INTRODUCTION

Keloid scars can cause pain or pruritus, disturb the range of motion, diminish sensation, or cause aesthetic deformities that may lead to significant psychosocial distress [1]. They are raised, firm, frequently pruritic and painful pathological scars characterized histologically by an overwhelming aggregation of fibroblasts and collagen type I within the inflammatory reticular dermis [2]. Keloids often extend beyond the boundaries of the original wound, unlike hypertrophic scars, which are typically confined to the original wound boundaries. Keloids generally do not spontaneously regress, and they therefore require appropriate treatment [3].

It is believed that genetic susceptibility, environmental factors, and several patient characteristics interact in a complex manner to cause the development of keloids, although the etiology is still unclear [4,5]. The prevalence of keloids tends to be higher in dark-skinned racial groups, ranging from 5% to 10% in Africans versus 0.1% in Asians [2]. Keloids are most common in the anterior chest, shoulders, upper back, and ears [6]. More than 80% of keloids in the ear are reported to occur in the earlobe and ear helix [7].

Current therapies for keloids include intralesional corticosteroid injections, cryotherapy, surgical revision, radiotherapy, and laser therapy [8]. Surgical resection is one of the important treatments for keloids in the ear. For ear keloids, many surgical methods have been reported, including standard keloidectomy, wedge resection, and core excision [9,10].

In this paper, we review the aesthetic defects that can be induced by volume reduction after wedge resection through four cases of patients with keloids that occurred in the earlobe and ear helix, which are frequent sites of keloids in the ear.

CASE REPORT

Case 1

A 24-year-old woman complained of a keloid in the right ear helix after a piercing. The keloid developed after an ear piercing 1 year ago, and no treatment had been performed for it. The size of the keloid was 1.2 × 1.2 × 0.8 cm. The keloid was removed through wedge resection under local anesthesia, and radiation therapy was performed for 3 days immediately after surgery. There were no complications in the wound healing process, and no specific product for scar management was used. At 6 months of follow-up, a slightly depressed scar was observed, but there was no significant deformity or recurrence (Fig. 1).
Case 2
A 29-year-old woman complained of a keloid in the left earlobe after a piercing. The keloid developed after an ear piercing 7 years ago, and no treatment had been performed for it. The size of the keloid was 2.5 × 2.0 × 1.0 cm. The keloid was removed through wedge resection under local anesthesia, and no radiation therapy was performed. There were no complications in the wound healing process, and no specific product for scar management was used. During 2 years of follow-up, no significant deformity or recurrence was observed (Fig. 2).

Case 3
A 51-year-old woman complained of a keloid in the left ear helix after a piercing. The keloid developed after an ear piercing 3 years ago, and the patient underwent surgical excision once, but the keloid recurred. The size of the keloid was 1.5 × 1.5 × 1.0 cm. The keloid was removed through wedge resection under local anesthesia, and no radiation therapy was performed. There were no complications in the wound healing process, and no specific product for scar management was used. During 1 year of follow-up, no significant deformity or recurrence was noted (Fig. 3).

Fig. 1. A 24-year-old woman with a keloid in the right ear helix after a piercing. (A) Intraoperative photograph; the keloid including the surrounding tissue was radically resected in a wedge shape, and the triangular defect was directly closed. (B) Six months post-operation.

Fig. 2. A 29-year-old woman with a keloid in the left earlobe after a piercing. (A) Preoperative photograph. (B) Two years post-operation.

Fig. 3. A 51-year-old woman with a recurrent keloid in the left ear helix after a piercing. (A) Preoperative photograph; the scar is noticeable from previous surgery. (B) One year post-operation.

Fig. 4. A 26-year-old woman with a keloid in the left ear helix after a piercing. (A) Preoperative photograph. (B) Six months post-operation.
Case 4
A 26-year-old woman complained of a keloid in the left ear helix after a piercing. The keloid developed after an ear piercing 8 years ago. The patient underwent surgical resection 2 years ago, but the keloid recurred. The size of the keloid was 1.3 × 1.0 × 1.0 cm. The keloid was removed through wedge resection under local anesthesia, and no radiation therapy was performed. There were no complications in the wound healing process, and no specific product for scar management was used. During 10 months of follow-up, no significant deformity or recurrence was observed (Fig. 4).

DISCUSSION

Treatments for keloids include surgical and non-surgical methods. Surgical resection is an important treatment modality for keloids in the ear, and several surgical methods have been used for keloid resection. Several studies have compared the recurrence rate of keloids according to the surgical method used. Lee et al. [11] argued that core excision was the best surgical method for keloids in the ear in terms of the recurrence rate. Park et al. [10] reviewed 1,027 patients who underwent surgical excision of keloids in the ear, and reported that the recurrence rate ranged from 7.6% to 11.2% depending on the surgical method. However, the differences in the recurrence rate between each method were not analyzed statistically since the surgical method was determined according to the type of keloid; furthermore, there have been few reports on the aesthetic results related to the ear shape after keloid removal.

Reconstruction of soft tissue defects following the surgical removal of keloids in the ear is still a challenging task for surgeons. Surgeons must consider the size and shape of the ear, scar, and recurrence. Even if reconstruction is successful, volume reduction and a deformity of the ear after surgery are inevitable to some extent. Therefore, it is important to perform surgery appropriately with consideration of the characteristics of the keloid (such as the location, size, and type) for each patient.

Studies have generally classified surgical methods for ear keloids into standard keloidectomy, wedge resection (radical keloidectomy), core excision (core extirpation), and a combination of these surgical methods. Standard keloidectomy is a method that removes the keloid by an elliptical incision through the keloid-involved surface, and it is mainly performed on pedunculated-type keloids. Wedge resection, also called radical keloidectomy, is commonly used when keloid has involved the anterior and posterior surfaces of the ear, but can also be used for cases of one surface involvement. Core excision was initially introduced as a surgical method to effectively treat "dumbbell-shaped" keloids in the ear [12], and then it was accepted as a method to specifically remove the keloid tissue and preserve the surrounding tissue as much as possible [13].

The surgical method may be selected depending on the size or type of the keloid, without there necessarily being a single optimal choice. In standard keloidectomy, the surgeon must remove all keloid tissue to reduce the risk of recurrence, and depending on the depth of the keloid, the thickness of the remnant skin flap may vary, so attention should be paid to both the recurrence risk and the reconstruction method during surgery. Core excision also requires attention to keloid recurrence due to incomplete excision, and trimming the remnant skin after keloid excision is necessary. After trimming, the distance from the defect to the ear contour border may be too short to be meaningful for preserving the tissue, or it may lead to a "dog ear" after closure of the defect, especially in areas such as the earlobe and ear helix. Wedge resection has the disadvantage of reducing the absolute volume of the ear after reconstruction to a greater extent than other surgical methods, since it removes even normal tissue, but the method is simple and none of the other considerations discussed above need to be taken into account. In particular, wedge resection can be performed relatively easily when the keloid is located in the earlobe or ear helix.

It is aesthetically important to maintain the symmetry of facial features, which are often bilaterally symmetrical or occur in pairs on the face. However, the overall shape of each ear cannot be compared at the same time when the face is viewed from the front. Ears often show asymmetry by default, and in particular, they show various types of asymmetry depending on various factors such as sex, race, and earlobe type [14,15]. Considering the aforementioned characteristics of the ear, it can be considered that the volume reduction itself caused by the surgical resection of keloids does not cause significant deformities of the ear and reconstructing the ear in a way that preserves the normal shape is more important than achieving symmetry of both ears. Thus, wedge resection can be an attractive option in that it can sufficiently preserve the intact shape of the ear, and Park et al. [10] even argued that wedge resection of keloids located in the earlobe has the advantage of obtaining a youthful appearance by reducing the size of the earlobe.

Therefore, we suggest some characteristics of patients that can predict better results when wedge resection is performed. First, if the keloid is close to the outer contour of the ear, the size of the defect after resection can be minimized. Second, if the keloid is in a long-detached earlobe, a youthful appearance of the ear can be obtained by removing some of the earlobe tissue together by wedge resection. Third, if the scapho-conchal angle is small, the asymmetry is relatively difficult to notice because the area of the ear observable from the front is small.

We present four cases in which earlobe and ear helix keloids were removed by wedge resection. In these cases, there was no deformity of the ear or keloid recurrence, and these cases indicate that wedge resection is still useful as a surgical method for keloids in the earlobe and ear helix. However, due to the limitations of a case report, an objective comparison of results between surgical methods was not possible. Nevertheless, based on our cases, there
is no need to avoid radical resection, such as wedge resection, in appropriately selected patients.

NOTES
Conflict of interest
Youngwoong Choi is an editorial board member of the journal but was not involved in the peer reviewer selection, evaluation, or decision process of this article. No other potential conflicts of interest relevant to this article were reported.

Patient consent
The patients provided written informed consent for the publication and use of their images.

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