



Technical Notes

The crux of helix curvature: A potential surface landmark for the anterior border of the sigmoid sinus in minimally invasive presigmoid approaches

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ABSTRACT

Background: Surgical landmarks are widely used across all surgical specialties to assist surgeons in accurately estimating the deep anatomical structures. We describe the crux of helix curvature as a potential indicator for the anterior border of the sigmoid sinus (SS) in the setting of minimally invasive presigmoid approaches.

Methods: Anatomy investigations were performed on injected cadaveric heads to identify consistent surface surgical landmarks estimating the crux of the SS.

Results: Presigmoid mastoid was noted in the center of the skin incision in 100% of the specimens. The crux of helix curvature was superimposed on the anterior border of the SS on 6 sides (60%). On the other four sides, the curvature lays within 5 mm of the anterior SS border (40%).

Conclusion: For the minimally invasive presigmoid approaches, the “crux of helix curvature” can be used as a landmark for the anterior border of the SS, which can aid in the speed and safety of the procedure. The ease of use of this landmark makes it particularly convenient for physicians early in training.

Keywords: Crux helix, Ear anatomy, Presigmoid approach, Sigmoid sinus, Surgical landmarks

INTRODUCTION

The existence of landmarks can be dated back to the origin of surgical specialties. These landmarks have evolved to include surface, bony, and intraoperative markers that improve patient safety and outcome during surgical procedures. These surgical landmarks should estimate deep anatomical structures accurately considering interindividual anatomic variability.^[1] Herein, we describe the crux of helix curvature as a potential indicator for the anterior border of the sigmoid sinus (SS) in the setting of minimally invasive presigmoid approaches.

MATERIALS AND METHODS

This is a human cadaveric study performed at the Goodyear Lab-University of Cincinnati. Five injected cadaveric heads on both sides (a total of 10 slides) were used. The aim is to assess the crux

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of helix curvature as a consistent surface surgical landmark estimating the course of the anterior border of SS. The target anatomical structure was reached using minimally invasive presigmoid approaches.

RESULTS

The presigmoid mastoidectomy was observed in the exact center of the skin incision in 100% of the sample. The crus of helix curvature was superimposed on the anterior border of the SS on 6 sides (60%). On the other four sides, the curvature lays within 5 mm of the anterior SS border (40%).

DISCUSSION

Minimally invasive presigmoid approach

The posterolateral skull base approaches around the SS are routinely used for middle and posterior fossa pathologies. There is a profound disparity between the pre- and retro-sigmoid approaches regarding the available superficial anatomical landmarks. The localization of the posterior aspect of the SS and the transverse-sigmoid junction is extensively studied compared to the paucity of signs focusing on the presigmoid territory.^[3,5] In addition, the constant refinement of the presigmoid approaches to achieve minimal invasiveness renders the new modified minimally invasive approaches to have shorter incisions and focused skin incisions. This will shrink the exposed bony surface and lessen the accessible surface or skeletal anatomical indicators. The need for new superficial landmarks to trace the anterior boundary of the SS may be helpful for lateral skull base approaches. For recently described retro- or infra-labyrinthine presigmoid approaches, a straight or slightly curved skin incision can be used instead of the conventional sizeable periauricular flap. The typical bony landmarks for surgical planning, such as asterion, mastoid emissary foramen, and the digastric notch, will be inaccessible, and the surgeon depends more on the use of navigation. Although navigation is used routinely for complex skull base approaches, the navigation errors cannot be underestimated, and these anatomical landmarks can be used in such situations.^[6]

The crus of the helix as a landmark

Based on our cadaveric investigations, we find a potential correlation between one of the internal folds of the pinna, namely, the crus of the helix and the anterior border of SS. For hearing-preserving presigmoid approaches, the “crus of helix curvature” can be used as a surface landmark to design the location of skin incision and then as an imaginary line on the mastoid bone to delineate the posterior boundary of the presigmoid approach [Figure 1].

The crus of the helix is a fold of cartilage in the pinna located above the external auditory canal (EAC). The crus (the Latin

for “foot”) represents the inferomedial end of the helix and correlates to the concha below and the tragus in front.^[4] The crus of the helix is well known in the acupuncture and alternative medicine community for the “Daith piercing,” where they use the crus as a traditional target to treat migraine.^[2]

The “crus of helix curvature” characterizes a simple and easy-to-use landmark, and its proximity to the intended incision may prove a helpful surface landmark of the SS. In addition, the “crus of helix curvature” may aid in planning the center of the bony mastoid opening in both vertical and horizontal directions.

The surgical landmarks that utilize the local bony anatomy within the surgical exposure are likely to be more accurate compared to skin surface landmarks.^[7] However, we think that, in the setting of presigmoid approaches, this superficial landmark has a potential value for two possible applications in operative steps. First, the curvature of the crus can give the surgeon an instant rough estimate about where the bony corridor is likely to be, aiding in choosing the location and length of the skin incision. Second, this landmark can also be applied after exposure of the mastoid to address the boundaries of the intended bony opening. The boundaries comprise the EAC anteriorly, the MacEwen’s triangle superiorly, and the anterior border of the SS posteriorly. This will avoid a large skin flap to expose bone structures to identify the site of the SS, namely, the asterion and digastric notch. Thus, this surface landmark can fit nicely in the operative step without affecting the operative fluency, which may shorten the operative time by minimizing the length of the skin incision and the bony exposure. Finally, the crus of helix curvature may serve as an adjunct to neuronavigation, which is currently regarded as a surgeon mate during complex skull base approaches.^[6]

We applied the “crus of helix curvature” landmark for a limited infratentorial presigmoid approach on five formalin-fixed, injected adult cadaveric heads on both sides, for a total of 10 sides. A straight incision over the retroauricular sulcus and along the anterior edge of the mastoid process was made. The incision is centered in the vertical plane on the posterior extension of the crus of the helix. Presigmoid mastoid was noted in the center of the skin incision in 100% of the specimens. The crus of helix curvature was superimposed on the anterior border of the SS on 6 sides (60%). On the other four sides, the curvature lays within 5 mm of the anterior SS border (40%). This was consistent with the simplicity and the applicability of this landmark for such approaches.

Limitations

The principal limitation of this surface landmark is related to its accuracy, which needs to be verified in the future studies. However, we believe that this is an easily applicable landmark with significant value during complex skull base procedures. In

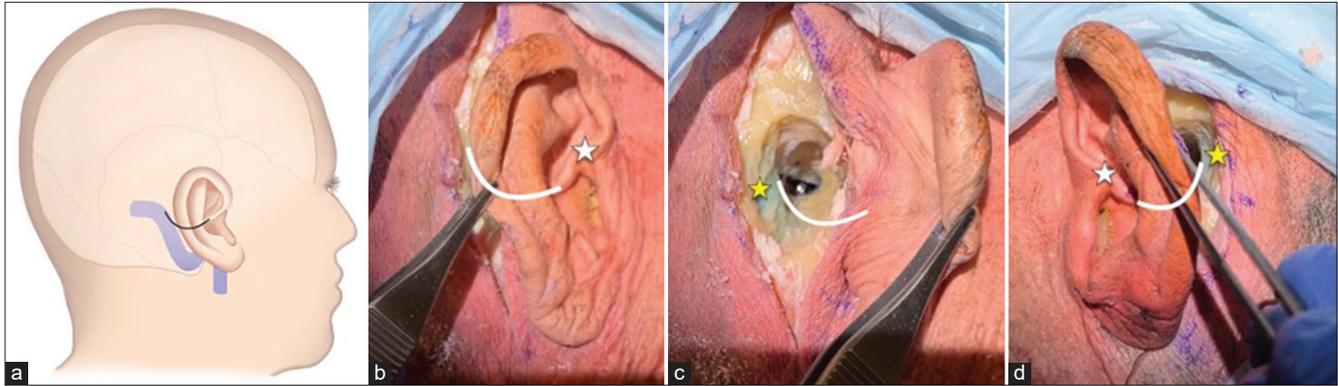


Figure 1: The “Crus of Helix curvature” landmark for identification of the anterior border of the sigmoid sinus during a minimally invasive presigmoid approach. (a) Artistic depiction of the relevant anatomy. (b) description of the landmark in the pinna for the right-side approach on a cadaver. (c) Description of the landmark for the right-side presigmoid approach on the same cadaver as in (b). (d) The landmark applied to the right-side approach on another cadaver model. An imaginary line that follows the curvature of the crus posteriorly can trace the potential position of the anterior margin of the SS. The White Asterix denotes the crus, and the yellow Asterix denotes the sigmoid sinus, in (b), (c), and (d).

addition, the variability of this landmark in terms of age, gender, or racial characteristics can be validated in the future studies.^[5]

CONCLUSION

For the minimally invasive (focused) presigmoid approaches, the “crus of helix curvature” can be used as a landmark for the anterior border of the SS, which can aid in the speed and safety of the procedure. The ease of use of this landmark makes it convenient for physicians early in training.

However, this sign should not be overrated. Further studies are needed to validate these findings in a larger cohort to increase the safety of complex lateral or posterior skull base approaches.

Declaration of patient consent

Patients’ consent not required as patients’ identities were not disclosed or compromised.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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