

## Letter to the Editor

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# Prostaglandin application improves macro- and microcirculation after aorto-hepato-mesenteric bypass in chronic mesenteric ischemia

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Dear Editor,

Chronic mesenteric ischemia (CMI) is an uncommon cause of abdominal afflictions. The spectrum of therapeutic options ranges from mesenteric artery angioplasty and stenting to surgical revascularization.

We used orthogonal polarization spectral (OPS) imaging to assess microcirculation after revascularization of the celiac artery and the superior mesenteric artery. Furthermore, we applied a prostaglandin I<sub>2</sub> derivative (iloprost, Ilomedin®, BayerVital GmbH, Leverkusen, Germany) after bypass reperfusion and demonstrated the effect of this vasodilative agent on microcirculatory parameters.

Our patient was a 52-year-old woman who suffered from a complete obstruction of the celiac artery as well as high-grade stenosis of the superior mesenteric artery (SMA). Therefore, we performed an open revascularization using the greater saphenous vein of the left thigh as graft (reversed vein bypass from the supraceliac aorta sequentially to the celiac artery (termino-lateral anastomosis) and the superior mesenteric artery (termino-terminal anastomosis)). After bypass reperfusion, we administered 3 µg iloprost as bolus directly into the bypass.

The agreement of the patient was obtained before the aforementioned procedure and the measurements.

Immediately following laparotomy, bypass reperfusion and iloprost administration, we measured the microcirculation of stomach, pancreas, small intestine and right hemi-colon.

Microhemodynamic analysis included the quantitative analysis of capillary diameter (D), functional capillary density (FCD) and red blood cell velocity (RBCV). Using these parameters, we calculated the individual capillary volumetric flow rate (capillary blood flow (CBF); in picoliter/s; pl/s) and the perfusion index (PI).

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Bypass flow was estimated using the VeriQ System (MediStim ASA; Oslo, Norway) which is an ultrasound-based system to perform intraoperative Doppler velocity measurements.

Considering bypass flow as a correlate of macrocirculation, we found a temporal increase of the flow after iloprost administration (210 ml/min before iloprost; 240 ml/min after iloprost). Furthermore, we found an improved microcirculation of stomach, pancreas and small intestine. Iloprost administration was followed by an increased capillary blood flow (see Table 1).

To the best of our knowledge, our report is the first describing changes of macro- and microcirculation using *in-vivo*-measurements after open revascularization for chronic mesenteric ischemia.

The surgical procedure using a vein bypass in antegrade revascularization technique was published in several reports [1] and is considered to be the gold standard of treatment for CMI. We decided to apply iloprost in this special case as off-label use because of the severe form of CMI, among others reflected in a necrosis of the gallbladder wall. So, we aimed at an improved peripheral perfusion of the visceral organs using this prostaglandin I<sub>2</sub> analogue. With the intra-arterial application, we could avoid the distinctive first-pass effect of the lung.

OPS is used in the assessment of microcirculation after liver and pancreas transplantation [3,4]. Furthermore, Schaser et al. used OPS to quantify ischemia/reperfusion-induced microcirculatory changes in the terminal vascular bed of the internal carotid artery (ICA) in patients undergoing unilateral ICA endarterectomy [5]. As far as we know, the use of OPS has not been reported for the analysis of microcirculation of organs during surgical treatment of (chronic) mesenteric ischemia. In our opinion, the use of OPS is also interesting in the treatment of acute mesenteric ischemia to assess a successful revas-

Table 1

Results of the microcirculatory parameters: functional capillary density (FCD), red blood cell velocity (RBCV), diameter, capillary blood flow (CBF) and perfusion index (PI). Represented are the mean values  $\pm$  standard deviations

(A) Measured values									
	FCD (cm/cm <sup>2</sup> )			RBCV (mm/s)			Diameter ( $\mu$ m)		
	Before bypass	After bypass	After iloprost	Before bypass	After bypass	After iloprost	Before bypass	After bypass	After iloprost
Stomach	109.33 $\pm$ 33.93	179.91 $\pm$ 21.28	156.34 $\pm$ 32.98	0.21 $\pm$ 0.06	0.42 $\pm$ 0.08	0.56 $\pm$ 0.12	8.85 $\pm$ 1.22	9.35 $\pm$ 1.26	13.05 $\pm$ 2.17
Pancreas	124.48 $\pm$ 24.74	143.15 $\pm$ 31.69	163.02 $\pm$ 31.16	0.11 $\pm$ 0.05	0.45 $\pm$ 0.08	0.49 $\pm$ 0.03	8.73 $\pm$ 1.03	8.5 $\pm$ 2.29	12.23 $\pm$ 1.36
Small intestine	103.78 $\pm$ 17.06	124.9 $\pm$ 23.18	123.84 $\pm$ 5.51	0.10 $\pm$ 0.04	0.31 $\pm$ 0.10	0.28 $\pm$ 0.10	9.08 $\pm$ 1.91	11.28 $\pm$ 0.77	17.3 $\pm$ 2.05
Colon	126.33 $\pm$ 19.39	134.17 $\pm$ 17.38	155.33 $\pm$ 16.88	0.32 $\pm$ 0.12	0.23 $\pm$ 0.06	0.46 $\pm$ 0.10	9.13 $\pm$ 1.77	12.27 $\pm$ 2.30	12.4 $\pm$ 0.91

  

(B) Calculated values						
	CBF (pl/s)			PI		
	Before bypass	After bypass	After iloprost	Before bypass	After bypass	After iloprost
Stomach	13.44 $\pm$ 6.15	30.24 $\pm$ 13.63	76.17 $\pm$ 28.34	1469.39 $\pm$ 208.67	5440.48 $\pm$ 290.05	11908.42 $\pm$ 934.65
Pancreas	6.73 $\pm$ 2.79	27.91 $\pm$ 15.95	59.21 $\pm$ 14.66	837.75 $\pm$ 69.03	3995.32 $\pm$ 505.46	9652.4 $\pm$ 456.81
Small intestine	6.38 $\pm$ 3.28	31.66 $\pm$ 11.55	65.69 $\pm$ 27.69	662.12 $\pm$ 55.96	3954.34 $\pm$ 267.73	8135.05 $\pm$ 152.57
Colon	20.89 $\pm$ 7.37	28.04 $\pm$ 13.94	54.97 $\pm$ 10.09	2639.03 $\pm$ 142.9	3762.13 $\pm$ 242.28	8538.49 $\pm$ 170.32

cularization. In this work, we could show that the use of OPS is possible in the field of mesenteric ischemia.

Our results demonstrated an improved microcirculation after iloprost administration as suggested by animal experiments [2]. But there may also be a component of reactive hyperemia (due to the CMI and the temporal vessel occlusion during the bypass construction), so, the distinction against the iloprost effect is difficult.

However, we found contradictory results of the microcirculatory parameters for the colon compared to the other organs. In our opinion this observation may be attributed to the rather diverse ways of collateralization of the SMA and the inferior mesenteric artery (IMA), e.g. via meandering and the marginal artery of Drummond. The IMA itself has several collaterals, e.g. via the internal iliac arteries.

In conclusion, this report shows the improved microcirculation of the abdominal organs after aorto-hepato-mesenteric bypass and we have demonstrated directly the vasodilatative effect of iloprost for this particular application.

Further studies will have to validate our results in a larger study population.

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