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Research Article

Easy Grab - Removable Grip Adapters for Laparoscopy Forceps

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Abstract

3D printing is a promising and innovative technology for the production of medical devices and instruments compared to traditional manufacturing techniques. The objective of this work is to report the development of a 3D-printed removable adaptor for laparoscopic forceps, which allows to obtain the appropriate ergonometric for each user at a low cost. This is a novel concept design carried out at the Simulation Laboratory to enhance comfort to surgeons at their daily clinical practices.

Keywords: *3D printing, laparoscopy, laparoscopic surgery, ergonomics*

Introduction

3D printing has crossed practically all fields of science, and medicine is no exception, as the medical industry is expected to show different applications on this matter. This is mainly due to the growing demand for significant growth as 3D printing is being widely used in personalized and specific medical products for each patient and medical specialties. On the other hand, 3D printers are increasingly cheap due to the expiration of patents, which has substantially increased the accessibility to 3D printing [1].

3D printing allows us to make anatomical models for teaching, implants and tissue engineering, medical instruments and planning before surgery [2].

This is a promising and innovative technology for the production of medical devices and instruments compared to traditional manufacturing techniques. Oriented by patients' imaging, custom designs are created and so they are manufactured efficiently and accurately. It provides anatomical adjustment to patients and surgical safety to surgeons [3]. On the other hand, it allows us to manufacture on demand with relatively low costs, which gives it extreme relevance in our region.

Within the framework of this technological advance, we decided to apply this tool to innovate in the use of surgical instruments. In response to several surgeons complaints, we have detected the most important shortcomings among instruments used during surgery.

One of the biggest problems identified was the standardisation of measures in laparoscopy forceps, mainly used in laparoscopic surgery, lacking of data regarding to the topic when consulted in scientific database. The handle of these instruments generally tend to be adapted to medium to large hands, making it difficult to use in people with smaller hands.

This is especially relevant if we take into account that the current trend points to a greater number of female surgeons. According to the statistics given by the University of the Republic of Uruguay, from a total of 468 surgical residents admitted in the last 6 years, 278 (59.4%) correspond to women and 190 (40.6%) to men [4]. Laparoscopy forceps are the instruments for laparoscopic surgery, and these procedures could take long hours.

Therefore, it is vitally important to generate a comfortable grip that allows surgeons to be comfortable when performing procedures of both low or high complexity.

Objective of the Study

The objective of this work is to develop surgical supplies through 3D printing, adapted to the needs of surgeons with a good cost/benefit ratio.

Materials and Methods

Within the framework of the scholarship in research improvement, innovation and surgical simulation organized by the medical union of Maldonado and the Favaloro foundation, the development of grip adapters for laparoscopy forceps was encouraged, emphasizing the innovation of medical supplies for laparoscopic surgery.

Models of grip adapters for laparoscopy forceps were created. In order to do so, an Industrial Engineering team specialized in 3D printing was consulted for its design. They were provided with the measurements of a Maryland Forceps handle, used in our region and the component for its creation was selected based on the most appropriate characteristics for the surgical needs. Regarding to this last point, it was taken into consideration that the component used in the making of these adapters has to be not only flexible but also resistant to different types of sterilization and affordable.

This grip adapter was made of polyurethane thermoplastic filament (PUT), a resistant material that is characterized by its high flexibility providing a more comfortable grip for the surgeon's hand. Likewise, it has high durability, withstanding temperatures up to 80 degrees Celsius, being resistant to abrasion and chemicals, which gives it the ability to be sterilized in glutaraldehyde solutions.

Once the base of this model was planned, a new type of grip was designed, with the correct measures to a small-sized hand fit. A 25-year-old slim woman, 159 cm tall, IMC of 22, was taken as a model. To do this, the measures corresponding to the grip handle were taken considering its internal diameters (See figure 1), and the diameters of the first, fourth and fifth finger of the model, which are those used in the correct grip of the handle.

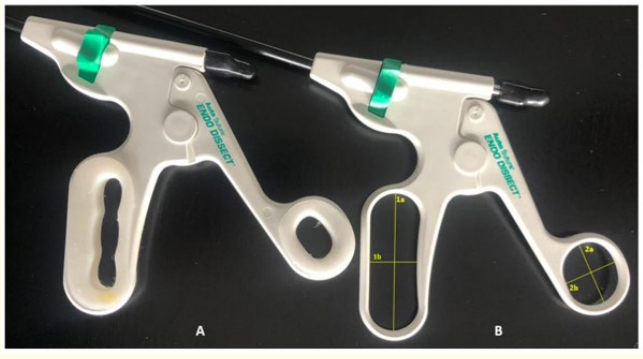

Figure 1: *A: Handle with adapters on. B: Handle without adapters, the largest longitudinal and transverse diameters are identified.*

Results

Two removable adapters were created for two different models of Maryland Forceps handles in PUT material.

The design was made in approximately 72 hours, and the printing time took approximately 24 hours.

The models are shown in figure 2.

Figure 2: *Removable grip adapters for handles in TPU material.*

Discussion

In the early stages, the grip adapters were evaluated by both research team participants and surgeons. In both groups, great satisfaction was expressed with the results.

As shown in figure 3 and 4, after testing the printed models based on the measurements of the hand that was used as a model, we can see the substantial difference in the grip of the handle. This is fundamental in the ergonomics of the surgeon when carrying out a surgical procedure, which shows how useful our grip adapter is. Based on the ergonomic provided by this grip adapter, we propose that it can make a big difference for a surgeon's comfort while performing surgery, improving surgical technique, even reducing operating time.

Figure 3: *Forceps handle and hand model for grip adapters design. Image without grip adapters on.*

Figure 4: *Forceps handle and hand model for grip adapters design. Image with grip adapters on.*

Conclusion

There are no similar models to the one shown. In scientific databases consulted, no research regarding to this problem was found.

We encourage to continue with this line of research, assessing thoroughly the needs of the surgeons from our region, as it can be evaluating other surgical instruments. Likewise, the team is working on a validation protocol that supports the use of these grip adapters by professionals in healthcare centers in our region. We emphasize that one of the main long- term objectives is to be able to generate personalized, low-cost models that enable an appropriate ergonomics adapted to the hands of each surgeon.

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