Surgical importance of the posterior auricular ligament when harvesting ear cartilage in rhinoplasty

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Introduction

Rhinoplasty in Asian patients has been greatly advanced overall and in terms of specific associated techniques over the past few decades [1]. In most Asian patients, autologous graft materials are necessary to augment or change the shape of the nose [2,3]. Among autologous graft materials, ear cartilage is most frequently used due to its efficiency and safety. However, instability of the auricular framework may arise as a form of donor site morbidity after the harvest of ear cartilage. This instability makes it difficult for patients to wear face masks or insert earphones [4,5]. Of the parts of the ear cartilage, the cymba, cavum, and tragus are generally used, and these are perceived to be the main components that account for auricular stability. The harvest of additional ear cartilage is sometimes unavoidable, even in patients with histories of multiple ear

Background

Ear cartilage is a preferred graft material in rhinoplasty. However, after harvest, instability of the auricular framework may arise as a form of donor site morbidity. In the harvest of ear cartilage, the posterior auricular ligament (PAL) is usually sacrificed in order to obtain as much cartilage as possible. Since damage to the PAL may cause auricular instability, we studied the periauricular anatomy using cadavers and evaluated auricular stability during surgery.

Methods

Six ears from hemifacial cadavers were studied to clarify the exact anatomy of the PAL. Then, the recoil force of the auricle was serially measured to evaluate the stability of the auricular framework in 30 patients during surgery: before making the skin incision (M1), before and after cutting the PAL (M2, M3), and after harvesting the cymba concha (M4). The differences in force observed after cutting the PAL (ΔM2-M3) and after harvesting the cymba concha (ΔM3-M4) were statistically analyzed.

Results

In the cadaveric study, the PAL was identified between the superficial and deep mastoid fasciae and connected the caudal aspect of the cymba concha to the deep mastoid fascia. During surgery, the PAL accounted for 16.20% of the total auricular recoil force. The recoil force decreased by 13.61 N and 11.25 N after cutting the PAL and harvesting the cymba concha, respectively. These decreases were statistically significant (P<0.05).

Conclusions

The results suggest that the PAL is a supporting structure of the auricle. Therefore, to preserve auricular stability, minimizing damage to the PAL while harvesting the ear cartilage may be helpful.

Keywords

Cadaver / Instability / Ear cartilage / Ligament / Rhinoplasty

Reference

This work was supported by the research fund of Chungnam National University. The Basic Science Research Program supported this research through the National Research Foundation of Korea (NRF), funded by the Ministry of Science, ICT, & Future Planning (NRF-2018R1A2B6007425).

Received: Aug 29, 2020 Revised: Oct 7, 2020 Accepted: Nov 10, 2020

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procedures. Therefore, we should consider factors involved in the preservation of auricular stability apart from ear cartilage. While harvesting the ear cartilage, the posterior auricular ligament (PAL), which is attached to the cymba concha, is usually sacrificed in order to obtain as much ear cartilage as possible. We suggest that in addition to the absence of the ear cartilage itself, damage to the PAL may contribute to auricular instability. This study consisted of a cadaveric study designed to evaluate the periauricular anatomy and a clinical study intended to measure auricular stability during surgery. Through this study, we evaluated the contribution of the PAL to auricular stability and assessed its precise location in cadavers.

**METHODS**

**Cadaveric study**
Between October 2019 and July 2020, six ears from three cadavers (two males and one female, aged 59 to 72 years) were dissected to clarify the exact location of the PAL. All cadavers were fresh and had not been embalmed. Dissection was initiated at the postauricular area using a rectangular incision and was continued layer by layer (Fig. 1A). After the postauricular area was exposed, the anatomical structures around the PAL were studied.

**Clinical study**
Between March 2020 and April 2020, 30 patients (three males, 27 females; mean age, 29.03 years) were included to measure auricular stability during the harvest of the ear cartilage. All patients had no prior trauma or surgical history of the ears. The patients included in this study underwent harvest of the cymba concha only. Informed consent was obtained prior to surgery. Since no standard method was available to evaluate the stability of the auricular framework, we designed a method to instrumentally measure the recoil force of the auricle. To help obtain an objective result, the postaurale was chosen as a measurement point (Fig. 2) [6,7]. In detail, the postaurale

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**Fig. 1.** Anatomical dissection of the postauricular area. (A) Skin incision with a rectangular design on the postauricular area. (B) The superficial mastoid fascia was elevated and tagged. A thick and fibrous fascial layer is visible in the cadaver. (C) The posterior auricular ligament is firmly attached between the deep mastoid fascia (arrow) and the posterior aspect of the ear cartilage (arrowhead).

**Fig. 2.** Anatomical landmarks of the auricle. Longitudinal axis of the ear connecting the two most remote points of the auricle (line sa to sb). sa, supraaurale, the most superior portion of the auricle; sb, subaurale, the most inferior portion of the auricle; pa, postaurale, the most posterior portion perpendicular to the longitudinal axis.
rare was tagged with 3-0 nylon sutures that were used to pull the auricle using a tension gauge (Harim Instruments, Seoul, Korea) (Fig. 3). The auricle was folded anteriorly with the tension gauge and was released gradually in the supine position. The recoil force of the auricle was measured when the folded auricle started to

move. The measurements were serially performed during the harvest of the ear cartilage, which was carried out using a posterior surgical approach. An initial measurement (M1) was made to assess the total recoil force of the auricle, and a skin incision was then made on a slightly lateral portion of the postauricular sulcus. Dissection was continued over the perichondrium of the ear cartilage, and the posterior auricular muscle and the PAL were identified. After the posterior auricular muscle was detached, a second measurement (M2) was performed. After cutting the PAL and harvesting the cymba concha, third (M3) and fourth (M4) measurements were performed sequentially.

The force differences ($\Delta M1$–$M2$, $\Delta M2$–$M3$, and $\Delta M3$–$M4$) were then evaluated based on the average values for each group (M1–M4).

**Statistical analysis**

Prior to the analysis, the cases with the highest and the lowest values for the initial measurement (M1) were excluded to reduce sampling error. The force differences between measurements were statistically analyzed using the Friedman and Wilcoxon signed-rank tests with SPSS for Windows version 27 (IBM Corp., Armonk, NY, USA).

**RESULTS**

**Cadaveric study**

Beneath the skin, the superficial mastoid fascia, which was thick and fibrous, was observed (Fig. 1B). The PAL was identified be-
### Table 1. Measured values of the recoil force

| Measurements | Range (N) | Mean ± SD (N) |
|--------------|-----------|---------------|
| M1           | 60–100    | 84.00 ± 10.17 |
| M2           | 30–72     | 53.43 ± 9.17  |
| M3           | 20–54     | 39.82 ± 7.34  |
| M4           | 16–48     | 28.57 ± 6.51  |

M1, preoperative initial measurement; M2, second measurement, taken after detaching the posterior auricular muscle; M3, third measurement, taken after cutting the posterior auricular ligament; M4, fourth measurement, taken after harvesting the cymba concha.

### Table 2. Wilcoxon signed-rank test

| Force difference | Z     | P-value \(^{(a)}\) |
|------------------|-------|---------------------|
| \(\Delta M1–M2\) | -4.635\(^{(b)}\) | 0.000\(^{(a)}\) |
| \(\Delta M2–M3\) | -4.632\(^{(b)}\) | 0.000\(^{(a)}\) |
| \(\Delta M3–M4\) | -4.638\(^{(b)}\) | 0.000\(^{(a)}\) |

M1, preoperative initial measurement; M2, second measurement, taken after detaching the posterior auricular muscle; M3, third measurement, taken after cutting the posterior auricular ligament; M4, fourth measurement, taken after harvesting the cymba concha; \(\Delta\), force difference.

\(^{(a)}\)Asymptotic two-sided significance; \(^{(b)}\)Based on positive ranks; \(^{(c)}\)Statistically significant, \(P < 0.05\).

### DISCUSSION

The fascial layers of the mastoid region have been investigated in several studies; however, the surgical anatomy remains unclear due to the anatomical complexity involved [8-10]. The postauricular area is divided into upper and lower portions by the superior temporal line. The upper portion is composed of three fascial layers: the superficial temporal fascia, the innominate fascia, and the deep temporal fascia. In contrast, the lower portion includes two fascial layers: the superficial mastoid fascia and the deep mastoid fascia. The superficial mastoid fascia corresponds to the superficial temporal fascia, and the deep mastoid fascia (which contains the origin of the posterior auricular muscle) corresponds to the innominate fascia in the temporal area. The main branch of the posterior auricular artery lies between the deep and superficial mastoid fasciae (Fig. 5) [8-12]. The PAL arises from the deep mastoid fascia and is attached to the eminence of the cymba concha, passing through the deep and superficial mastoid fasciae [9,13,14]. In this study, the superficial mastoid fascia was thick, and the PAL was located between the superficial and deep mastoid fasciae, as described in previous studies [8,9].

The ear cartilage is considered to be the main factor involved in the maintenance of the auricular framework. The cymba concha is
one of the most preferred autologous ear cartilages in rhinoplasty [5,15,16]. Even in patients with a history of multiple ear procedures, additional ear cartilage may be needed. The lack of ear cartilage can cause ear deformities or present practical difficulties, such as when wearing a face mask or inserting earphones. Therefore, we should consider factors other than ear cartilage that may be involved in the preservation of auricular stability. Since the PAL is attached to the caudal side of the cymba concha and is usually sacrificed to increase the quantity of ear cartilage obtained, we hypothesized that it may be helpful to preserve the PAL to maintain the auricular framework. In this study, the recoil force of the auricle significantly decreased after cutting the PAL, and the PAL accounted for 16.20% of the stability of the auricular framework. The mean decrease in the recoil force was 13.61 N after cutting the PAL (ΔM2–M3), which was similar to the decrease observed after harvesting the cymba concha (ΔM3–M4, 11.25 N). This finding indicates that the PAL is one of the supporting structures that maintains the physiological stability of the auricular framework. We did not evaluate the results of ΔM1–M2, even though this value was statistically significant. We believe that ΔM1–M2 is not influenced by a single factor, but rather by multiple factors including the skin, subcutaneous tissue, superficial mastoid fascia, and posterior auricular muscle.

This study had some limitations. First, the number of the cases was insufficient to fully clarify the anatomical complexity and auricular stability. Additionally, since all patients had no prior history of ear surgery, no postoperative ear deformity was observed. Further research is required to obtain numerical data associated with ear deformity. Second, the degree of damage to the PAL may relate to the type of surgical approach, namely an anterior or posterior approach. An anterior approach is generally thought to exert less damage on the posterior anatomical structures of the auricle, including the PAL. However, this study did not involve an anterior approach; thus, the two approaches were not compared. Third, due to the lack of a standard method available, the authors devised their own technique for the measurement of the auricular recoil force, despite the associated risk of technical error.

This study provides several suggestions for the maintenance of auricular stability. Although the PAL may not be the only factor in maintaining auricular stability, preserving the PAL should be considered in the case of a weak auricular framework; nevertheless, it is difficult to apply this recommendation to all patients. Moreover, preserving the PAL also is helpful in maintaining the vascularity of the auricular skin and preventing postoperative hematoma, as the PAL is concomitant with perforating branches of the posterior auricular artery [11]. Although preservation of the PAL decreases the harvestable quantity of the cymba concha, it can be overcome by changing the design of the ear cartilage or via optional harvesting of the cavum concha. In addition, the insertion of a biodegradable scaffold, such as a polycaprolactone or polydioxanone scaffold, into the donor site to maintain the auricular framework is a feasible option [17]. In conclusion, the results of this study suggest that the PAL is one of the supporting structures in the auricle. Therefore, minimizing damage to the PAL may be helpful to preserve auricular stability during the harvest of ear cartilage.

NOTES

Conflict of interest
No potential conflict of interest relevant to this article was reported.

Ethical approval
The study was approved by the Institutional Review Board of Chungham National University Hospital (IRB No. 2019-03-042) and was performed in accordance with the principles of the Declaration of Helsinki.

Patient consent
The patient provided written informed consent for the publication and the use of her images.

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REFERENCES

1. Jeong JY, Kim TK. Rebuilding nose: rhinoplasty for Asians. Uijeongbu: Medic Medicine; 2018.
2. Paik MH, Chu LS. Correction of the short nose using derotation graft. Arch Aesthetic Plast Surg 2012;18:35-44.
3. Tae SP, Song JK, Ju HS, et al. Nasal tip plasty using a batten graft with ear cartilage in East Asians. Arch Aesthetic Plast Surg 2016;22:57-62.
4. Grobbelaar AO, Matti BA, Nicolle FV. Donor site morbidity post-conchal cartilage grafting. Aesthetic Plast Surg 1997;21:90-2.
5. Han K, Kim J, Son D, et al. How to harvest the maximal amount of conchal cartilage grafts. J Plast Reconstr Aesthet Surg 2008;61:1465-71.
6. Alexander KS, Stott DJ, Sivakumar B, et al. A morphometric study of the human ear. J Plast Reconstr Aesthet Surg 2011;64:41-7.
7. Farkas LG. Anthropometry of normal and anomalous ears. Clin Plast Surg 1978;5:401-12.
8. Park C, Lee TJ, Shin KS, et al. A single-stage two-flap method of total ear reconstruction. Plast Reconstr Surg 1991;88:404-12.
9. Hongo T, Komune N, Shimamoto R, et al. The surgical anatomy of soft tissue layers in the mastoid region. Laryngoscope Invest Otolar-
10. Datta G, Carlucci S. Reconstruction of the retroauricular fold by ‘non-pedicled’ superficial mastoid fascia: details of anatomy and surgical technique. J Plast Reconstr Aesthet Surg 2008;61 Suppl 1:S92-7.

11. Park C, Shin KS, Kang HS, et al. A new arterial flap from the postauricular surface: its anatomic basis and clinical application. Plast Reconstr Surg 1988;82:498-505.

12. Wilson C, Iwanaga J, Simonds E, et al. The conchal vascular foramen of the posterior auricular artery: application to conchal cartilage grafting. Kurume Med J 2018;65:7-10.

13. Davis J. Aesthetic and reconstructive otoplasty. New York: Springer-Verlag; 1987.

14. Weerda H. Surgery of the auricle: tumors-trauma-defects-abnormalities. New York: Thieme Medical Publishers; 2007.

15. Sheen JH. Tip graft: a 20-year retrospective. Plast Reconstr Surg 1993; 91:48-63.

16. Mischkowski RA, Domingos-Hadamitzky C, Siessegger M, et al. Donor-site morbidity of ear cartilage autografts. Plast Reconstr Surg 2008; 121:79-87.

17. Min SH, Kim JH, Lee MI, et al. Evaluation of auricular cartilage reconstruction using a 3-dimensional printed biodegradable scaffold and autogenous minced auricular cartilage. Ann Plast Surg 2020;85: 185-93.