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Case Report

Brain Computer Interface: A Future Solution for Virtual Reality Navigation in Surgery Hands to Mind Control, Just Thinking

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Summary

In the future, patient's mind will control virtual reality (VR) scenarios during ambulatory surgery with a Brain Computer Interface (BCI) technology. Up today, we need our fingers to control a computer screen, we need head and neck movements to control a smartphone screen using 3D virtual navigation or Oculus technology. BCI is an innovative technology that introduced and extracted data from the human brain in a lab and demonstrated in clinical trials its positive results. BCI is a useful, innovative device with the possibilities in the future to perform VR navigations inside of the brain using just the human mind. During ambulatory surgery many patients cannot move their arms, hands, and heads and so on. In this article we review our experience with VR in surgery and describe traditional technologies to control VR scenarios. We discuss the possibilities to use emergent technologies to reduce pain and anxiety while surgeon is performing surgeries.

Keywords: Brain machine interface; Cybertherapy; Ambulatory surgery

Introduction

In the last ten years we have used VR systems to reduce pain and anxiety in different urban and indigenous regions in Mexico [1,2] such as during colposcopies [3], ambulatory surgery [4], cardiac surgery care unit [5- 7], upper endoscopy [8,9] and other different medical procedures. Different computer technologies have been used as well as different types of screens as the Head Mounted Displays HMD, glasses, and screens from projectors, computers, smartphones, and from the Oculus. There are VR scenarios developed for medicine use as the Forrest, Cliff Final, developed by Benda and Mark Wiederhold from Virtual Reality Medical Center in San Diego CA, and others designed for commercial purposes like the Free VR apps for smartphones. Each studied group need its own VR system, since it depends of body positions, the regions or types or their lesions, intravenous catheter used, the technique of medical or surgical procedure, age, gender, interest in technology, medicine specialty, if the patient goes to a private or public medical institution.

The best scenario for adults and elderly has been those developed just for medicine applications because they relax the patients. These doesn't apply to children who enjoy more arcade games. The best devices are those who can navigate with hand controllers during an ambulatory surgery. The best screen is the Oculus's one, which has higher resolution and immersion. Smartphones screens can be attached inside of the Oculus. The optimal system for VR navigation in medicine is chosen on a case by case basis.

In the future, the optimal VR system could be as follows: Real VR scenarios with high immersion without using HMD and computers, high capacity for navigation without using the body movements. These systems could be supported just with BCI technology that permits patients have brain implants for VR navigation stimulating vision areas to appreciate VR scenarios inside the patient´s brain. Pain could be controlled with deep microelectrodes placement in specific pain areas as the thalamus with midbrain stimulating brain activity. Mark Wiederhold has experience with VR navigation with systems controlling scenarios with just the patient´s mind, only by thinking, but the results are not satisfactory yet.

Pain in the intraoperative and in the postoperative time is one of many challenges in surgery. There are a lot of scientific and technological efforts to reduce it with robotics in Minimal Invasive Surgery, hibernation, energy, brain electrical stimulation, analgesics, anesthetics and still is not enough. BCI could be in the future a solution to reduce pain in surgery.

Emergent technologies for the brain are being developed in many laboratories in the worldwide laboratories as DARPA, these projects are related with two wide areas: nanotechnology and brain computer interface BCI [http://www.humanconnectomeproject.org/]. With nanotechnology, neuroscience researchers have developed brain implants with two purposes: one is to extract information from the brain to be sending to a computer [10] and the second is to send information to the brain from a computer [11].

The computer analyzes the brain information to translate these in motions, words, responses, etc. An example for the first application is to extract electroencephalogram information to a computer in locked-in patients to dialogue with them with written words in a computer screen. Other BCI applications are made to write on a screen just with the patient´s will and control one or many robot arms to help themselves and drink water. Electrical stimulation from a computer to the brain to stimulate specific areas to improve and modulate muscles in disabled patients is another example [12]. In the last example (to send information to the brain from a computer), researchers are rising human attention to perform accuracy task in battle fields.

[10] and why not to improve surgeon attention for surgeries? Other applications are considering introducing virtual reality scenarios inside of specific brain areas as part of our vision without using our eyes, optic nerves. The patients will only use the vision areas and optic pathways in the occipital lobes connected or involved with the rest of all the nervous system. These applications could be addressed for distraction or reduce somatic or visceral pain during ambulatory surgery using just BCI. Furthermore, there exist the possibilities with the same application to navigate watching our own experiences using brain stimulation into specific memory areas as hippocampus where we can find our past life; this experience could be considered virtual reality inside of the brain when it is part of our life into our memory [13]. More applications could be to block pain areas in the brain with electrical stimulation into the thalamic nucleus. This would disappear somatic or visceral pain pathways avoiding use of medication. There have been descriptions of experiences related with deep brain stimulation for intractable pain [14-16].

Up today, the current technology permits us, to use a computer and a head mounted display with the patients but they must use their fingers, head motions, and hands controls for virtual navigation. In many cases, an assistant helps users by manipulating the computer keyboard to move the virtual reality scenario while the patient watches. Similar patient's experiences have using Google card boards, because they move their heads and necks for navigation, this is an uncomfortable position for the patients while laying down during surgery. A new BCI is the Emotive's device for mental commands algorithm which recognizes patient´s thoughts that can be assigned to control virtual reality scenarios for navigation using 32 electrodes on the skull. Patient´s brain control can replace traditional input devices like keyboards, without the part of moving the head, neck, fingers, hands, arms, enhancing interactive virtual experiences during surgeries. Emotive's devices convert brain waves into digital signals that can be used to control anything that speaks in 1's and 0's.

Emergent BCI technologies will improve the capacity for virtual navigation in the future in the intraoperative and recovery time and probably will disappear the surgical pain with medications. Probably computers or cell phones will be reduced in size, so they could be inside of our brains as ordinary implants. Cyber therapy uses VR (out of the brain) and it is a noninvasive device that works in the majority of patients as virtual anesthesia on patients that undergo medical or surgical procedures. BCI technology will be the best method to disappear pain and anxiety during surgeries in the future (Figures 1-7).

Figure 1: Patient´s fingers controlling virtual reality scenario laying down in the intraoperative using keyboard during cyst removing.

Figure 2: Anesthesiologist's fingers controlling keyboard of a Laptop for VR navigation patient underwent bilateral and open hernioplasty with regional anesthesia and VR anesthesia.

Figure 3: Resident controlling VR navigation patient in the unit care in his postoperative cardiac surgery.

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Figure 4: Tablet on patient´s hands for virtual navigation umbilical hernia repair.

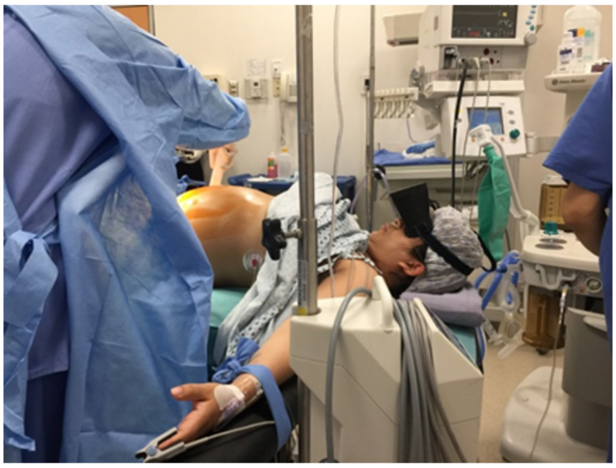

Figure 5: Head and neck patient´s motion to control VR on smartphone´s screen into a Cardboard Cleaning abdominal wall before to perform a cesarean.

Figure 6: Indigenous patient without moving his arms, hands and finger during ambulatory surgery assistant is controlling VR navigation with a computer.

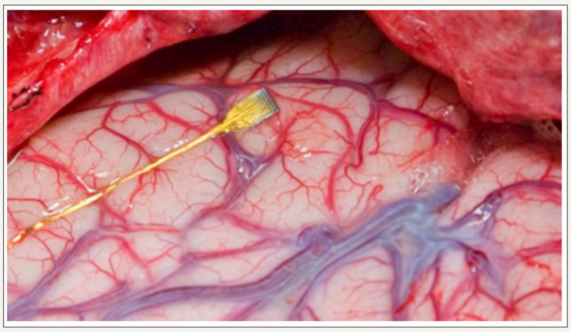

Figure 7: Brain implant.

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