Brief Report

The Effect of Thoracic Epidural Bupivacaine and an Intravenous Adrenaline Infusion on Gastric Tube Blood Flow During Esophagectomy

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BACKGROUND: Gastric tube necrosis is a major cause of anastomotic leak after esophagectomy. A correlation has been shown between reduced flux at the anastomotic end of the gastric tube and anastomotic leaks.
METHODS: We prospectively studied the effect of intraoperative thoracic epidural bupivacaine and subsequent adrenaline infusion on hemodynamics and flux in the gastric tube.
RESULTS: Administering the epidural bolus significantly decreased flux at the anastomotic end of the gastric tube ($P < 0.01$). Gastric flux was returned to baseline by an adrenaline infusion.
CONCLUSIONS: The administration of a thoracic epidural bolus may decrease flux at the anastomotic end of the gastric tube.
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Anastomotic leakage is a major cause of mortality after esophagectomy.[1–3] Patients usually undergo an esophageal resection with immediate reconstruction using tubularized stomach based on a blood supply from the right gastroepiploic artery; the left gastric, left gastroepiploic, and short gastric arteries are divided. The anastomotic end of this newly formed gastric tube is vascularized by an intramural plexus of vessels supplied from branches of the right gastroepiploic artery. Ischemia of the anastomotic end of this gastric tube is a major cause of anastomotic leaks.[4,5]

Laser Doppler flowmetry was introduced in 1972.[6] The technique has been validated against other methods of measuring tissue blood flow[7–9] and is an established method of measuring gastric blood flow.[10]

Thoracic epidurals containing a mixture of local anesthetics and opioids are widely used to provide analgesia for patients undergoing esophagectomy. The effect of thoracic epidurals on blood flow in the newly fashioned gastric tube is unknown. Vasodilatation from an epidural-induced sympathetic block to the stomach (T6–10)[11] may increase blood flow to the gastric tube. Conversely, epidural-induced hypotension may decrease gastric tube blood flow. The aims of this study were to determine the effect of a thoracic epidural and subsequent IV adrenaline infusion on blood flow in the newly formed gastric tube.

METHODS

With local research ethics committee approval and written informed consent, adult patients consecutively scheduled to undergo an esophagectomy and receive thoracic epidural analgesia for postoperative analgesia were recruited for the study. Patients with a contraindication to epidural analgesia, patients with a history of ischemic heart disease, and patients receiving β-blockers or other antihypertensive medications were excluded from the study.

Patients were premedicated with diazepam. On arrival in the anesthetic room, arterial and venous cannulae and a midthoracic epidural catheter were inserted under local anesthesia. No epidural test dose was administered. After administration of oxygen, anesthesia was induced with fentanyl and propofol. Placement of an appropriate-sized double-lumen endobronchial tube was facilitated by succinylcholine. Anesthesia was maintained with isoflurane in an oxygen/air mixture. Neuromuscular blockade was maintained by intermittent boluses of atracurium. Patients' lungs were ventilated to normocapnea. Before being placed in a lateral position, patients received a central venous catheter and a study

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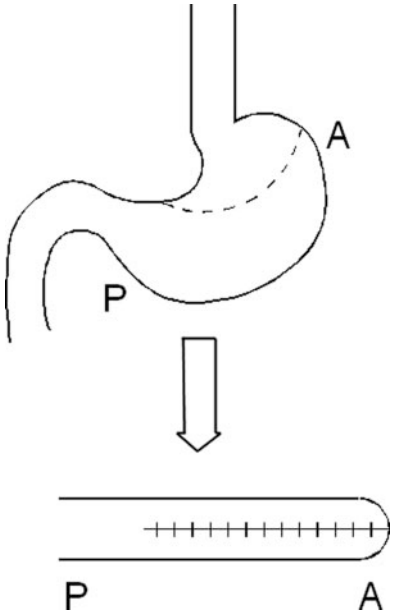

Figure 1. Formation of the gastric tube. A = anastomotic end, P = pyloric end, dotted line represents resection line.

pulmonary artery catheter via the left internal jugular vein. Fluid management was standardized. Warmed lactated Ringer's solution was administered at 10 mL · kg^{-1} · h^{-1}. Blood loss was replaced with colloid if the hemoglobin concentration was >8 g/dL, or with allogeneic blood if the hemoglobin concentration was <8 g/dL.

All resections were performed via a left thoracoabdominal sixth intercostal space incision. The tumor was resected en-bloc with adjacent tissue, including lymph nodes. After construction of a gastric tube based on a blood supply from the right gastroepiploic artery, laser Doppler flow probes (DP8C, Moor Instruments, Axminister, UK) were sutured to the serosal surface of the anastomotic and pyloric end of the tubularized stomach (Fig. 1). The flow probes were attached to a laser Doppler monitor (DRT4, Moor Instruments). Data from the laser Doppler monitor were archived to an attached computer. After the tubularized stomach was covered with a damp swab, surgery was stopped for the duration of the study.

Data were collected during three 5-min study periods. The baseline study period commenced when patients had been hemodynamically stable for 10 min. The laser Doppler flux trace was marked, pulmonary artery wedge pressure was measured, and three thermodilutional cardiac output measurements were averaged. Standard hemodynamic variables were calculated. After 5 min, the flow trace was re-marked, cardiac outputs were remeasured, and hemodynamic variables recalculated.

Patients then received a 0.1 mL/kg bolus of epidural 0.25% bupivacaine, a dose higher than usually used in clinical practice. The second study stage commenced when the systolic arterial blood pressure had decreased by 30% (30 min after the epidural bolus). During the second 5-min study period, the laser Doppler flux trace was marked and hemodynamic measurements were made as described above. At the end of the second study period, patients received an IV infusion of adrenaline titrated to achieve baseline arterial blood pressure. When baseline arterial blood pressure had been achieved, or our predetermined maximum adrenaline infusion rate of 400 μg/h was reached, the third 5-min study period started. After all measurements had been taken, the Doppler flux probes were removed and the surgery was completed.

Table 1. Demographic Data

Patients' details	
Sex (M/F)	6/4
Age (yr)	70 ± 6
Weight (kg)	69 ± 19
Height (cm)	165 ± 13
ASA grade 1/2/3	1/7/2

Data are mean ± SD.
ASA = American Society of Anesthesiologists.

Flux measurements acquired during each of the three 5-min study periods were averaged using MoorSoft for Windows/DRT4 version 1.2 (for DRT4 Monitor v5.02). The average of the hemodynamic values obtained at the start and the end of each study period was calculated. Statistical analysis was performed using Microsoft® Excel 2002. Nonparametric tests were used to analyze the data. The Friedman test was used to analyze the overall differences among the three study periods. In case of significant overall effects, changes were evaluated in detail with the Wilcoxon's signed rank test, to determine the significance of differences between baseline and epidural periods and between epidural and adrenaline periods.

RESULTS

Twelve patients were recruited. One patient was excluded because surgery was unexpectedly difficult, and a second patient was excluded because the epidural was not sited at the midthoracic level. Demographic data for the 10 patients studied are summarized in Table 1.

To examine the effect of the epidural bolus, we compared the epidural and baseline periods. The administration of a thoracic epidural bolus resulted in a significant decrease in anastomotic flux (Table 2 and Fig. 2), a significant decrease in arterial blood pressure and cardiac index (Table 2), but no significant change in pyloric flux (Table 2 and Fig. 3). Comparing the epidural and adrenaline periods, the administration of an adrenaline infusion resulted in significant increases in anastomotic flux, pyloric flux, arterial blood pressure, and cardiac index (Table 2 and Figs. 2 and 3).

The upper limit of the sensory block level was above T4 in all patients. The lower limit of the sensory block level was below T10 in all patients.

Table 2. Flux and Hemodynamic Data

Variable	Baseline period	Epidural period	Adrenaline period	*P**	*P*†
AF‡	98 (29–459)	76 (22–223)	132 (37–456)	<0.01	<0.01
PF§	228 (38–951)	192 (40–724)	253 (58–697)	NS	<0.02
SAP‡	128 (116–151)	79 (69–102)	132 (103–152)	<0.01	<0.01
MAP‡	92 (77–103)	60 (51–78)	86 (53–105)	<0.01	<0.01
DAP‡	67 (56–78)	50 (38–62)	62 (37–82)	NS	<0.02
CI‡	3.5 (2.2–4.2)	2.6 (1.8–3.2)	4.4 (2.3–5.3)	<0.01	<0.01
SVR‖	1112 (774–1721)	934 (623–1190)	795 (511–1495)	NS	NS
HR‖	80 (62–112)	77 (61–97)	94 (69–111)	NS	NS
CVP	13 (9–20)	12 (9–20)	14 (10–21)	NS	NS
PAWP	14 (8–20)	13 (9–18)	14 (9–21)	NS	NS

Values given are median (range).

AF = anastomotic flux [product of average speed and concentration of moving red blood cells (dimensionless perfusion unit)]; PF = pyloric flux; SAP (mm Hg) = systolic arterial blood pressure; MAP (mm Hg) = mean arterial blood pressure; DAP (mm Hg) = diastolic arterial blood pressure; CI (L/min/m^2) = cardiac index; SVR (dyn · s/cm^5) = systemic vascular resistance; HR = heart rate; CVP (mm Hg) = central venous pressure; PAWP (mm Hg) = pulmonary artery wedge pressure; NS = not significant.

* Baseline vs. epidural.

† Epidural vs. adrenaline.

‡ $P < 0.001$; § $P < 0.05$, ‖ $P < 0.01$; for overall effect.

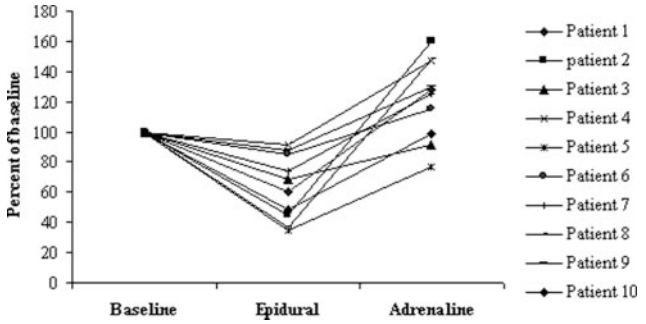

Figure 2. Changes in flux at the anastomotic end of the gastric tube during the study.

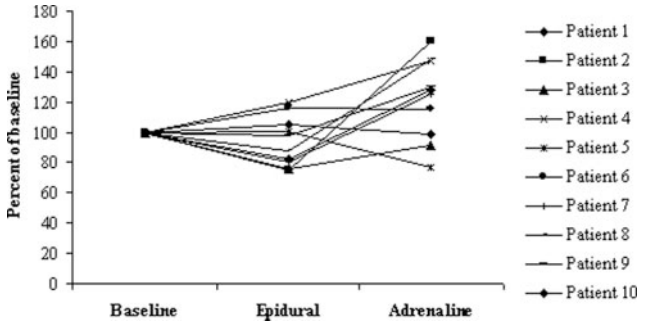

Figure 3. Changes in flux at the pyloric end of the gastric tube during the study.

DISCUSSION

This study shows that, compared with the pyloric end, blood flow at the anastomotic end of the newly formed gastric tube is reduced (Table 2) and a thoracic epidural bupivacaine bolus further decreases this flow. Ischemia of the gastric tube is a major cause of anastomotic leaks.[4,5] As a relationship has been shown between low blood flow at the anastomotic site, measured by laser Doppler, and subsequent anastomotic leak,[12] this further reduction in gastric tube blood flow by a thoracic epidural may be clinically important.

In this study, epidural bupivacaine resulted in a significant decrease in cardiac output and arterial blood pressure, probably by blocking the cardiac sympathetics.[13,14] We postulate that arterial blood pressure has a greater effect on blood flow through the plexus of vessels supplying the anastomotic end of the gastric tube than on the relatively undisturbed arterial blood supply to the pyloric end of the gastric tube.

We considered adrenaline as an appropriate drug to reverse the predicted thoracic epidural-induced decrease in cardiac output and arterial blood pressure. The effect of IV adrenaline on gastric tube perfusion has not been described. Our study demonstrated that an adrenaline infusion significantly increased blood flow at both ends of the newly formed gastric tube (Figs. 2 and 3). This study suggests that anesthesiologists should be cautious in accepting intraoperative hypotension secondary to epidural administration in patients undergoing esophagectomy.

Limitations of this study include small sample size and short study period. We are studying the effect of vasoconstrictors on blood flow in the gastric tube. In conclusion, the administration of a thoracic epidural bupivacaine bolus may decrease the flux at the anastomotic end of the gastric tube.

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