



New Technique for Portal Flow Modulation in Porcine Major Liver Resection

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Editorial

The liver function depends on the integrity of the micro-architecture to optimize the exchange of metabolites between blood and hepatocytes [1]. The portal flow shift through the sinusoidal network increases after resection leading to stimulation of sinusoidal endothelial cells [2] and initiation of liver regeneration [3]. If extensive, hepatectomy could be associated with disequilibrium between the portal flow rate and the liver volume leading to “barotrauma induced liver insufficiency” [4,5].

Thresholds for portal flow rate per 100g of liver [6] and portal pressure [7]. Were identified above which the risk of post-operative liver failure is high [8,9]. This phenomenon is partially interplayed by the important reduction in the arterial flow of the remnant liver as a consequence of the excess in portal flow rate through the sinusoidal network [10]. It was found that healthy remnant liver volume superior to 20% of the theoretical total liver volume [11] and/or superior to 0.5% of the body weight is considered mandatory after major hepatectomy [12,13] to avoid post-operative liver failure. Modulation of the portal flow is attempted when there is a risk for post resection failure by embolization or ligation might be necessary to induce regeneration of the future liver [14] but cancer may progress [15,16].

Many techniques were tried [17–20]. These techniques do not allow precise control of the portal flow rate and might have adverse effects. Therefore, Professor Eric VIBERT developed an adjustable vascular ring “MID-AVRTM” to protect the hepatic microarchitecture from the initial harmful increase in portal flow rate and pressure after major liver resection.

In a multidisciplinary study funded mainly by the “Agence de la Biomedecine” through its program of Research (AOR 2009), by project ANR-13-TECS-0006 (IFlow), and by Virtual Liver Network (German Bundesministerium für Bildung und Forschung [BMBF]). We studied the safety and efficacy of the ring in portal hemodynamics modulation in a porcine model with 75% and 90% liver resection. This modulation technique is flexible and reversible.

The study protocol was designed in a staged fashion to enable achievements of certain goals. In this regards, large white porcine animals were allocated to the following groups:

- Group 1: composed of randomly allocated animals to undergo 75% liver resection with or without the application of the adjustable vascular ring around the portal vein. This group consisted of 17 animals, of them 8 animals underwent liver resection and ring placement and 9 animals underwent only liver resection. This allocation targeted the study of the safety and the efficacy of the vascular ring in ameliorating the hepatic function and regeneration following this type of hepatectomy.
- Group 2: consecutive series of 16 animals that underwent 75% resection with 7th day sacrifice protocol. This allocation targeted optimization of the invasive hemodynamics monitoring

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of the porcine model while conducting liver resection, which would allow building up accurate predictive mathematical models at multi-scale level and investigating the role of ICG in *in-vivo* evaluation of liver function during major liver resection.

- Group 3: composed of consecutively allocated animals to undergo 90% resection with and without the application of the adjustable vascular ring around the portal vein. This group consisted of 6 animals, of them 3 animals underwent 90% liver resection with the application of the vascular ring around the portal vein and 3 animals underwent only liver resection. This allocation targeted the study of the efficacy of the vascular ring in ameliorating liver function and regeneration following this potentially lethal liver resection.

- Group 4: consecutive series of 6 animals that underwent 75% liver resection with 3rd day sacrifice protocol. This allocated targeted the investigation of early volume and histopathological changes.

The highlights of our results indicated the safety of the ring and the feasibility of percutaneous removal. In the 75% hepatic resection model, the ring group was able to improve the microarchitectural regeneration. However, the 75% resection was not challenging enough to test the full potentials of the ring since several measures were statistically similar in both arms; with and without ring.

In the 90% resection, which was generally lethal for our pigs, one animal in the ring group survived till day three with remarkable volume regeneration but with all manifestation of hepatic failure. Several mathematical models were developed to predict the interaction between the change in both volume and hemodynamics. This technique could be useful for preparation prior to extensive liver resection or living donor transplantation.

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