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TITLE

WILL AUGMENTED REALITY HELP DEVELOP ROBOTIC-ASSISTED LAPAROSCOPIC AORTIC SURGERY?

INTRODUCTION

Augmented reality (AR) is a technology in development in many surgical specialties, especially those with a robot assisted approach such as in gynecology with the uterine fibroma or as in digestive surgery with liver tumor resection. In vascular surgery, robotic-assisted approaches for aortic interventions are used only by a few centers. To the best of our knowledge, AR has not been used in vascular surgery until now. Aortic interventions using a robotic approach require a learning curve that could be significantly reduced if anatomical landmarks such as the abdominal aorta and its main branches could be projected through the abdominal area. Our project is to use AR to reduce operating times, particularly dissection times, and make this type of surgery more accessible and more secure.

MATERIALS AND METHODS

Our method consists of creating a 3D model of the abdominal aorta and the left renal vein, which is the main landmark during dissection of the infra-renal aorta in the pre-aortic fat, by manually segmenting the pre-operative scanner images, and projecting it onto a robotic-assisted laparoscopic sequence using a manual registration. The registration is done by manually rotating and translating the 3D models using keyboard and mouse, until the model fits the target landmark in the image. The registration is initially performed on an image with the hidden aorta by using the left renal vein as a landmark. Then, to ensure the reliability of the left renal vein as a landmark, the registration was done again on an image with the visible aorta.

3D Slicer software is used for reconstructing the 3D models. Meshlab software is used to simplify and smooth the 3D models of the aorta and the left renal vein. An in-house augmented reality software is developed to register and overlay the 3D models on top of the robotic images.

RESULTS

The difficulty lies in obtaining reliable anatomical landmarks and therefore structures that are fully visible, with their contours. For example, the kidney is difficult to use as a landmark because of the pre-renal fat, which makes it impossible to discern the precise contours. However, the left renal vein remains relatively fixed and can be used as a landmark. This landmark seems reliable and has enabled us to make relatively accurate projections of the aorta on several patients, despite a large amount of intraperitoneal fat in one case. Preliminary results were obtained from a per-procedure case of robot-assisted laparoscopic aortic surgery for abdominal aortic aneurysm. An example on image 1 and 2 shows the registration checking done on an image with visible aorta.

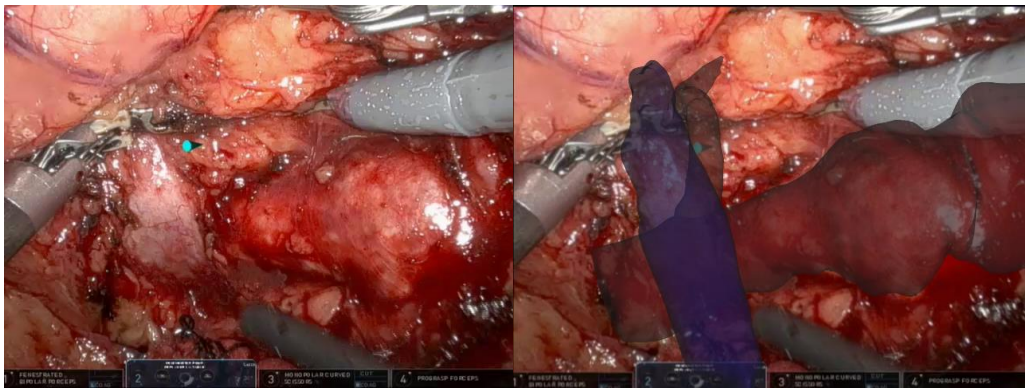

Image 1 : Original robotic image *Image 2 : Augmented image*

CONCLUSION

The development of AR in vascular surgery, especially focused on aortic intervention, is a promising technology which can make it accessible for more in-training operators and can decrease significantly the learning curve. The medium-term objective would be to have automated registration using an algorithm.