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Technical note

From stereoscopic recording to virtual reality headsets: Designing a new way to learn surgery

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ABSTRACT

Objective. – To improve surgical practice, there are several different approaches to simulation. Due to wearable technologies, recording 3D movies is now easy. The development of a virtual reality headset allows imagining a different way of watching these videos: using dedicated software to increase interactivity in a 3D immersive experience. The objective was to record 3D movies via a main surgeon's perspective, to watch files using virtual reality headsets and to validate pedagogic interest.
Material and methods. – Surgical procedures were recorded using a system combining two side-by-side cameras placed on a helmet. We added two LEDs just below the cameras to enhance luminosity. Two files were obtained in mp4 format and edited using dedicated software to create 3D movies. Files obtained were then played using a virtual reality headset. Surgeons who tried the immersive experience completed a questionnaire to evaluate the interest of this procedure for surgical learning.
Results. – Twenty surgical procedures were recorded. The movies capture a scene which is extended 180° horizontally and 90° vertically. The immersive experience created by the device conveys a genuine feeling of being in the operating room and seeing the procedure first-hand through the eyes of the main surgeon. All surgeons indicated that they believe in pedagogical interest of this method.
Conclusions. – We succeeded in recording the main surgeon's point of view in 3D and watch it on a virtual reality headset. This new approach enhances the understanding of surgery; most of the surgeons appreciated its pedagogic value. This method could be an effective learning tool in the future.

1. Introduction

Simulations must be developed in order to improve learning and ensure safer surgical practice [1]. There are several different approaches to simulation. In medicine, we can use role-play or a high-fidelity patient simulator; in surgical practice, human cadavers, animals, low-fidelity synthetic simulators and, more recently, virtual reality (VR), are available for use [2]. With the development of robotics, such as the da Vinci Surgical System (Intuitive Surgical, Sunnyvale, CA), students can train in a variety of ways. Moreover, simulations enhance visualization due to their stereoscopic approach [3] and allow for training specific to endoscopic surgery. In the neurosurgical field, the NeuroTouch (NAJD Metrics) simulator has been designed to provide haptic feedback [4].

The above-mentioned novel tools, nevertheless, have some limitations. First, they cannot be applied to all types of surgical procedures. Second, they concentrate on skill, e.g., with respect to hand movements, but not on knowledge of the different steps involved in a surgical procedure. Furthermore, the tools cannot be applied in order that knowledge of the duration of a surgical procedure is acquired. Presently, to learn about surgical procedures in a step-by-step manner outside of the operating room, technical notes or videos are reviewed in two dimensions [5]. A method of three-dimensional (3D) recording has been recently developed but the need to wear specific glasses has limited its use [6].

New tools are currently being developed, including VR headsets (designed initially by Oculus; Irvine, CA). These headsets allow for total 3D immersion using stereoscopic views of a scene (i.e., two screens, one for each eye). Moreover, head tracking permits the observer not only to visualize the scene but also to view what happens in the area around the central view. VR allows us to design software that increases interactivity, permitting students to be active rather than just passively watching the videos. In this article, we introduce our first study that aimed at improving surgical learning.

Objectives were to test feasibility to record main surgeon point of view in 3D in various neurosurgical procedures; then to use VR

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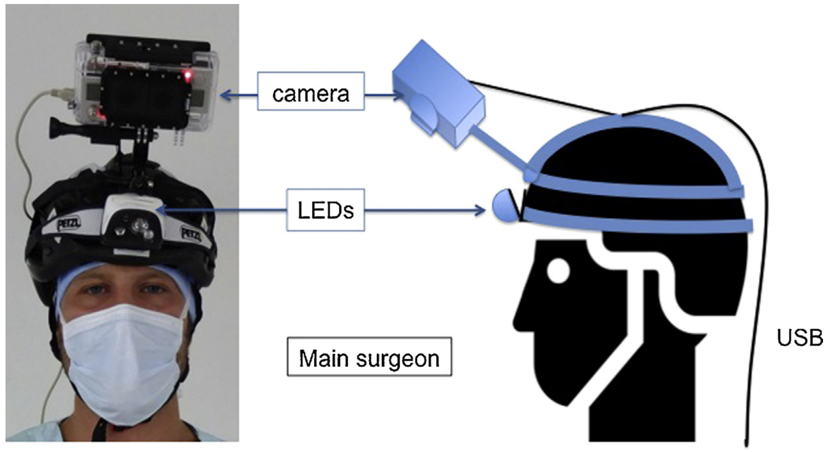

Fig. 1. Front view (photo) and lateral view (picture) of recording device: one stereoscopic camera (two cameras side-by-side) and two LEDs are placed on a helmet. The helmet is on head of main surgeon. Cameras are inclined to record surgeon point of view.

headsets to watch files obtained; finally, to have feedback from surgeons about this VR application.

2. Material and methods

2.1. Surgical recording

Patients were informed of the study procedures, and consent to record the surgery was obtained. The surgical procedures were recorded using a system combining two side-by-side cameras (GoPro, San Mateo, CA). The distance between the two lenses corresponded to the mean distance between two eyes (6 cm). The two cameras were connected to synchronize different commands. The system was placed on a helmet to improve surgical comfort and avoid any problems caused by the weight of the original recording device on the forehead of the surgeon. The device was linked via a USB port to an external battery situated in the back pocket of the surgeon. We added two LEDs just below the cameras to enhance luminosity (Fig. 1). The first LED was an ambient light, used instead of scialytic lamps. The other LED was a focal lamp allowing for a deeper operative field, thereby ensuring optimal luminosity in the region of interest.

Cameras were inclined approximately 45° from the horizontal plane to ensure the same field of view as that of the surgeon. The view was checked using a WiFi connection between the camera device and a smartphone. The surgeon placed an object in the central field of vision of the camera device, with the position of the cameras then checked by watching a streamed recording of the view on the smartphone.

Recording was controlled using the WiFi command packaged with the initial device. For the first recording, we assisted the surgeon by maintaining control of the command.

If preferred by the surgeon, access to the recording button could be achieved by placing the command in a sterile pocket on the operating table. We began recording after the checklist was completed and prior to the incision.

Three senior surgeons used the device to record the different surgical procedures. We tested this recording method on various surgeries to determine if it was applicable to a different context and position.

2.2. Virtual reality headset

After the surgery was performed, two files were obtained in a mp4 format, one for each eye. The two files were then edited using professional software Adobe Premiere Pro CC (Adobe Systems, San Jose, CA) to create 3D movies presented side by side. Accuracy, luminosity and contrast were then checked. Different sequences were cut to create new files corresponding to the different steps of the surgical procedure.

The new files were then played using a VR headset (the prototype Rift DK2 [Oculus VR, Irvine, CA] was used initially; the Gear VR Innovator [Samsung, Seoul, South Korea], designed to be used with the S6 Edge [Samsung] device, is now employed). At the outset, we at first used a VR player, MaxVR (Supersinfulsilicon software, St Edmonton, AB) that permitted the use of an appropriate virtual screen. However, a computer engineer subsequently designed a mobile software called Surgevry (Revinax, Montpellier, France) that uses a special template for each surgical procedure permits the observation of procedures and creates a movie specially designed for the type of surgery that has been recorded. In the central field of view, a screen corresponding to the immersive video can be seen. In the upper field of view, different stages of the surgical procedure are divided into chapters according to time. In lateral fields of view, data can be added to explain surgery. For example (Fig. 2), in the left field of view, X rays, computed tomography (CT) or magnetic resonance imaging (MRI) scans can be integrated and visualized; in the right field of view, anatomical chart or 3D reconstruction can be seen.

2.3. Validation from surgeons

In order to obtain a representative sample of the surgical population, thirty other surgeons (mainly neurosurgeons, different generations, from residents to seniors, with an academic function or not) tried the VR headset (Gear VR). They watched one of the surgical procedures that we have recorded with the method described (external ventricular drainage) during 10 minutes. After this brief experience, they were asked to fill out a form to determine the interest of using this new method (Table 1). We identified, in the first questions, the surgical experience or degree of the different surgeons (specialty, university status). Second part of questionnaire was to obtain their initial impression using this device: nausea, stressful, surprising, interesting, captivating; then, did they think this method could have any pedagogical interest and to quantify it (1 to 5). Third part focused on the way they would use it (to learn from it, to teach with it), if they though that this device will be part of the learning procedure in the future, and if they would use it. Possible answers were "certainly not", "probably not", "maybe", "probably", "certainly". Fourth part was to know their feelings about their own past and the way they used to learn: if this device has been available during their studies, did they think