Stereoscopic augmented reality for da Vinci™ robotic biliary surgery

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Abstract

New laparoscopic techniques put distance between the surgeon and his patient.

Reference

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Abstract

INTRODUCTION

New laparoscopic techniques put distance between the surgeon and his patient.

PRESENTATION OF CASE

3D volume rendered images directly displayed in the da Vinci surgeon's console fill this gap by allowing the surgeon to fully immerse in its intervention.

DISCUSSION

During the robotic operation the surgeon has a greater control on the procedure because he can stay more focused not being obliged to turn is sight out of his operative field. Moreover, thanks to depth perception of the rendered images he had a precise view of important anatomical structures.

CONCLUSION

We describe our preliminary experience in the quest of computer-assisted robotic surgery.

Keywords: Robotic surgery, Mixed reality, OsiriX, 3D, Da Vinci
1. Introduction

A significant problem in laparoscopic surgery is the distance between the surgeon and the patient. Robotic surgery further increases the gap by completely removing tactile feedback. Despite this, robotic surgery with the da Vinci™ system (Intuitive Inc., Sunnyvale, CA) brings numerous advantages, among which is three-dimensional visual capability. We report herein our preliminary experience using stereoscopic 3D volume rendered images directly displayed in the da Vinci™ surgeon's console via the TilePro™ multi-input display during totally robotic-assisted cholecystectomy.

2. Presentation of case

A 55-year-old female patient presented with symptomatic gallstone disease. CT studies with intravenous and biliary contrast media were obtained during the diagnostic process. This allowed the surgeon to proceed with the reconstruction of 3D images of optimal quality using OsiriX (v3.9.1, 64 bit, Pixmeo©), an open source DICOM workstation. The organs, blood supply, and the relationships between vital structures were established, including gallbladder position and the location of the cystic and bile ducts (Fig. 1). A custom OsiriX plugin was designed and written to generate a stereoscopic image pair appropriate for display within the TilePro™ multi-input display in the da Vinci surgeon's console. Stereoscopic volume rendered images appeared in the inferior part of the display and were updated in real time in the surgeon's console (Fig. 2). Using a 3D mouse (3DConnexion Inc., Silicon Valley, CA, USA) installed on the console bar, the surgeon could manipulate the volume according to his needs.

During the procedure, the surgeon switched to the stereoscopic reconstruction four times. He first looked at the spatial location of the gallbladder. Its relationship with the common hepatic duct and the common bile duct was easily established. Finally, the absence of an aberrant biliary duct was confirmed. Images were easily manipulated thanks to the joystick installed on the robotic console. Operating room time was 105 min. There were no intraoperative complications. The postoperative course was uneventful.

3. Discussion

This report illustrates the use of robotic-assisted cholecystectomy for cholelithiasis with stereoscopic volume rendered images displayed directly in the surgeon's field of view. 3D reconstructions were rendered very easily by the surgeon thanks to a software package (OsiriX), which is now widely distributed throughout the medical community and the use of which happens to be within the reach of all surgeons, without the need for specific training in radiology or computer science.

Such information, once confined to the radiology room or in specialised colloquia, is now accessible to any non-specialist physician. Thanks to the plugin programmed within our institution, the surgeon could directly display the preoperatively rendered images in the surgeon's console. These were processed by the plugin according to specific criteria of parallax and distance between the eyes, and appear to the surgeon with a field depth comparable to the endoscopic images directly displayed in the upper half of the screen. The surgeon could promptly consult the patient's information without having to leave his operating position. Not having to turn his head out of the surgical field to look at radiological
information on a secondary monitor was considered by the surgeon to be an advantage, because he could stay more focused on his intervention. Relevant patient anatomy and the relationships between anatomical structures were readily available in front of him. Depth perception was subjectively considered to be a valuable factor in image analysis.

4. Conclusion

We report our preliminary experience using stereoscopic volume rendered images displayed directly with a dedicated OsiriX plugin in the da Vinci robot console via TilePro™ during robotic-assisted cholecystectomy.

Greater control during the robotic procedure was achieved because the surgeon has not to leave is operating position or turning is head out of the surgical field looking for radiological or supplementary information. Depth visualisation of the virtual rendered images gave the surgeon a real advantage in terms of spatial localisation.2,4 Visualisation of the relationship between important anatomical structures was thereby facilitated. This technique represents a step forward in computer-assisted robotic surgery.

Conflict of interest statement

None.

Funding

None.

Ethical approval

Written consent obtained.

Author contributions

FV, NCB and FP participate to the writing of the paper and the establishment of the procedure. Dr. JS wrote the plugin and participate to the technical setup of the procedure. MJ, OR and PM participate to the review and corrections of the paper.

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**Figures and Tables**

**Fig. 1**

Use of OsiriX is very intuitive and let the surgeon render 3D images very quickly from simple CT series.

**Fig. 2**
The OsiriX plugin allows the surgeon to directly display in his field of view the information previously prepared. In the upper part the endoscopic view and in the lower part the stereoscopic virtual reconstruction.

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