Microvascular reperfusion of pump-embalmed porcine tissue versus gravity-embalmed human tissue

Wouter Willaert[1], Tom Van Hoof[2], Piet Pattyn[1], Katharina D'Herde[2]
[1]Department of Gastrointestinal Surgery and [2]Basic Medical Sciences, Ghent University Hospital, Ghent, Belgium

Introduction

Establishing the best circumstances for Thiel embalming may facilitate a subsequent vascular reperfusion. The microvascular flow of paraffinum perliquidum (PP) in pump-embalmed porcine small intestines was compared with that observed in gravity-embalmed human tissue.

Methods

The feeding arteries of fresh small intestines from two adult pigs were cannulated and connected with a pump that injected blue Thiel embalming solution (flow rate of 3 mL/min). Next, the specimen was placed on the stage of a modified microscope, where a pump-driven vascular reperfusion with red PP was established (flow rate of 0.6 mL/min). Static pictures of the microcirculation were captured. Afterwards, 1 mg of 1,1'-dioctadecyl-3,3,3',3'-tetramethylindocarbocyanine perchlorate which incorporates into endothelial cell membranes was dissolved in 0.2 mL 99.8% of ethanol and mixed with 1.8 mL PP.(1) Then, a bolus of 0.5 mL of this mixture was administered. Dynamic fluorescence imaging of the microcirculation was done using a high sensitivity digital camera. As a control, this reperfusion was performed in Thiel embalmed small intestines prelevated from a pig that was embalmed with a pump shortly after dead. This procedure was also repeated in a small intestine from two Thiel embalmed human bodies, but embalming was done by gravity and the reperfusion was installed at 2 mL/min.

Results

PP totally reperfused the mesenterial vessels and gradually spread in the surrounding fat. PP circulated in the capillaries, before entering the veins. No extravasation was observed. Fluorescence microscopy demonstrated a 3D vessel network recruited in the intestinal wall and clearly visualized the mesenterial vasculature (fig 1). PP had an identical flow in the small intestine of a Thiel embalmed pig. PP was blocked in arterial branches of gravity-embalmed human tissues, probably due to multiple brownish mucosal spots (fig 2).

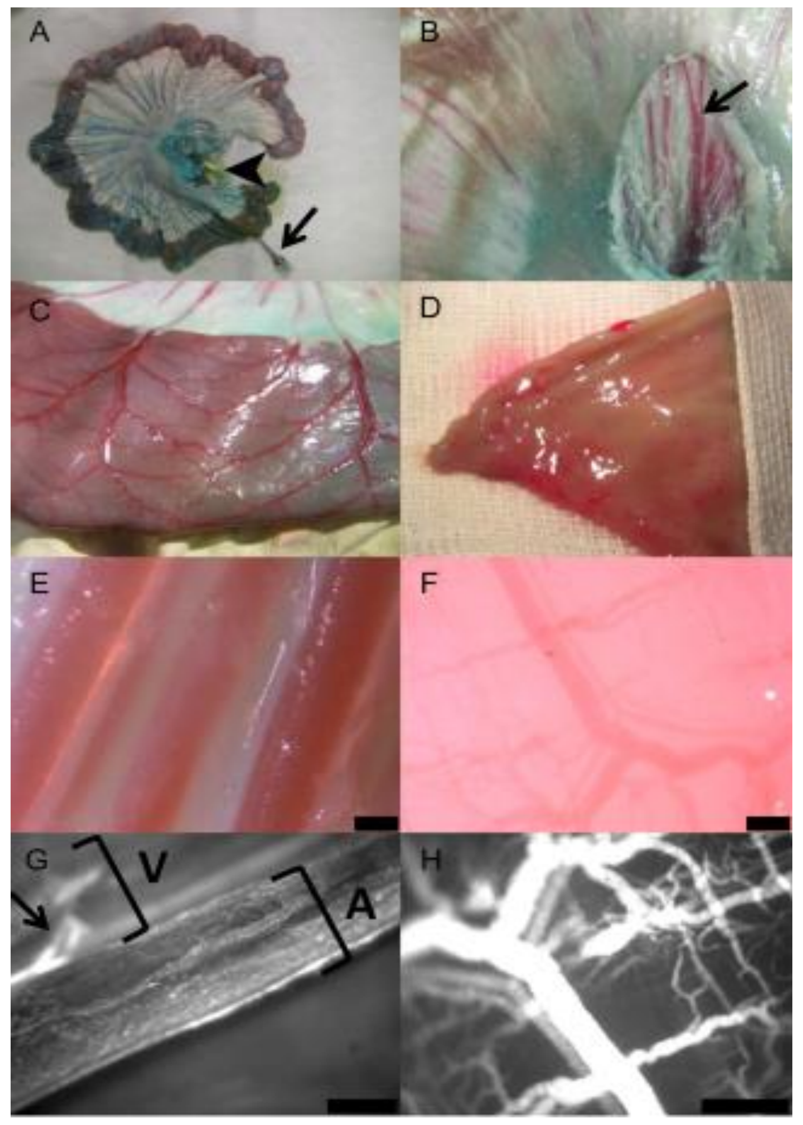

Fig.1: (A) Arterial catheters for perfusate circulation (arrow) and for pressure measurement (arrowhead). (B) Red PP in mesenteric vessels (arrow). (C) PP recruits intestinal wall vessels. (D) Reperfused mucosa has a natural appearance. (E) Mesenterial and (F) intestinal wall vessels are uniformly reperfused by PP (scale bar 200 µm). (G) Fluorescent agent binds to the endothelial cells of the mesenterial artery (A), vein (V) and venous valve (arrow) (scale bar; 200 µm). (H) Fluorescence imaging of reperfused intestinal wall vessels and capillaries (scale bar; 100 µm).

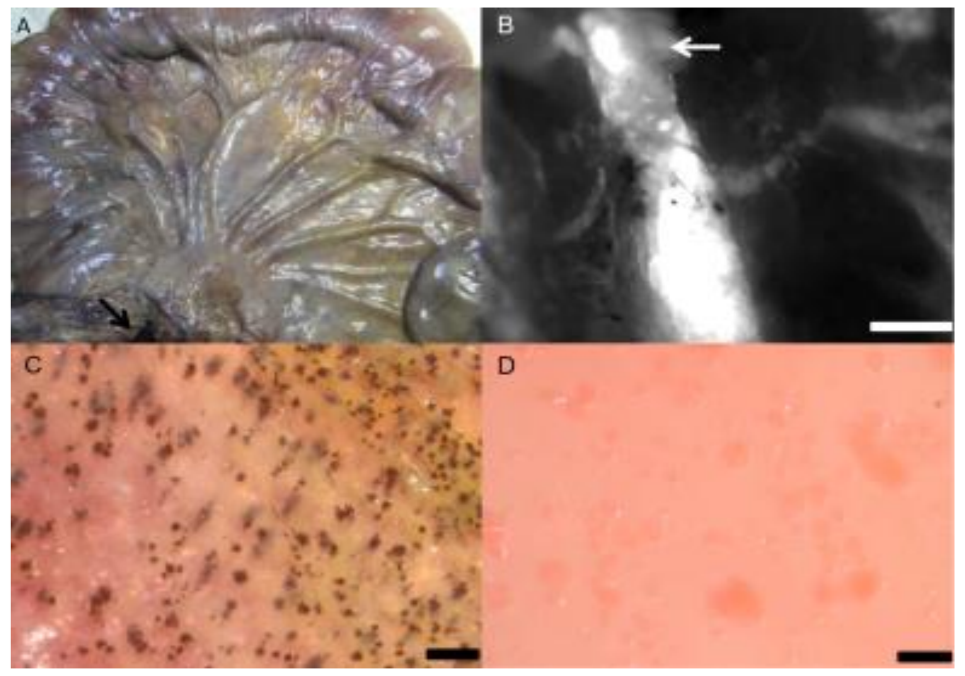

Fig.2 : (A) Thiel embalmed human small intestine with an arterial catheter (arrow) to inject PP. (B) PP is blocked in the intestinal wall arterioles. (C) Mucosa filled with brown spots, which are fixed in the vessels due to the embalming procedure and hinder vascular reperfusion. (D) In contrast, porcine intestines embalmed with the pump have no mucosal debris. (scale bar; 200 µm).

Conclusion

PP runs in the total vascular network of porcine small intestines that were pump-embalmed before as well as after surgical resection. Third spacing of PP does not occur. PP is blocked in arterial branches of human gravity-embalmed tissue. This underscores that pump-embalming shortly after dead creates the best circumstances for a successful vascular reperfusion.

References

1.Li Y, Song Y, Zhao L, Gaidosh G, Laties AM, et al. (2008) Direct labeling and visualization of blood vessels with lipophilic carbocyanine dye DiI. Nature Protocols 3: 1703-1708.

Contact: wouter.willaert@ugent.be