasodilatation may increase portal venous flow to the liver, as occurs with isoflurane. Isoflurane maintains the hepatic artery buffer response better than other volatile anaesthetic agents.<sup>2</sup> The effects of desflurane on the buffer response and liver blood flow have not been assessed in humans. Therefore, we have compared the effects of isoflurane and desflurane

anaesthesia on small bowel and hepatic microcirculatory flow during major surgery in human using laser Doppler flowmetry (LDF). The laser Doppler flowmeter (PF3, Perimed, Jarfalla, Sweden) uses a helium/neon laser (632.8 nm). This light is guided to the measurement site via 1.75 m of optical fibre. Two identical adjacent fibres receive backscattered light from the tissues, which is transmitted to independent photodetectors. This backscattered portion consists of light scattered from the static tissue matrix, which has not been Doppler-shifted, and a spectrally broadened component resulting from interactions with moving red blood cells. Optical mixing of these components at the photodetector surface produces an electrical signal which results in an output voltage. This varies linearly with the product of mean red blood cell velocity and red blood cell concentration.

The laser Doppler produces an arbitrary scale of perfusion units (PU), a deflection of 2.5 V = 250 PU, set when calibrating the machine with latex microspheres 2  $\mu$ m supplied by the manufacturer. While this is generally accepted as a measure of flow in tissue microcirculation, LDF provides an accurate estimation of total liver blood flow in humans.<sup>3</sup>

### Methods and results

After obtaining Ethics Committee approval and informed patient consent for this prospective, randomized single-blind, crossover study, we studied 10 adult patients undergoing elective major upper abdominal surgery. Patients with liver disease were excluded.

After premedication with temazepam 20 mg orally, anaesthesia was induced with thiopentone 3 mg kg<sup>-1</sup> and fentanyl 3  $\mu$ g kg<sup>-1</sup>. Neuromuscular block was produced by atracurium 0.5 mg kg<sup>-1</sup> followed by an infusion of 0.4 mg kg<sup>-1</sup> h<sup>-1</sup>. Patients were allocated randomly to receive either desflurane or isoflurane (1 MAC) in oxygen-enriched air. (1 MAC was taken as the end-tidal concentration of the volatile agent in oxygen, adjusted for age,

JULIE O'RIORDAN, MB, CHB, FFARCSI, HUGH A. O'BEIRNE, MB, CHB, BAO, FFARCSI, YATIN YOUNG, MRCP, FRCA, MARK C. BELLAMY, MA, MB, BS, FRCA, Intensive Care Unit, St James' University Hospital, Leeds LS9 7TF. Accepted for publication: September 6, 1996.

Correspondence to M. C. B.

Table 1 Laser Doppler flow in the jejunum and liver segment III during desflurane or isoflurane anaesthesia (median (interquartile range))

	Blood flow (PU)	P
Gut (isoflurane)	94 (75–154)	0.02
Gut (desflurane)	186 (146–262)	
Liver (isoflurane)	137 (58–168)	0.26
Liver (desflurane)	175 (54–453)	

according to our pharmacy data sheets.) Randomization was achieved using pre-sealed envelopes containing instructions for the order of administration of volatile agent. A radial artery cannula and central venous catheter were inserted. Direct pressure readings were measured (Spacelabs Medical 90309, Redmond, WA, USA). Inspired and end-tidal concentrations of volatile agent and end-tidal carbon dioxide concentrations were monitored using Datex modules fitted to an Ohmeda Modulus CD anaesthetic machine (Ohmeda, Madison WI, USA). The lungs were ventilated to maintain normocapnia.

After surgical incision and exposure of the liver, jejunal blood flow and segment III liver blood flow were measured by laser Doppler flowmetry.

All measurements were performed at steady state (inspired/end-tidal concentration <1.1). Volatile agents were then interchanged and measurements repeated when steady state had been produced with the second volatile agent.

Blood flow data were analysed using the paired Wilcoxon signed rank sum test and backward stepwise multiple regression analysis (SPSS for Windows 6.0). Variables included mean arterial pressure, central venous pressure and gut perfusion units. Results are expressed as median (interquartile range). Haemodynamic variables were compared using Wilcoxon's signed rank sum test and expressed as mean (interquartile range). There were no differences in mean arterial pressure (78 (70–89) mm Hg for isoflurane compared with 74 (65–81) mm Hg for desflurane), central venous pressure (8.5 (2–12) mm Hg compared with 8.5 (3–10) mm Hg) or heart rate (82 (70–89) beat min<sup>-1</sup> vs 83 (62–101) beat min<sup>-1</sup>) between periods of isoflurane compared with desflurane administration. However, gut blood flow was significantly higher during desflurane than during isoflurane administration. Differences in liver blood flow were much less marked (table 1).

Multiple regression described liver blood flow as (1.3 × gut blood flow) – 24,  $P < 0.0001$ ,  $r^2 = 0.85$ .

## Comment

In this study we have used laser Doppler flowmetry (LDF) to measure liver and gut

microcirculatory blood flow during major surgery with two different volatile agents in humans. We have shown that during major surgery, desflurane anaesthesia at 1 MAC was associated with significantly greater gut flow than 1 MAC of isoflurane. As there were no systemic haemodynamic differences between the two agents, it is likely that differences in gut blood flow were mediated by a local mechanism.

Liver microcirculatory flow, as measured by LDF in a previous study, correlated well with perfusion pressure.<sup>4</sup> Hepatic perfusion in this study was slightly greater during desflurane than during isoflurane administration, but this was not significant. Increasing portal blood flow tends to reduce hepatic arterial blood flow in the presence of an intact hepatic artery buffer response, thus maintaining near constant total hepatic blood flow. Although a type II error cannot be excluded, the similarity in total hepatic flow between agents implies an intact hepatic artery buffer response with desflurane and isoflurane. This has been shown previously in dogs, but not in humans.<sup>5</sup> The hepatic artery buffer response is a semi-reciprocal autoregulatory mechanism whereby changes in portal flow inversely affect hepatic arterial flow. This is mediated at the level of the hepatic arteriole and is thought to be a non-neuronal, adenosine-dependent process.<sup>2</sup>

Multiple regression analysis indicated that gut blood flow accounted for 85% of the variability in liver blood flow. This suggests that liver blood flow in this model was largely portal in origin.

Any technique which preserves gut and liver blood flow may reduce morbidity and mortality.<sup>6</sup> These results indicate that desflurane may be beneficial, particularly in high-risk patients.

## References

- Gelman S. General anaesthesia and hepatic circulation. *Canadian Journal of Physiology and Pharmacology* 1987; **65**: 1762–1779.
- Lautt WW, Greenway CV. Conceptual review of the hepatic vascular bed. *Hepatology* 1987; **7**: 952–963.
- Kotzampassi K, Eleftheriadis E, Aletras H. Experimental and clinical evaluation of capsular and parenchymal total liver perfusion. *HPB Surgery* 1992; **6**: 99–104.
- O'Beirne HA, Young Y, Guillou P, Bellamy MC. Liver microcirculation during major surgery in man. *British Journal of Anaesthesia* 1995; **75**: 661P.
- Eger EI. New inhaled anaesthetics. *Anesthesiology* 1994; **80**: 906–922.
- Tighe D, Moss R, Haywood G, Webb A, Al-Saady N, Heath F, Bennett D. Dopexamine hydrochloride maintains portal blood flow and attenuates hepatic ultrastructural changes in a porcine peritonitis model of multiple system organ failure. *Circulatory Shock* 1993; **39**: 199–206.