ABSTRACT

Many otologic surgeries, including cochlear implantation and mastoidectomy, require a post-auricular incision for exposure. The auricle must be retracted forward in order to enable an unobstructed view of the surgical field and improve procedural outcomes. Typical methods of securing the ear include tape, a small stitch, or an assistant’s finger, depending on surgeon preference. In this paper, we propose a novel design for a tool that retracts the auricle safely, effectively, and consistently with the appropriate tension for closure of a post-auricular incision. The tool attaches to the helix with a compression fit, and then anchors between the triangular fossa and the helical crus. The tool’s efficacy is demonstrated through a test fit and comparison to standard methods. This anchoring tool enables the surgeon to retract the pinna easily and effectively.

Keywords: Otologic surgery, post-auricular incision, mastoidectomy, tympanoplasty

1. INTRODUCTION

Many otologic surgeries require a post-auricular incision for access to the middle ear and mastoid. Mastoidectomies, a procedure requiring a post-auricular incision, are performed an estimated 30,000 to 60,000 times per year in the US [1]. Cochlear implantations, another procedure requiring a post-auricular incision, are performed over 120,000 times per year globally [2]. Other surgeries that may require a post-auricular incision include chronic middle ear disease, cholesteatoma, and tympanic membrane perforations. Post-auricular incisions are also used in facial plastic surgery procedures, including cosmetic face lift.

The location of the post-auricular incision enables ready access to the mastoid portion of the temporal bone and can additionally be used to improve visualization of the middle ear during otologic surgery, or for harvesting fascia or cartilage grafts for reconstructive procedures. From a cosmetic standpoint, these incisions are generally well-camouflaged in the post-auricular sulcus and the tension-free closure provides excellent wound healing with minimal scar [3].

While the value of the post-auricular incision has been well-established, there remain some challenges in implementation. In order to benefit from the incision, the auricle must be retracted away from the surgical field to provide an unobstructed view. The retraction method varies depending on the clinical scenario as well as surgeon training and preference.

During the surgical procedure, the incision is typically held open using various sizes and configurations of the Weitlaner retractor. These have the advantage of retracting the soft tissue at the surgical site while also holding the pinna forward, out of the surgeon’s view. Other retraction methods have been developed to be more situationally adept during procedures such as cochlear implantation [4]. However, since these retractors are based within the incision; they must be removed prior to closure.

During closure of the post-auricular incision, the pinna must be held forward in order to enable access to the incision for suturing. The ideal amount of retraction causes the wound edges to approximate with minimal tension, while creating an unobstructed view of the length of the incision. Several imperfect methods are currently used to accomplish this task.

The first method, shown in Fig. 1 (left), is retraction with a hand or finger. This requires an assistant or scrub tech to hold the ear while the surgeon sutures. This prevents the assistant from performing additional tasks and presents an increased risk of needle-stick injury to the surgeon or the assistant holding the ear. An alternative method is to place a stitch from the tragus to the helix, cinching the ear down on itself (Figure 1, middle). This creates an additional puncture wound, leading to the possibility of bruising, pain, and scarring, and may provide insufficient...
retraction, depending on the size of the ear. Surgical tape can also be used (Figure 1, right), but frequently becomes ineffective when wet, due to irrigation or blood.

FIGURE 1: (Left) Retraction with hand or finger. (Middle) Retraction with stitch. (Right) Retraction with tape.

Due to the challenges encountered with current retraction methods, we have developed a tool that secures the pinna in an effective and consistent manner. One end of the device uses a compression fit to secure the helix, while the other end anchors the tool between the triangular fossa and the helical crus (relevant anatomy shown in Figure 2).

FIGURE 2: Pinna and relevant anatomy from (Right) lateral view and (Left) posterior view.

The proposed tool clears the surgical field of the auricle, poses essentially no risk to the patient or the surgeon, and will fit the average patient’s external ear.

2. MATERIALS AND METHODS

There were several design objectives for our ear retraction tool. First, the tool must independently stabilize the auricle in a position suitable for suturing while posing no additional risk to the surgical team or patient. Second, the tool should fit a standard sized ear. Furthermore, the tool should produce a surgical field comparable to the methods currently in practice.

Our tool design is shown in Figure 3. The omega-shaped portion attaches to the helix by a compression fit. The crescent-shaped portion fits between the triangular fossa and the helical crus providing enough traction to secure the auricle anteriorly. The chosen geometries enable a generalized tool that conforms to ear anatomy. Further, the force provided by the crescent-shaped “anchor” is suitable for keeping the auricle out of the view of the surgical field. Tool geometry was based on a generalized ear model [5]. Additionally, the prototype described in the results section’s size parameters were chosen to fit it to a particular ear using an iterative rapid prototyping and test fitting process.

The tool is printed using a FormLabs 3D printer (Model Form 2: Formlabs Inc.; Somerville, MA) and is made of Grey Pro resin. The current resin is not biocompatible, however, the Formlabs printer can produce tools with resins that are [6]. Fig. 3 shows the tool from two different view angles. Note that during a surgery, once the procedure is complete, the device is easily removed and discarded.

FIGURE 3: Anchoring tool (Left) side view. (Right) front view.

3. RESULTS AND DISCUSSION

The tool was test fit to ensure the auricle is pulled clear of the surgical field in a manner comparable to standard methods. As shown in Fig. 4, the tool provides surgical access to the post-auricular sulcus, comparable to current methods as previously described and demonstrated in Fig. 1. Due to the nature of the device, the optimal size parameters may vary across individual users. Anatomical differences found in the helix, triangular fossa, and helical crus might affect the device’s wearability. Future work will be needed to determine how many standard sizes will cover a large percentage of natural anatomical variation among patients.

FIGURE 4: Tool on ear and resulting unobstructed surgical field

4. CONCLUSION

In this paper, we present a novel device used to stabilize and retract the auricle during closure of a post-auricular incision. We demonstrate that it provides retraction reliably and effectively. Retraction is qualitatively equivalent to existing methods, which are cumbersome and unreliable. Since it is made of plastic and
has no moving parts, it is likely that a future clinical version of the tool can be made at little cost through 3D printing or injection molding. Additionally, the tool can be made in multiple sizes, or custom manufactured for each patient. Future work will include manufacturing the tool with biocompatible resin to test with human subjects. This tool provides a low-cost and reliable method to retract the auricle during closure of a post-auricular incision.

REFERENCES


