New low-cost magnifying device for temporal bone laboratory

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1. Introduction

Otolaryngology is a particular challenge for residents and young surgeons, requiring different skills, including working with microscope in a very complex and small operating field. Furthermore, the anatomical complexity of this area places the operator millimetres from potentially dangerous landmarks. The human cadaveric temporal bone is an ideal simulator for training in ear surgery, conferring experience both in anatomical knowledge and surgical technique. Usually, temporal bone is mounted securely in a bone holder in the same position as in actual surgery. It is dissected using a dedicated magnifying system, such as a surgical microscope or an endoscopic equipment, represents one of the most significant costs. The aim of this study is to test and demonstrate the utility of a commercial USB as a low-cost solution to equip the laboratory with a good magnifying system and illumination.

2. Methods

This device is a portable video magnifier with 200 times magnification ability and it can easily be operated by plugging directly into laptop, smartphone or tablet. It has a 1.3 megapixel complementary metal–oxide–semiconductor (CMOS) sensor with a resolution of 1280 × 720 pixels. The focus ranges from 10 mm to 500 mm while the magnification ratio is from 10x to 200x. This USB microscope camera has 8 LEDs, the focus and brightness can be manually changed to illuminate properly the dissection field. The device is compatible with Mac, Windows PC and Android Smartphone which OTG support. The interface is USB2.0/micro-USB. The manufacturer is Teslong from China (www.teslong.com). This product, known as ms100 USB microscope, is also available on www.amazon.com at the price of 38.99 USD.

The device is equipped with adjustable height stand useful to leave both hands free. Fourteen temporal bones could be subjected to microdissection by the same surgeon at the ICLO Teaching and
Research Center of Arezzo (Italy) using a high-speed otologic drill and, as magnifying system, either a surgical microscope or the digital USB microscope connected to a laptop (Fig. 1). The surgical procedures completed on each example were:

1) transcanahtympanotomy with stapedotomy (Fig. 2);
2) mastoidectomy (Fig. 3)
3) posteriortympanotomy (Fig. 3).

3. Results

In seven cases, the surgical microscope was employed while the remaining specimens the digital USB microscope was used (in four cases installed as a “microscope” on its adjustable height stand, in three cases held as an “endoscope” by the non-dominant hand of the surgeon). The digital USB microscope allowed the surgeons to complete surgical procedures in all cases with a good vision and without particular drawbacks. The use of standard surgical microscope had not significantly shorter operation times compared to the use of the digital USB microscope (Table 1).

4. Discussion

Temporal bone laboratory is relevant to the otologic surgeons and residents. Simulation is a mandatory component of surgical training (Mowry and Hansen, 2014; Meléndez García et al., 2014). However, setting up a temporal bone laboratory can be very expensive, especially because of the high costs of an operating microscope or endoscopic equipment (rigid endoscope, light source, camera, and monitor). We have highlighted that this digital USB microscope represent a low-cost solution to equip the laboratory with a good magnifying system and illumination. This device cannot give an operating/dissecting experience comparable to standard otologic microscope, mainly in terms of image quality and maneuverability. Anyway, this device is able to capture and save high-resolution images and videos of surgical procedures. We compared dissection times with USB microscope versus standard surgical microscope only observing that using USB microscope, temporal bone dissection can be carried out within reasonable time. There are many digital microscopes available online with low cost designed for multiusage purpose (ideal for children, students, collectors, testers, and anyone interested in exploring the microscopic world) and support Mac and Windows PC, Android smartphones and tablets. The device we adopted had a water resistant camera head, which makes it ideal for temporal bone laboratory (irrigation). It is fundamental for the surgeon to observe the operating field. A display monitor connected to a camera, facilitates step-by-step the surgical vision: the digital USB microscope allows to follow surgery in a laptop display and even to easily record good quality videos and capture pictures. The diameter of the probe of 8 mm (0.315 inch) has proved to be adequate not to create annoying obstruction for the introduction of the instrumentation (drill, suction tube, microinstrumets) in the mastoid cavity. However, the diameter of the probe was found to be cumbersome while working

|                      | Tympanotomy & Stapedotomy | Mastoidectomy | Posterior tympanotomy |
|----------------------|---------------------------|---------------|-----------------------|
| Surgical Microscope  | 10.2 ± 1.2 (minutes)      | 8.3 ± 1.0 (minutes) | 10.8 ± 1.2 (minutes)  |
| Digital USB Microscope | 11.0 ± 1.2 (minutes)      | 8.6 ± 1.1 (minutes) | 11.0 ± 1.0 (minutes)  |
| P value: 0.2361      | P value: 0.6031           | P value: 0.7406 |                       |
through the external auditory canal, but this disadvantage has been exceeded by keeping the device in front of the outer tissue fixed on the holder and increasing the magnification (Fig. 1). Anyhow, it is evident that a low-cost USB microscope has several limitations compared to a standard surgical microscope or to high definition endoscopic camera, which guarantees a higher quality view of the complex three-dimensional ear anatomy and reproduce the exact live surgery conditions. The advantage of an USB microscope is mainly the costs; besides it offers the possibility to use the device as a “microscope” (using the stand) or an “endoscope”, giving the unique possibility to practice both microscopic and endoscopic ear surgery skills with the same instrument. Fourteen temporal bones are not enough to obtain a significant statistical difference. However, the intent of our statistical analysis was not to demonstrate that USB microscope could replace the surgical microscope. Our objective was to point out that during temporal bone dissection USB microscope can be used to support standard microscope just to film the steps of dissection or to photograph anatomical details, without significant loss of time. The possibilities for this set up are very exciting, particularly in developing nations where funds are limited and access to dissection labs is scarce. This low cost alternative could be used in these areas to help train more temporal bone surgeons.

5. Conclusions

The magnifying system is relatively small, portable, and easy to clean and disinfect; it may be integrated without any drawbacks in a dissection and training temporal bone laboratory, offering the considerable advantage of lower costs.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.joto.2019.02.001.

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