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Article

Surgical Sharp Hazard Shelter

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Abstract: Surgical sharp hazard is highly prevalent and needs more attention to prevent it. We developed shelter tools to prevent surgical sharp hazards. In the developing process, clinical feedback was given to improve its clinical application and availability. The developed surgical sharp hazards can be used in the surgical room as safety tools.

Keywords: Sharp hazard, Medical safety

1. Introduction

In medical practice, staff safety for sharp hazards is a high-priority issue. Most of the attention is focused on accidents related to intravenous needles. Therefore, a lot of designs have been proposed to prevent injuries, including needle collection boxes, safety needles, and syringes. However, there are other sharp surgical tools in the operating room without proper design to protect medical staff. Suture needles and orthopedic wires are frequently used during daily practice and contribute to more severe penetrating injuries compared with syringe needles. However, there is no commercial or standard protector for such surgical sharp tools. Therefore, We developed the concept of a surgical sharp hazard shelter to prevent or decrease the incidence related to surgical sharp tools.

2. Materials and Methods

We observed routine procedures of surgeries in which suture needles and orthopedic wires were used. Suture needles are grasped by needle holders placed horizontally on the surgical table. In the horizontal placement of the needle holder, the suture needle may be directed downward to penetrate the surgical sterile drape of the table or upward to cause accidents. Orthopedic wires are frequently used in fixation surgical procedures and placed in horizontal alignment. Drape roll padding beneath wires is used to pick up wires of small diameter and also cause accidents. A safe place for the containment of sharp surgical tools was designed as a round shell and puzzle-like linings. The former was designed to decrease the occupying volume in the surgical table, the latter contains sharp tools to prevent accidents from slipping out. The prototype of the shelter was designed by the computer software "Sketchup (ver 2017, Trimble Inc.)" (Figs. 1–5). After several versions of modification, a provisional 3D model was printed by a Polylactic acid (PLA) Fused Deposition Modeling (FDP) machine (Figs. 6 and 7). Clinical trials and testing were performed and small modifications were applied to the 3D model as per the user's suggestions (Figs. 7 and 8). The final 3D model was printed by a metal powder bed fusion machine (AMP-250, Tongtai Machine & Tool Co, Ltd., Taiwan) as shown in Fig. 9.

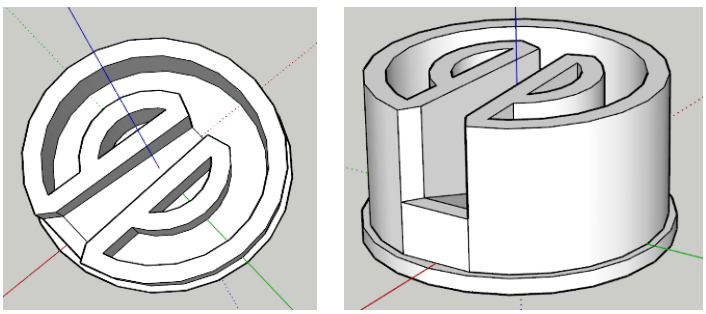

Fig. 1. The first version of model with a simple circle with central slot in one piece without a detachable cap.

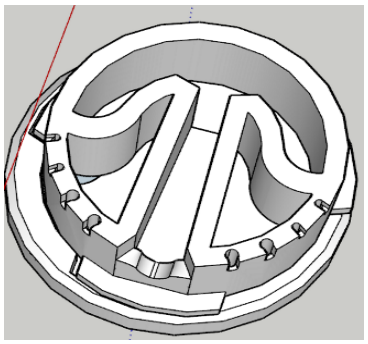

Fig. 2. The second version of model with an anterior curve area for disposable needles, bilateral wing-like area for transient needles and pins storage, posterior holes for transient needles insertions.

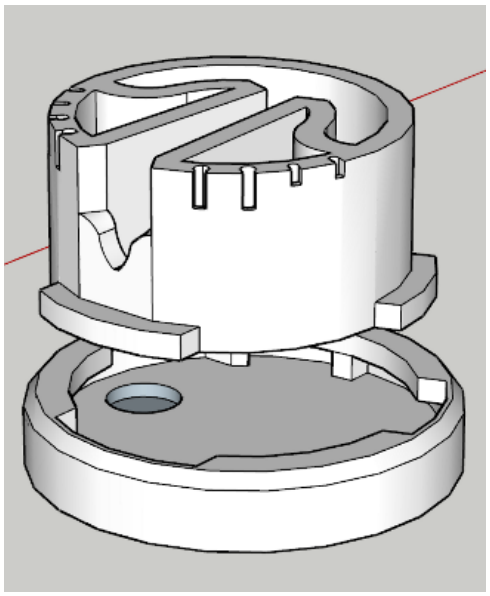

Fig. 3. Detachable cap with small depression for magnetic disc.

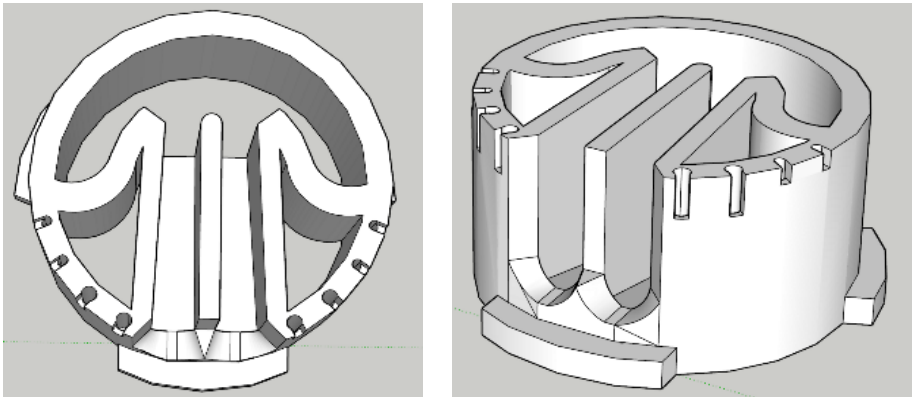

Fig. 4. Two-needle holder.

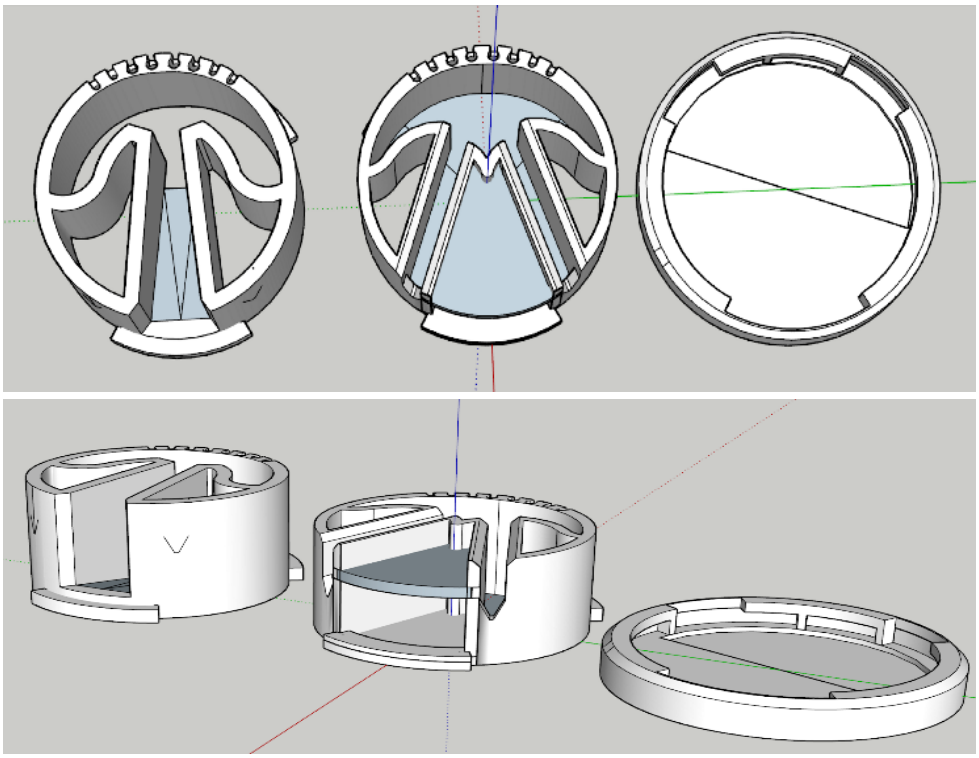

Fig. 5. The final version of the model: needle insertion hole of rim moves to anterior portion and a detachable cap with a magnetic plate on half of the area.

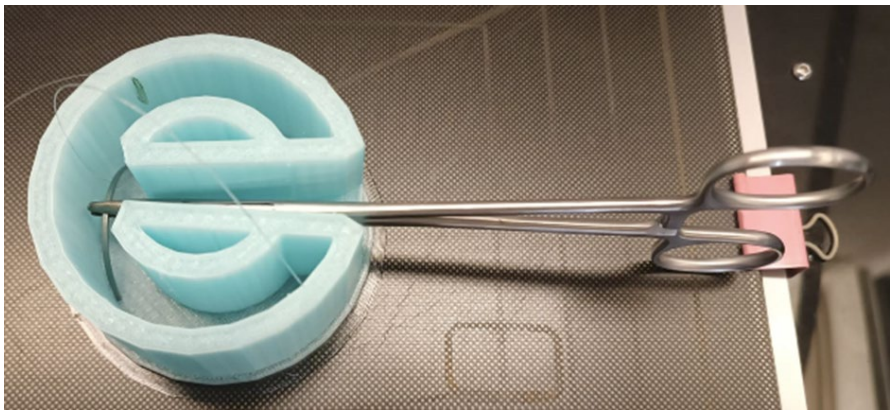

Fig. 6. Fist version of the model with needle holder placement and the clipped needle point downward.

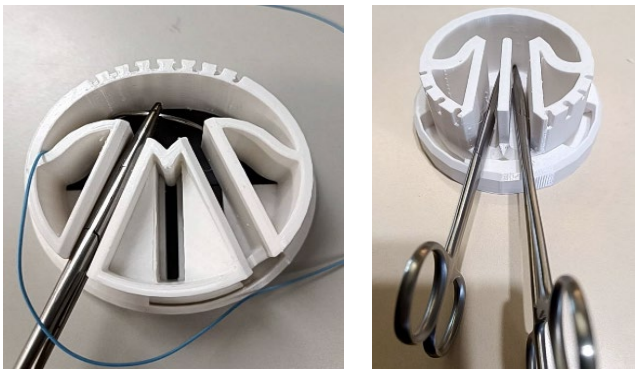

Fig. 7. The second version with double instrument placement.

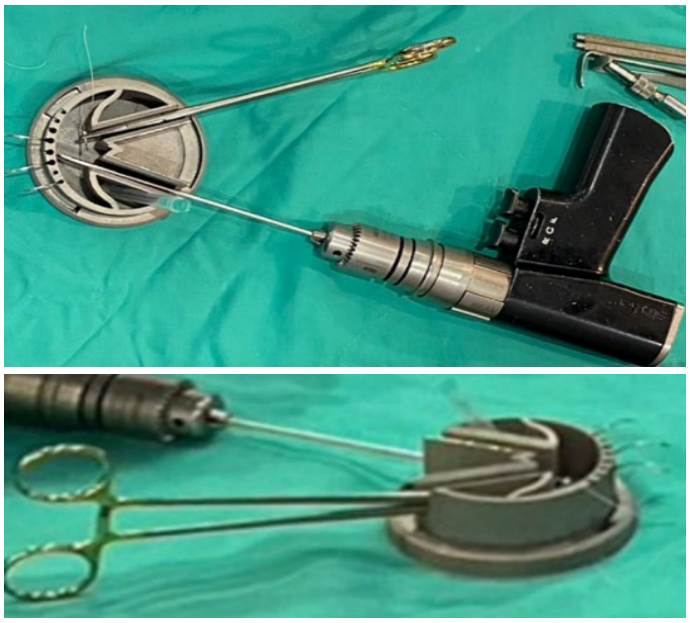

Fig. 8. Surgical tools placed in the developed sharp hazard shelter of final metallic version.

Fig. 9. Metal powder bed fusion machine (AMP-250) by Tongtai Machine & Tool Co, Ltd.

3. Results

The finalized model had a short cylindrical shape with a diameter of 70 mm and a height of 35 mm. The center slot width was about 12 mm. Anterior curved slot was the area for the needle or other sharp tool container. The bilateral wing area could be filled with sponges for a needle or wire trap. The base of the center slot was designed for a needle holder grasped suture needle or power tool attached orthopedic wire. A narrow slot allowed the needle holder to be upright and prevent it from flipping. The base plate was also used as a cap to collect used needles or worn wires by a magnet. The base cap accommodated over 20 suture needles, which were usually used in ordinary surgery. After the surgery, sharp tools were counted by unscrewing the base cap and all used needles and wires were disposed of. We used the plastic prototype of the developed sharp hazard shelter and approved its clinical practicality. The design was refined by gathering information from such practical uses. The final model of the shelter was made of metal for their application.

4. Discussion

Working safety in the operating room is crucial and highly prioritized. In the operating room, absolute sterility is required and hazardous surgical tools are used. Safety issues are managed with strict discipline and complicated procedures. Surgical devices are

designed for efficient usage and sophisticated purposes. Safety devices are rarely invented for clinical application. However, events related to surgical hazards were reported by 19 to 38%[1] of medical staff. Such high incidence reveals the importance of shelter devices for surgical hazards. With such a high experience rate, few medical staff follow strict policy (9%)[2]. Easiness in using safety devices may increase adherence to the policy. The developed sharp hazard shelter has excellent clinical availability and easiness of use and can be used in surgical fields for safer operations.

5. Conclusions

Safety in the medical working environment is critical not only for patients but medical staff. As an innovative device, the developed sharp hazard shelter can be used widely in operating rooms and needs further modifications for the safety of medical staff.

Author Contributions: conceptualization, S.-H. Lin, Y.-C. Lee, M.-H. Peng, H.-W. Tsai and M.-L. Hsieh; methodology, 3D model creation, PLA model print and finishing, S.-H. Lin; writing—original draft preparation, S.-H. Lin; writing—review and editing, S.-H. Lin; clinical test and modification feedback, Y.-C. Lee, M.-H. Peng, H.-W. Tsai and M.-L. Hsieh. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest: The authors declare no conflict of interest.

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