Dopamine and intestinal mucosal tissue oxygenation in a porcine model of haemorrhage

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Summary

Haemorrhage is associated with intestinal mucosal hypoxia and impaired gut barrier function. Dopamine increases oxygen delivery to the intestinal mucosa and may thus counteract haemorrhage-induced mucosal hypoxia. Jejunal mucosal tissue oxygen tension (mucosal $P_{O_2}$) and jejunal oxygen saturation of mucosal microvascular haemoglobin (mucosal $HbO_2$) were measured in 14 anaesthetized pigs. Seven animals served as controls (group C) and seven received continuous infusion of dopamine 16 $\mu$g kg$^{-1}$ min$^{-1}$ (group D) while 45% of blood volume was removed in three equal increments. Resuscitation was performed using shed blood and fluid. Mean arterial pressure and systemic oxygen delivery decreased significantly during haemorrhage and returned to baseline after resuscitation in both groups. Mucosal $P_{O_2}$ decreased from 4.4 to 1.7 kPa after haemorrhage ($P<0.01$) and further to 1.5 kPa after resuscitation ($P<0.01$) in group C whereas group D showed an increase from 3.9 to 5.9 kPa after the start of the dopamine infusion ($P<0.05$), but no significant difference from baseline after haemorrhage (2.3 kPa) (ns) or resuscitation (3.1 kPa) (ns). Mucosal $HbO_2$ decreased from 52 to 32% after haemorrhage ($P<0.05$) and increased to near baseline (37%) (ns) after resuscitation in group C whereas group D showed no significant changes from baseline (54%) throughout the experiment. Comparison between groups showed higher mucosal $P_{O_2}$ and $HbO_2$ values for group D animals after the start of the dopamine infusion ($P<0.05$ each), after the first two steps of haemorrhage ($P<0.01$ each) and after resuscitation ($P<0.05$ each). We conclude that i.v. dopamine 16 $\mu$g kg$^{-1}$ min$^{-1}$ improved tissue oxygenation of the small intestinal mucosa during moderate haemorrhage and subsequent resuscitation. (Br. J. Anaesth. 1997; 79: 357–362).

Key words

Sympathetic nervous system, dopamine. Complications, haemorrhage. Gastrointestinal tract, mucosal oxygenation. Pig.

The intestinal vascular response to haemorrhage is characterized by mesenteric arterial vasoconstriction and redistribution of blood flow from the muscularis towards the mucosal layer of the intestinal wall.

Despite this autoregulatory escape phenomenon, tissue hypoxia during haemorrhage occurs primarily within the mucosal layer of the intestine. Mucosal tissue hypoxia has been implicated as an important mechanism contributing to haemorrhage-induced mucosal tissue injury, increased mucosal permeability and microbial translocation. Dopamine is a known intestinal vasodilator and therefore may counteract haemorrhage-induced intestinal mucosal hypoxia. Recent studies suggest that dopamine may specifically increase mucosal blood flow and tissue oxygenation by redistributing blood flow from the intestinal muscularis and serosa towards mucosa. Dopamine has been reported to attenuate the concomitant decrease in mucosal villus blood flow after endotoxin-induced mucosal vasoconstriction, and to increase mucosal tissue $P_{O_2}$. However, the efficacy of dopamine in preserving intestinal mucosal oxygenation during haemorrhage has never been investigated.

The purpose of this study was to examine the effects of dopamine on small intestinal mucosal oxygenation during stepwise haemorrhage and subsequent resuscitation. Tissue oxygenation was assessed directly using two different and independent measuring techniques: Clark-type surface oxygen electrodes for evaluation of mucosal tissue oxygen tension and tissue reflectance spectrophotometry for determination of oxygen saturation of mucosal microvascular haemoglobin. A pig model was chosen because of the anatomical and physiological similarity of the digestive and cardiovascular systems of swine and humans.

Materials and methods

ANIMAL PREPARATION

The study was approved by the Federal Ministry of Science and Research. Fourteen domestic pigs (33–41 kg) were fasted overnight, but had free access...
to water. The animals were anaesthetized with ketamine hydrochloride 20 mg kg\(^{-1}\) i.m., the trachea intubated orally and the lungs ventilated mechanically with a positive end-expiratory pressure of 5 cm H\(_2\)O. Tidal volume and ventilatory frequency were adjusted with a positive end-expiratory pressure of 5 cm H\(_2\)O. Tidal volume and ventilatory frequency were adjusted to maintain \(P_{\text{aCO}}\) at 4.7–5.7 kPa, \(P_{\text{aO}}\), was adjusted to maintain \(P_{\text{aO}}\) at 13.3–16.0 kPa. Anaesthesia was maintained by continuous infusion of fentanyl 20 \(\mu\)g kg\(^{-1}\) h\(^{-1}\) and midazolam 0.8 mg kg\(^{-1}\) h\(^{-1}\). Neuromuscular block was produced by bolus injections of vecuronium 0.15 mg kg\(^{-1}\).

After induction of anaesthesia the right carotid artery was cannulated for measurement of systemic mean arterial pressure and for blood sampling. A balloon-tip thermodilution pulmonary artery catheter (Baxter Edwards Critical-Care, Irvine, CA, USA) was inserted via the right internal jugular vein for measuring cardiac output and pulmonary artery occlusion pressure, and for mixed venous blood sampling. A separate 14-gauge catheter was inserted via the right internal jugular vein for infusion of dopamine. An 8.5-French gauge catheter was inserted into the left internal jugular vein for withdrawal of 45% of calculated blood volume in three steps.

A midline laparotomy was performed and a small part of the jejunal mucosa exposed by an antimesenteric enterotomy. The boundary of the mucosa was sutured to the oval opening of a cork plate. The intestine was reintroduced into the abdominal cavity with the exception of the exposed mucosa. The mucosal preparation was covered by a humidified Servo-controlled chamber heated to 37 °C.

Animals were given Ringer’s lactate and gelatine i.v. to maintain pulmonary artery occlusion pressure at 12–14 mm Hg. The infusion was stopped with the beginning of haemorrhage and resumed with re-transfusion of shed blood.

MEASUREMENT TECHNIQUES

Systemic haemodynamics and blood-gas tensions

Arterial, pulmonary artery and central venous pressures were measured using Statham P10EZ pressure transducers (Spectramed-Statham, Bilthoven, The Netherlands). Cardiac output was measured by the thermodilution method, in triplicate, with 10-ml injections of ice-cooled saline. Arterial and mixed venous blood-gas tensions were measured using an AVL automatic blood-gas analyser (AVL Biomedical Instruments, Graz, Austria) and a haemoximeter (OSM2, Radiometer, Copenhagen, Denmark).

Small intestinal mucosal tissue oxygenation

The methodology has been described previously in detail. Briefly, two Clark-type multiwire surface electrodes (Eschweiler, Kiel, Germany) were positioned on the exposed mucosa to record mucosal tissue oxygen tension (mucosal \(P_{\text{O}}\)). A single electrode consists of eight platinum wires, each 15 \(\mu\)m in diameter, representing eight individual measuring points, and a silver-silver chloride reference electrode. The electrodes were kept in place by small polyvinyl chloride caps surrounded by a transparent thin rubber patch with a diameter of 2 cm. During each set of measurements, mucosal \(P_{\text{O}}\) was recorded continuously for a period of 150 s at a frequency of 1 Hz. An Erlangen microlightguide spectrophotometer (EMPHO II; BGT, Überlingen, Germany) was used to measure oxygen saturation of the mucosal microvascular haemoglobin (mucosal HbO\(_2\)). The spectrophotometer includes one central illuminating microlightguide surrounded by six detecting microlightguides with a diameter of 250 \(\mu\)m each and a rapidly rotating bandpass interference filter disk for generation of monochromated light within the spectral range of 502–628 nm. This filter disk permits sampling in steps of 2 nm and a sampling rate of 100 spectra s\(^{-1}\). Monochromated light is transmitted to a photomultiplier tube operated at current mode, fed into a current-to-voltage converter, and amplified by a cascade amplifier. The voltage signal is offset compensated, filtered by a low-pass filter, fed into an analogue-to-digital converter and transferred to an IBM compatible computer. The algorithm used to calculate oxygen saturation of microvascular haemoglobin has been validated for intestinal mucosal tissue. The microlightguide array was fixed to the mucosal surface in a manner identical to that used for the \(P_{\text{O}}\) electrode. At each measuring time, 1024 values of mucosal HbO\(_2\) were recorded at a frequency of 7 Hz.

EXPERIMENTAL PROCEDURE (FIG. 1)

After surgical preparation, pigs were allowed to stabilize for 120 min. Pulmonary artery occlusion pressure was maintained at 12–14 mm Hg by infusion of Ringer’s lactate and gelatine. At the end of the experiment, pigs were given bolus injections of vecuronium 0.15 mg kg\(^{-1}\) and \(fentanyl 20 \mu\)g kg\(^{-1}\) to prevent spasm of the intestinal wall. The pigs were given a continuous infusion of dopamine 16 \(\mu\)g kg\(^{-1}\) min\(^{-1}\) (group D). In both groups 45% of calculated blood volume was removed in three equal steps. Resuscitation was performed using re-transfusion of shed blood and infusion of fluid in order to restore pulmonary artery occlusion pressure to baseline. Measurements of systemic haemodynamic variables and intestinal mucosal tissue oxygenation were made at 30-min intervals.

![Figure 1](image-url)
of the stabilization period, baseline measurements of hemodynamic state, blood-gas tensions and intestinal tissue oxygenation were performed (t=0 min). At this time, animals were allocated randomly to one of two experimental groups: group C (n=7) served as controls, whereas group D (n=7) received continuous i.v. infusion of dopamine 16 µg kg⁻¹ min⁻¹ with a concentration of saline 2 mg ml⁻¹ (Leopold Inc., Graz, Austria), beginning after baseline measurements and continued throughout the experimental period. After a set of measurements at t=30 min, infusion of Ringer’s lactate and gelatine was stopped in both groups and 45% of calculated shed blood was re-transfused and infusion of Ringer’s lactate and gelatine was resumed in order to restore pulmonary artery occlusion pressure to baseline. Two final measurements were performed at t=180 min and t=210 min.

At the end of the experiment, animals were killed with a central venous bolus injection of potassium chloride 40 mmol.

STATISTICAL ANALYSIS

Results are expressed as mean (SEM). Comparison between baseline values was made using the unpaired t test. Overall effects within and between groups were evaluated by repeated measurement analysis of variance (ANOVA). In the case of significant differences, further comparisons were made with paired t tests (within-group to baseline) and unpaired t tests (between groups at individual times). P≤0.05 was considered significant. The Bonferroni-Holm procedure was used for correction of multiple comparisons.

Results

There were no significant differences in baseline systemic variables between group C (no dopamine) and group D (dopamine) (table 1).

Mean arterial pressure, pulmonary artery occlusion pressure and systemic oxygen delivery decreased significantly during stepwise bleeding and returned to baseline after resuscitation in both groups. Systemic oxygen consumption and arterial pH did not change significantly over time in either group. Except for a significant increase after resuscitation in group C animals, arterial packed cell volume (PCV) remained unchanged.

jejunal mucosal tissue oxygenation (figs 2, 3)

There were no significant differences in baseline mucosal tissue oxygen tension (mucosal PO₂; fig. 2) and oxygen saturation of mucosal microvascular haemoglobin (mucosal HbO₂; fig. 3) between the two groups.

In group C animals, mucosal PO₂ decreased progressively from 4.39 (0.37) kPa at baseline to 1.75 (0.20) kPa after stepwise bleeding (t=150 min) (P<0.01) and further to 1.45 (0.47) kPa after resuscitation with shed blood and fluid (t=210 min) (P<0.01). In group D animals, mucosal PO₂ increased from 3.85 (0.48) to 5.87 (0.52) kPa after starting dopamine (t=30 min) (P<0.05), decreased to 2.32 (0.45) kPa after bleeding (t=150 min)—which was not significantly different from baseline—and increased again to 3.09 (0.57) kPa after resuscitation (t=210 min). Comparison between groups showed that mucosal PO₂ was higher in group D animals after the start of the dopamine infusion (t=30 min) (P<0.05), after the first two steps of bleeding (t=60 and 90 min) (P<0.01 each) and after resuscitation (t=210 min) (P<0.05).

Table 1 Changes in systemic variables in animals treated without (group C) and with dopamine (group D) during stepwise bleeding (t=60, 90, 120 min), after bleeding (t=150 min) and after resuscitation (t=180, 210 min). Baseline is t=0 min. Dopamine infusion was started after baseline in group D animals. MAP = Mean arterial pressure; PAOP = Pulmonary artery occlusion pressure; DO₂ systemic oxygen delivery; PO₂ = systemic oxygen consumption; pHₑ = arterial pH; PCV = packed cell volume. Values are mean (SEM). *P<0.05, **P<0.01 vs baseline (paired t test)

<table>
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<tr>
<th>Time (min)</th>
<th>0</th>
<th>30</th>
<th>60</th>
<th>90</th>
<th>120</th>
<th>150</th>
<th>180</th>
<th>210</th>
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<tbody>
<tr>
<td>MAP (mm Hg)</td>
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<tr>
<td>Group C</td>
<td>111 (7)</td>
<td>111 (7)</td>
<td>105 (6)</td>
<td>76 (3)**</td>
<td>63 (4)**</td>
<td>69 (4)**</td>
<td>120 (3)</td>
<td>117 (4)</td>
</tr>
<tr>
<td>Group D</td>
<td>105 (4)</td>
<td>107 (4)</td>
<td>95 (6)</td>
<td>74 (9)**</td>
<td>59 (8)**</td>
<td>65 (7)**</td>
<td>114 (8)</td>
<td>119 (7)</td>
</tr>
<tr>
<td>PAOP (mm Hg)</td>
<td></td>
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<tr>
<td>Group C</td>
<td>13.9 (3)</td>
<td>13.4 (0.4)</td>
<td>11.3 (0.5)**</td>
<td>9.6 (0.4)**</td>
<td>9 (0.7)**</td>
<td>8 (0.2)**</td>
<td>14.4 (0.6)</td>
<td>12.4 (0.7)</td>
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<td>Group D</td>
<td>13.9 (1)</td>
<td>12 (0.8)</td>
<td>9.1 (0.7)**</td>
<td>7.9 (0.8)**</td>
<td>6.9 (0.9)**</td>
<td>7.4 (0.8)**</td>
<td>12.9 (0.5)</td>
<td>12.9 (0.9)</td>
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<tr>
<td>DO₂ (ml kg⁻¹ min⁻¹)</td>
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<tr>
<td>Group C</td>
<td>20.9 (1.8)</td>
<td>20.7 (2.2)</td>
<td>16.2 (1.5)</td>
<td>10.8 (0.4)**</td>
<td>8.8 (0.6)**</td>
<td>9.9 (0.5)**</td>
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<td>Group D</td>
<td>21.2 (2.5)</td>
<td>24.1 (1.9)</td>
<td>20.3 (1.3)</td>
<td>13.4 (1.6)*</td>
<td>11.2 (0.9)**</td>
<td>10.8 (0.9)**</td>
<td>21.3 (1)</td>
<td>19.9 (1.5)</td>
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<td>PO₂ (ml kg⁻¹ min⁻¹)</td>
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<tr>
<td>Group C</td>
<td>6 (0.8)</td>
<td>6.1 (0.8)</td>
<td>5.5 (0.7)</td>
<td>4.6 (0.4)</td>
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<td>6.1 (0.4)</td>
<td>5.7 (0.4)</td>
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<td>pHₑ</td>
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<tr>
<td>Group C</td>
<td>7.46 (0.02)</td>
<td>7.46 (0.01)</td>
<td>7.46 (0.01)</td>
<td>7.46 (0.01)</td>
<td>7.43 (0.01)</td>
<td>7.42 (0.01)</td>
<td>7.43 (0.02)</td>
<td>7.47 (0.01)</td>
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<td>Group D</td>
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<td>7.41 (0.02)</td>
<td>7.39 (0.03)</td>
<td>7.39 (0.04)</td>
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<td>PCV (%)</td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Group C</td>
<td>22.6 (1.1)</td>
<td>24 (1.2)</td>
<td>23.2 (1.2)</td>
<td>22.5 (1.1)</td>
<td>22.7 (1.2)</td>
<td>22.7 (1.4)</td>
<td>23.6 (1.4)</td>
<td>25.6 (1)**</td>
</tr>
<tr>
<td>Group D</td>
<td>25.1 (1.8)</td>
<td>27.1 (1.4)</td>
<td>27.3 (1.1)</td>
<td>25.5 (0.9)</td>
<td>25.4 (0.9)</td>
<td>25.8 (0.8)</td>
<td>27.8 (1.1)</td>
<td>28.3 (0.8)</td>
</tr>
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</table>
Dopamine infusion was started after baseline in group D animals (arrow). Values are mean (SEM). *

Haemorrhage (Bleed.) and resuscitation (Resus.). Baseline is time = 0 min. Dopamine infusion was started after baseline in group D animals (arrow). Values are mean (SEM). *P < 0.05, **P < 0.01 vs baseline (paired t test); †P < 0.05, ††P < 0.05 vs group C (unpaired t test).

In group C animals, mucosal HbO2 decreased from 52 (5) % to 32 (4) % after haemorrhage (t = 150 min) (P < 0.05) and increased to 37 (2) % after resuscitation (t = 210 min) (ns). In group D animals, mucosal HbO2 was never significantly different from baseline, despite an increase from 54 (6) % to 69 (1) % after the start of dopamine (t = 30 min), a decrease to 50 (8) % after haemorrhage (t = 150 min) and an increase to 55 (5) % after resuscitation (t = 210 min). Comparison between groups showed that mucosal HbO2 was higher in group D animals after the start of the dopamine infusion (t = 30 min) (P < 0.05), after the first two steps of haemorrhage (t = 60 and 90 min, P < 0.01 each) and after resuscitation (t = 180 and 210 min, P < 0.05 each).

Discussion

HAEMORRHAGE AND SMALL INTESTINAL MUCOSAL TISSUE OXYGENATION

In this study stepwise loss of 45% total blood volume progressively reduced small intestinal mucosal tissue oxygenation in the pig (figs 2, 3). Spectrophotometrically determined mucosal HbO2 reflects oxygen delivery to the mucosal and, to a lesser extent, the submucosal layer of the intestinal wall12 and has been shown to be related linearly to changes in mucosal blood flow during bleeding.13

The 39% reduction observed at the end of the bleeding period in this study is similar in magnitude to declines in mucosal HbO2 and blood flow in comparable haemorrhage models.4 The first study to measure mucosal tissue P02 within the small intestine during bleeding, Clark-type surface P02 electrodes appear to be specifically suitable for monitoring tissue oxygenation of the small intestine, as their catchment volume is limited to the villus tip area.16 The villus tip is thought to be preferentially susceptible to tissue hypoxia during haemorrhage or other intestinal low-flow conditions,4 because tissue P02 is considerably lower at the villus tip than at the base, already under resting conditions.17 This P02 gradient is enlarged during reductions in mucosal blood flow.18 Thus critically low tissue P02 values first appear at the villus tip. In these experiments, mucosal P02 was reduced by 60% of baseline values after haemorrhage and thus was more pronounced than total mucosal oxygen delivery, as measured by mucosal HbO2. In contrast with mucosal HbO2, mucosal P02 did not recover after resuscitation with shed blood and fluid even though arterial pressure and systemic oxygen delivery returned to pre-haemorrhagic values (table 1). Therefore, decreased tissue oxygenation persisted mainly within the villus tip area. This finding is in accordance with the morphological observation of villus tip injury after resuscitated haemorrhage.5

DOPAMINE AND MUCOSAL TISSUE OXYGENATION

Infusion of dopamine 16 μg kg⁻¹ min⁻¹ increased mucosal P02 and mucosal HbO2 to above baseline values in this pig model, although only changes in mucosal P02 were statistically significant (group D animals, figs 2, 3; t = 30 min). This observation is in agreement with previous findings where i.v. infusion of dopamine 2–32 μg kg⁻¹ min⁻¹ enhanced jejunal mucosal P02 and HbO2 in a dose-related manner but did not change jejunal serosal P02.2 Similarly, in cats, dopamine 10–25 μg kg⁻¹ min⁻¹ increased jejunal blood flow to the mucosa and submucosa, whereas muscularis and serosal blood flow decreased slightly.6 In contrast, intra-arterial infusion of dopamine 0.1 and 0.5 μg kg⁻¹ min⁻¹ into the superior mesenteric artery of dogs has been reported to increase total mesenteric blood flow but to decrease mucosal blood flow as measured by radioiodine absorption from the gut lumen.19 However, the results obtained were only descriptive, as the sample size of two dogs at each dose did not allow statistical analysis. Thus the majority of experimental data suggests that dopamine selectively improves intestinal mucosal blood flow and tissue oxygenation. Mucosal vasodilatation seems to be mediated mainly by stimulation of postsynaptic vascular DA1 receptors, as blockade of these
receptors by specific antagonists prevents vasodilatation to a considerable extent, and DA₁ specific agonists such as fenoldopam increase mucosal PO₂ which is similar to dopamine.

Dopamine-mediated mucosal vasodilatation maintained tissue oxygenation near baseline after withdrawal of 30% of total blood volume in this study (figs 2, 3; t=60 and 90 min), demonstrating that dopamine was effective in improving tissue oxygenation during moderate levels of haemorrhage. However, during and after the last step of bleeding, where volume of shed blood was increased to 45% of total blood volume, mucosal PO₂ and HbO₂ decreased to similar absolute values in both groups and a significant difference between the groups was no longer observed (figs 2, 3; t=120 and 150 min). The intestinal vasoconstrictor response induced by haemorrhage is mediated by stimulation of the sympathoadrenal and renin-angiotensin system and is largely dependent on volume of shed blood. Hence, when blood loss exceeds 30% of total blood volume, dopamine is no longer effective in competing with the pronounced vasoconstrictor stimulus. A marked difference between the two groups was observed after resuscitation (figs 2, 3; t=180 and 210 min); while mucosal tissue PO₂ remained significantly decreased in group C animals and reached minimum values at the end of the observation period, recovery to near baseline was observed in group D animals. Mucosal HbO₂ was also significantly higher in group D than in group C animals after resuscitation. Therefore, intestinal mucosal tissue oxygenation could be restored completely in dopamine-treated animals, whereas depressed tissue oxygenation persisted in controls, especially within the villus tip area. It should be noted that dopamine may have improved mucosal blood flow and tissue oxygenation by increasing perfusion pressure within the superior mesenteric circulation in addition to regional vasodilatation. However, this latter mechanism seems unlikely to have occurred in these experiments as arterial pressure did not differ between groups (table 1).

CLINICAL RELEVANCE AND LIMITATIONS OF THE STUDY

Haemorrhage-induced intestinal mucosal hypoxia has been shown to contribute to impaired gut barrier function in experimental models, as seen by increased mucosal permeability, bacterial translocation and mucosal injury. As alterations in gut barrier function may contribute to the pathophysiological processes leading to multiple organ failure and death in severely ill patients, prevention of intestinal mucosal hypoxia seems to be a valuable therapeutic aim in the clinical setting. Our data suggest that dopamine 16 μg kg⁻¹ min⁻¹ may be useful in improving intestinal mucosal tissue oxygenation during haemorrhage and subsequent resuscitation. A previous study in the same model demonstrated that an equal dose of dopamine produced a more than four-fold increase in intestinal mucosal tissue PO₂ after endotoxin-mediated mucosal vasoconstriction. However, these results should be extrapolated to humans and especially to critically ill patients with great caution. Responses of the peripheral vasculature to dopamine have been shown to vary between different mammals. Studies in dogs suggest that the vasodilator effect of dopamine within the superior mesenteric circulation can be overridden by concurrent stimulation of α adrenoceptors at doses higher than 10 μg kg⁻¹ min⁻¹. Yet, this vasoconstrictor effect in dogs is not representative of other mammals, such as pigs, cats and rabbits, where vasodilatation persists at i.v. doses of 20, 26 25 and 50 μg kg⁻¹ min⁻¹. In humans, the mesenteric vasoconstrictor threshold is still unknown. Clinical evaluation of whether or not dopamine is suitable to treat intestinal mucosal hypoxia could be facilitated by monitoring techniques measuring mucosal tissue oxygenation. At present the only clinical technique that is thought to provide an estimate of gastrointestinal mucosal perfusion or tissue oxygenation is gastric tonometry, which permits pH calculation of gastric mucosal cells (pH₇). Only one study has examined the effects of dopamine on pH₇ in hypotensive patients with hyperdynamic sepsis. That study conflicts with ours as a decrease in pH₇ was observed, despite an increase in arterial pressure and systemic oxygen delivery during infusion of dopamine. Although a high mean infusion rate of dopamine 26 μg kg⁻¹ min⁻¹ was used, it is unlikely that this effect on pH₇ was caused by α adrenoceptor-mediated mucosal vasoconstriction, as treatment with noradrenaline, a more potent α adrenoceptor agonist, in the same study caused an increase in pH₇. A different explanation is based on observations that dopaminergic receptors may not be distributed uniformly within the gastrointestinal tract. The proximal portion of isolated human gastroduodenal arteries responded to dopamine with α adrenoceptor-mediated vasoconstriction, whereas the distal epiploic branches responded with DA₁ receptor-mediated vasodilatation. Similarly, after infusion of dopamine 25 μg kg⁻¹ min⁻¹, vascular resistance in the superior mesenteric artery decreased by 50%, whereas it did not change in the coeliac artery in the cat. Thus vasodilatation mediated by stimulation of dopaminergic receptors may be limited to specific parts of the gastrointestinal tract, leading to redistribution of blood flow and tissue oxygenation within this organ after infusion of dopamine.

In summary, we observed that dopamine improved mucosal tissue oxygenation of the porcine jejunum during moderate haemorrhage and subsequent resuscitation. At present, extrapolation of these results to humans and especially critically ill patients is limited because it is uncertain if the intestinal mucosal vascular response to dopamine infusion is similar in pigs and humans.

References


