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Patient's Self-monitoring of Transurethral Surgical Images Using a Head-mounted Display

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ABSTRACT

We present an application of head-mounted display (HMD) to patient's self-monitoring of transurethral resection of bladder tumor (TURB). Six patients wore the HMD as an imaging monitor to view the operation in real-time during their TURB. Following the operation, the patients completed a questionnaire that evaluates understanding of the state of their disease and satisfaction with the HMD. As a result, monitoring the operation in real time through the HMD helped to increase patients' understanding of the state of their disease and satisfaction. For selected patients, the use of HMD could help to increase the patient's understanding of their disease.

Introduction

Although recent medical advances have brought many benefits to patients, they have also created a gap between patients and medical providers. This is not in agreement with the basic concept of "patient-centered care", which is that medical providers should shift their focus away from the disease and to the patient.[1] Some researchers have also demonstrated that good communication between medical providers and patients contributed to patient satisfaction.[2]

Bladder cancer is the second most common genitourinary malignancy in the United States. Transurethral resection of bladder tumor (TURB) is the gold standard of care for this disease. Although TURB can be performed with the patient awake using lumbar anesthesia, the surgical procedure is not generally displayed in real-time to the patients. However, patients' real-time monitoring of their surgery could allow them to share their experience of the surgery with their surgeons.

Recently, modern head-mounted displays (HMDs) with high-resolution images have become commercially available at an affordable cost. We previously showed the clinical application of the latest HMDs for medical providers in minimally invasive surgeries, ultrasonic examinations, ureteral stent placement and transurethral procedures.[3,4] The significant utility of the HMD motivated us to use it as an imaging monitor for patients. Thus, we examined the feasibility of patients using an HMD during transurethral surgery and evaluated whether this technique could contribute to enhanced patient-centered care.

Case presentation

This study was carried out under the approval of our university's ethics committee. We enrolled six patients with bladder tumors who were interested in monitoring their surgical procedure in real-time. Five of the six enrolled patients were men and the mean age was 73 years (range, 60–81 years). The enrolled patients received a detailed explanation of TURB. Written informed consent was obtained from all patients before wearing an HMD during TURB.

Under lumbar anesthesia, patients were placed in the lithotomy position. Patients wore the commercially available modern HMD (HMZ-T2; Sony Corporation, Tokyo, Japan) during TURB. Cystoscopic images were displayed on the HMD (Fig. 1). The HMZ-T2 has a 0.7-inch organic electroluminescent screen for each eye, a resolution of 1280 × 720 pixels, and a weight of 330 g. The patients wore the HMD throughout the surgical procedure. Surgeons performed typical TURB using a two-dimensional rigid cystoscope and a vertical monitor (Karl Storz, Culver City, CA). The surgeons also partly used an HMD that was designed for medical use, the HMM-3000 MT (Sony Corporation, Tokyo, Japan), which had with a resolution of 1280 × 720 pixels and a weight of 490 g, to confirm the image that the patients were viewing (Fig. 2). The procedures were

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Figure 1. Photograph of a patient wearing the head-mounted display (HMD) during transurethral resection of bladder tumor (TURB). Cystoscopic images were displayed on the patient's HMD.

uneventful in all patients, with a mean operation time of 55 minutes (range, 28–95 minutes).

After the procedure, all patients completed a questionnaire regarding (1) their understanding of the state of their disease; (2) the image quality provided by the HMD; (3) the wearability of the HMD; (4,5) adverse effects caused by the HMD; and (6,7) satisfaction with using the HMD during the surgery. The results are shown in Table 1. In all patients, monitoring the operation through the HMD helped to increase their understanding of the state of their disease. Image quality and wearability of the HMD were "excellent" or "good". There were no major adverse events related to wearing the HMD. However, one of the six patients experienced mild eye fatigue related to viewing the images through the HMD. Four patients hoped to wear the HMD again if they had another TURB and would recommend the use of the HMD to family members undergoing TURB in the future.

Discussion

This is the first report of patients using the HMD to share their operation with their surgeons. The HMD could bring real-time surgical imaging to patients using a natural head position. This new image monitoring system could provide selected patients with a better understanding and greater satisfaction without major complications.

Figure 2. Photograph of the patient and the surgeon wearing the head-mounted display (HMD) during the surgery. Cystoscopic images were simultaneously displayed on both HMDs.

Table 1
Results of the questionnaire

Questions	Results
1. Improvement of understanding of the disease (yes/partially/no)	6/0/0
2. Image quality of the HMD (excellent/good/average/fair/poor)	5/1/0/0/0
3. Wearability of the HMD (excellent/good/average/fair/poor)	3/3/0/0/0
4. Adverse events related to wearing the HMD (none/mild/severe)	6/0/0
5. Adverse events related to watching images provided by the HMD (none/mild/severe)	5/1/0
6. Desire to use the HMD again (yes/neutral/no)	4/2/0
7. Desire to recommend the HMD to a family member (yes/neutral/no)	4/2/0

HMD: head-mounted display.

The HMD was first introduced for medical purposes at the beginning of 2000.[5] Earlier HMDs were not suitable for clinical practice because of their heavy weight and poor image quality. However, modern HMDs have become suitable for clinical application because of dramatic improvements in image quality and wearability. The HMZ-T2, which was used by patients in the current study, is one of the latest HMDs, and has a resolution that enables good image quality and a relatively light weight that can provide acceptable wearability. The current study proposed the usefulness of the HMD for patients to share the operation procedure in real-time. By monitoring HMD, patients can share the same high-resolution images with attending surgeons, better understand the state of the disease, and immediately understand the surgical effect. The experience of sharing the operation with surgeons would likely lead to enhanced patient satisfaction and patient-centered care. Surgeons can also wear the HMD to watch the same image that is monitored by patients.

To share operative information, a conventional monitor was placed around the patient. However, placing additional monitors for patients usually requires costly equipment and space. An operative HMD monitoring system for patients can be easily equipped in every operation room and in every institution because of the HMD monitoring system's small size and affordable cost.

Conclusion

According to the questionnaires, all patients were satisfied with using the HMD during the surgery, and both the HMD image quality and wearability were good. The patients' understanding of the disease without major complications increased using the HMD system. The use of HMD by patients could help to promote patient-centered care.

Consent

This study was carried out under the approval of our university's ethics committee.

The enrolled patients received a detailed explanation of TURB and written informed consent was obtained from all patients before wearing an HMD during TURB.

Conflict of interest statement

Dr. Kihara, a professor and chairman of Department of Urology, Tokyo Medical and Dental University Graduate School, has received

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