

The Effect of Epidural Anaesthesia on Peripheral Resistance and Graft Flow Following Femorodistal Reconstruction

N.C. Hickey, M.P. Wilkes, D. Howes, J. Watt and C.P. Shearman

Departments of Surgery and Anaesthetics, Queen Elizabeth Hospital, Edgbaston, Birmingham B15 2TH, U.K.

Objective: To determine the extent to which epidural anaesthesia influences peripheral resistance and graft blood flow following femorocrural reconstruction.

Design: Prospective, controlled study measuring blood flow, arterial pressure and peripheral resistance in femorocrural bypass grafts for 20 min following onset of epidural anaesthesia with 15ml of 0.25% bupivacaine.

Patients: Twenty patients undergoing femorocrural reconstruction for critical lower-limb ischaemia with in situ long saphenous vein, under general anaesthesia. Ten patients had epidural cannulae inserted preoperatively and injected with bupivacaine after completion of the graft.

Results: Peripheral resistance fell in all 10 patients receiving epidural anaesthesia from a mean (range) of 1.07 PRU (0.32–2.2) to 0.49 PRU (0.19–0.72), compared to control values of 0.95 PRU (0.39–2.0) to 0.91 PRU (0.41–1.51; $P < 0.01$, Wilcoxon). There was a tendency for blood pressure to fall in the study patients (not significant) but graft blood flow still increased from 98 ml min^{-1} (41–221) to 160 ml min^{-1} (101–250), compared to flow in the control patients of 101 ml min^{-1} (45–176) at baseline to 104 ml min^{-1} (56–168; $p < 0.01$) at 20 min.

Conclusions: Epidural anaesthesia significantly decreases peripheral resistance and increases graft blood flow in femorocrural grafts and would appear, therefore, to be of benefit for patients undergoing femorodistal reconstruction.

Introduction

Epidural anaesthesia (EA) is widely used for patients undergoing femorodistal reconstruction for peripheral vascular disease. In addition to the benefits of avoiding general anaesthesia, it is believed that the resulting peripheral vasodilatation confers haemodynamic benefit to the graft.¹ Infiltration of the epidural space with local analgesic agents produces a sympathetic blockade and thus increases total limb blood flow and perfusion through collateral vessels and small distal vessels.² Cousins and Wright demonstrated a significant reduction in peripheral resistance and an increase in graft blood flow in 10 of 13 patients undergoing aortofemoral, iliofemoral or femoropopliteal bypass grafting after injection of lidocaine into an epidural cannula, with a mean increase in graft flow of 51%.³ A reduction in peripheral resistance is likely to be particularly valuable in patients undergoing femorocrural reconstruction to a single calf vessel, but little is known of the extent to which epidural anaesthesia influences graft performance in these elderly patients

with severe, distal atherosclerosis and critical lower limb ischaemia. Indeed, the ability of epidural anaesthesia to increase limb blood flow is greatly reduced in atherosclerotic patients when compared to normal controls.⁴ This study was instigated, therefore, to investigate the effects of epidural anaesthesia on peripheral resistance and graft blood flow in patients undergoing femorocrural bypass surgery.

Patients and Methods

Local ethical committee approval was granted and informed consent was obtained from all patients. Ten patients (three female, four diabetic; mean age 72, range 62–81 years) with critical lower limb ischaemia⁵ (mean ABPI 0.22, range 0–0.63) underwent femorocrural reconstruction to a single calf vessel using *in situ* long saphenous vein under general anaesthesia. Diabetics had critical ischaemia but no neuropathy on clinical examination. Patients were premedicated with temazepam (10mg) 2 hours preoperatively and anaesthesia was induced with thiopentone (4–6 mg kg^{-1}). Muscle relaxation was established with atracurium (0.6 mg kg^{-1}) and anaesthesia maintained

Please address all correspondence to: Mr N.C. Hickey, Worcester Royal Infirmary, Ronkswood Branch, Newtown Road, Worcester WR5 1HN, U.K.

with 60% nitrous oxide in oxygen and isoflurane. Additional analgesia was provided by fentanyl. Blood pressure was maintained by a mixture of crystalloid and colloid but dextran was not used. Prior to surgery, an epidural cannula was inserted via the L1 or L2 disc space.

On completion of the distal anastomosis and revascularisation of the limb, graft blood flow was continuously recorded by an intraoperative flowmeter ("Op-Dop", SciMed; U.K.). An arterial pressure line was inserted into the graft via a proximal branch so that the flowmeter was able to derive peripheral resistance (in arbitrary peripheral resistance units, PRU) from blood flow and mean arterial pressure measurements.⁶

Fifteen ml of 0.25% bupivacaine was injected into the epidural cannula and all parameters were recorded for 20 min. Identical measurements were made in 10 controls (two female, three diabetic; mean age 69, range 59–81) who underwent femorocrural bypass under general anaesthetic without epidural analgesia and differences between groups were analysed by the Wilcoxon signed rank test.

Results

All preoperative and operative parameters were similar between the two groups including ankle pressure, ABPI, level of distal anastomosis, recipient vessel, volume of preoperative fluid received and blood transfusion requirement.

Peripheral resistance fell in all 10 patients over the 20 minutes after epidural injection of bupivacaine (see Fig. 1) but not in controls (see Table 1). The mean percentage fall was 83% (36–146%). Mean arterial pressure (MAP) also fell, from a mean (range) of 83 mmHg (72–108) to 70 mmHg (54–85, not significant). The increase in graft blood flow resulting from the decreased peripheral resistance was thus attenuated by the fall in arterial blood pressure, but flow still increased in all study patients by a mean of

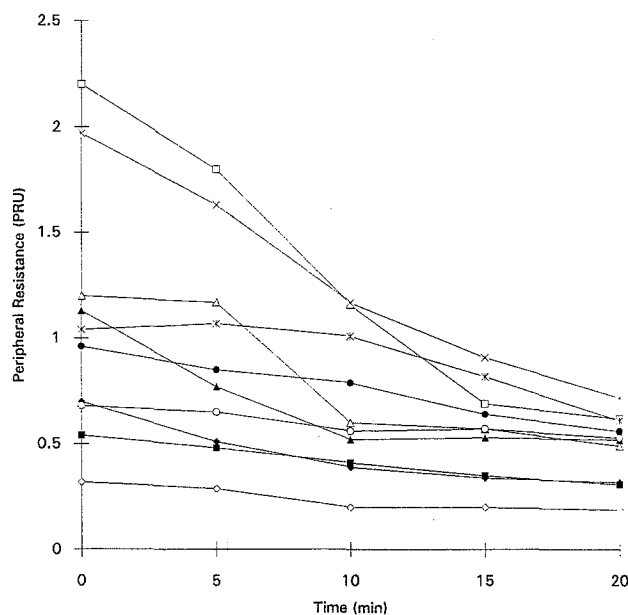


Fig. 1. Changes seen over 20 min in peripheral resistance in 10 femorocrural grafts after instigation of epidural anaesthesia.

81% (13–146%, see Table 1, Fig. 2). No blood pressure or flow changes occurred in controls.

No obvious differences in response to epidural anaesthesia were seen between diabetics and non-diabetics.

Limb salvage was achieved in all patients. Thirty day primary graft patency was confirmed by Duplex scanning as 100%.

Discussion

Graft blood flow and peripheral resistance (measured by the "Op-Dop") are important predictors of outcome after femorodistal reconstruction.^{7,8} Sympathectomy may produce vasodilatation and increase graft flow⁹ and the pharmacological sympathectomy achieved by epidural anaesthesia seems equally effective.³ This study confirms that epidural anaesthesia

Table 1. Changes seen over 20 min in peripheral resistance and graft blood flow in 10 femorocrural grafts after instigation of epidural anaesthesia, compared to 10 controls

	Peripheral Resistance (PRU)			Graft blood flow (ml min ⁻¹)		
	Controls	Epidural	Significance	Controls	Epidural	Significance
Baseline mean (range)	0.95 (0.39–2.0)	1.07 (0.32–2.2)	N.S.	101 (45–176)	98 (41–221)	N.S.
20 min mean (range)	0.91 (0.41–1.51)	0.49 (0.19–0.92)	$p < 0.01$	104 (56–168)	160 (101–250)	$p < 0.01$

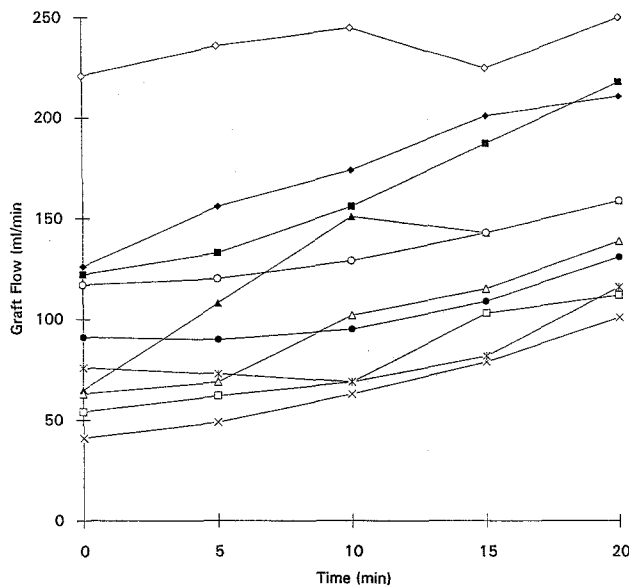


Fig. 2. Changes seen over 20 min in blood flow in 10 femorocrural grafts after instigation of epidural anaesthesia.

significantly reduces peripheral vascular resistance and thus increases graft blood flow following femorocrural reconstruction to a single calf vessel in patients with critical lower limb ischaemia and quantifies the degree to which it is effective. The drop in mean arterial pressure seen in this study after instigation of EA would not be seen in the usual clinical situation where analgesic injection would commence before surgery, allowing the anaesthetist to respond to the vasodilatation by volume loading with colloid.⁴ Indeed, haemodynamic stability is likely to be better under epidural than general anaesthesia.¹ Thus the effect on graft blood flow is liable to be even greater than that seen here.

Epidural anaesthesia may not have been adopted universally for femorodistal reconstruction because of fears that it may steal blood from the distal (ischaemic) muscle beds in the calf and foot as a result of more efficient dilatation of more proximal, normal (non-ischaemic) tissues in the thigh and pelvis. Thus epidural block would reduce peripheral tissue perfusion due to a critical redistribution of flow. It has been demonstrated, however, that epidural anaesthesia produces a significant increase in foot perfusion in atherosclerotic patients.^{4, 10} Increases in skin blood flow match those seen in normals. The changes seen in total foot blood flow are not as dramatic but still marked. In this study, reconstruction was to a single calf vessel, below an occluded popliteal artery. Thus the changes seen in graft resistance and flow must largely have resulted from manipulation of the distal, ischaemic vasculature.

Traditional thinking dictates that critically ischaemic tissues are maximally vasodilated and incapable of further reduction in peripheral resistance. Spasm in the distal circulation does occur, however, during femorodistal bypass. Graft resistance is reduced by intragraft injections of vasodilators such as papaverine and iloprost, the effects of which are synergistic with those of epidural anaesthesia.^{11, 12}

The reduction in peripheral resistance achieved by epidural injection of bupivacaine is likely to be due to other factors in addition to sympathetic blockade, including abolishing the pain reflexes that contribute to vasoconstriction.¹

There are other benefits of epidural anaesthesia for femorodistal bypass in addition to those of improved graft flow. The increase in limb blood flow reduces the risk of venous thrombo-embolic complications, there is a reduction in operative blood loss and cardiac complications, whilst EA may also inhibit platelet aggregation and reduce Factor VIII activation, further reducing the risk of early graft occlusion.^{13, 14} Conversely, general anaesthetic agents, including halothane, enflurane and neuroleptic agents may increase vascular resistance in the legs and upon recovery from a general anaesthetic a stress reaction occurs, resulting in sympathetic activation and a reduction in limb blood flow.^{1, 4}

In conclusion, this study demonstrates that epidural anaesthesia effectively reduces peripheral resistance and thus increases graft blood flow after femorocrural bypass for critical lower limb ischaemia and may therefore be the anaesthetic technique of choice for distal reconstruction.

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