Operation-Microscope-Mounted Touch Display Tablet PC for Intraoperative Imaging Visualization: Technical Note and Comparison with other Modalities

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Abstract

OBJECTIVE: The authors have developed a novel sterile draped touch display solution for convenient intraoperative access to imaging data. This study describes the technology and clinical experience with the system.

METHODS: We developed a flexible-mounted touch display tablet PC (Apple iPad) that allows fixation of the display on the operation microscope and fine adjustments during the surgery when the microscope is moved. We compared this setup with a conventional wall-mounted flat-panel and a mobile display stand in illustrative cases of vestibular schwannoma.

RESULTS: The surgeon was able to employ the system without the need to leave the operation field or need for external assistance while referring to imaging data. Commanding through imaging data with sterile gloves on the touch display was more convenient, precise and faster than with other modalities.

CONCLUSION: The operation-microscope-mounted touch display provides useful assistance for intraoperative imaging visualization in neurosurgical procedures.

Key Words: touch display system, intraoperative imaging access, neurosurgical tool

Running Title: Touch display system for intraoperative imaging: Technical note

Introduction

During neurosurgical procedures, access to imaging data of the patient is often required. Currently used displays are often remotely located from the surgeon, causing delays in decision making and inconvenience for the surgeon because of lack of self access to the imaging. Some commercially–available operation microscopes have an integrated imaging viewer in the eye-piece side, however, such microscopes are not commonly affordable in every center. Therefore we propose a solution of using a touch display tablet computer (iPad, Apple Inc., Cupertino, California) in combination with a DICOM viewer software application (Osirix, Osirix Foundation, California) mounted at the operation microscope. The new system was used in two cases of vestibular schwannomas in comparison with a conventional wall-mounted display and a mobile display stand. In the current study, we present our initial clinical experience with this system.

Patients and Methods

Patients

The new system was applied in 2 operative cases at Shinshu University Hospital. Both cases suffered from vestibular schwannoma. The first patient was a 36-year-old man with left hearing disturbance, who was referred to our service for surgery after MRI examination revealed an 11x11x12 mm size of a mass in the left cerebello-pontine angle (CPA). The second patient was a 65-year-old woman who was suffering from left hemifacial spasm, hearing disturbance and tinnitus. MRI revealed a 36 x 20 x 28 mm mass in the left CPA (Figure 1).

Informed consent was obtained from both patients. Surgery was performed as usual and the use of the new system did not influence the standard medical treatment for the patients.

Methods

The touch display system consisted of a touch display tablet computer (iPad, Apple Inc., Cupertino, California) and a flexible and adjustable arm, which were mounted

to the operation microscope (Olympus OME 8000, Olympus, Tokyo, Japan) (Figure 2). The system was placed in such position for easy access by the surgeon, ie; above the eye-piece of the microscope. The arm of the system could be moved independently from the microscope and therefore allowed fine adjustments of the display when the operation microscope was moved. The touch display system was then draped together with the microscope for sterile use by the surgeon.

Imaging data of the patients were viewed using a DICOM viewer (Osirix for iPhone, Osirix Foundation). CT and MRI data of the patients were transferred from our hospital PACS system to the Osirix database in the touch display tablet computer before surgery (Figure 3). The software allowed scrolling through imaging series, magnification and measurement of length and volume.

Comparison with other available systems was also performed. A wall-mounted display is being used at present in our institution. It consists of 19-inch display mounted on the wall of the operating theater and is connected directly to the hospital PACS system. It is located approximately 3 meters from the surgeon and it has to be operated by another person for sterility issue. Another system we had employed before was a mobile display stand. It consisted of 24-inch display mounted on a mobile stand of 160 cm in height (Figure 4). It was connected to the hospital PACS system, however it also had to be operated by another person.

Results

Clinical experience with the touch display system

Imaging data of the patients were easily transferred from the PACS system to the touch display tablet computer in DICOM format. The set up of the touch display system took approximately 15 minutes including sterile wrapping of the microscope. Degree of freedom of the microscope arm was not affected by the touch display system and movement of the surgeon did not show any significant problem as well. The surgeon could command and scroll through the imaging data intuitively and could manipulate easily even with usage of gloves and sterile cover around the screen of the tablet computer.

Tumors were totally removed and surgeries were successfully performed without any complications. Postoperative courses were uneventful (Figure 1). No surgical complications associated with intraoperative imaging visualization were encountered. The system was stable during the surgery and did not interfere with the course of the operation. Even without any electrical charge, the system could last until the end of surgery, which took approximately 8 hours.

Comparison with other modalities

We employed a wall-mounted system and a mobile display stand and compared them with our newly developed system. The wall-mounted system was located 3 meters from the surgeon and with the display screen size of 19-inch, it did not provide an appropriate view of the images for the surgeons. Furthermore, it had to be operated by another person, therefore it was quite inconvenient for the surgeon because he could not view the images independently and the course of the operation had to be interrupted.

As for the mobile display stand, it was placed 1 meter from the surgeon. The images could be viewed without any problem by the surgeon in terms of distance. However, it also gave the same inconvenient problem as the abovementioned system. Furthermore, the size and height of the mobile display stand was not compact, therefore it used up space.

Discussion

Various imaging modalities available nowadays give potentially more and better information for any give patient. Furthermore, image guidance is now commonly used during many neurosurgical procedures. Multimodality imaging in neurosurgery has been correlated with improved outcome of various diseases. [1-6] Rapid advances in DICOM data and its application for the past couple of years have brought various possibilities in assisting surgeons during neurosurgical procedures. In this study we have demonstrated one way of using the DICOM data intraoperatively to assist the surgeon more conveniently.

Touch-display system is a sensible solution because referring to patient`s imaging during surgery is frequently desired to compare intraoperative findings with its radiological

correlates, and conventional displays often contain usability limitations, as they are located remotely to the operation field and commanding through the images requires removal of surgeon`s sterile gloves or external assistance (video). Other technologies for imaging visualization in the operation room range from conventional light boards to wall-mounted displays or mobile displays, even operation-microscope-integrated system. In the latter, the surgeon can refer to the imaging without moving the head away from the operating microscope, but this input sometimes interferes with the operative field and furthermore, the images neither can be managed by the surgeon independently.

Our newly developed system is compact, as it is possible to be mounted on the operation microscope without interfering the degree of freedom of microscope arm. Furthermore, in a space-limited operation room, other tools might also be employed during the procedures, therefore such non space-consuming imaging viewer will be preferred, whereas our previously used mobile system does not support this need (video).

Some commercially-available navigation systems or operation microscope-integrated imaging system can give real-time imaging information to surgeon, however, those systems might not be affordable in every neurosurgical centers. On the other hand, our touch-display system is easy to mount and is definitely affordable for every center. DICOM data obtained from the PACS system of the hospital could be transferred to the touch display system using commonly-used Apple laptop (Apple Inc., Cupertino, California). The software needed to transfer the data is also an open-source software, therefore it will not be a burden to the center. If the operation room is connected to a wireless internet connection, it will even enhance the benefit of using touch-display system, since more data of the patient could be easily transferred to the system via wireless connection.

Recently, the usage of tablet based computer system in health care setting is increased and gains popularity. News and web-based reports on its use have been noticed in other medical fields, however, there has been no scientific report on its use and carefully mounted system in neurosurgical field. Our study is the first to demonstrate the use of intraoperative neuroimaging visualization solution in skull base surgery. It allows quick

and intuitive assistance in understanding and interpretation of the pathological anatomy and surrounding structures.

Conclusion

We reported the first study to integrate a solution for intraoperative imaging visualization into the operative workflow, which can be used intuitively and has the potential to increase safety of neurosurgical procedures. We have developed a stable and reliable operation-microscope-mounted touch displays system and recommend it for more convenience in intraoperative imaging visualization. With the continuously evolving diversity of available applications for ultramobile touch sensor devices, the use of such system will not be limited to intraoperative imaging visualization in the future.

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Figure 1

(A-C) Preoperative MR images of case 1, showing enhanced mass in cerebello-pontine angle with the size of ….. (D) Postoperative MR image of case 1, showing complete resection of the tumor. (E-G) Preoperative MR images of case 2, showing enhanced mass in cerebello-pontine angle with the size of ….. (D) Postoperative MR image of case 2, showing complete resection of the tumor.

Figure 2

Touch-display system is mounted on the operation microscope, and is positioned just above the surgeon for easy access. Flexible arm is used on the touch-display system so that the surgeon could manipulate and/or change angle when necessary. The system is sterile-wrapped along with the operation microscope. Even with the existence of sterile wrap and gloves, touching and scrolling the images on the touch-display system was not affected.

Figure 3

Flowchart of workflow for touch-display set up.

Figure 4

Comparison with wall-mounted display and mobile display, (A) showing the wall-mounted display, and (B) showing the mobile display stand.

Video

Video showing the set up of touch-display system, usage during surgery, and comparison with other modalities.