

Framework Changes Using Costal Cartilage for Microtia Reconstruction

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Objective: Since a known growth-of-cartilage framework is used for reconstruction of microtia under the Brent technique, we set out to address the behavior of the framework under the Nagata technique.

Design: A retrospective analysis of costal cartilage auricular reconstruction procedures.

Patients: A total of 28 patients who underwent costal cartilage auricular reconstruction between 1998 and 2005.

Interventions: Reconstruction of microtia using the 2-stage Nagata technique.

Main Outcome Measures: The parameters checked were patient age at the time of reconstruction, follow-up time, and measurements of the auricular

framework height and width both at the time of implantation (represented by the template size) and at final follow-up.

Results: A significant change in auricular height and width was observed. The height decreased by 3.1%, while the width increased by 4.0%. This change was not influenced by follow-up time.

Conclusions: Auricular reconstruction with the Nagata technique was undertaken when the patients were aged 9 to 10 years, when the auricle had reached nearly its final size. According to our patient sample, it is our opinion that a policy change is unjustifiable.

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MICROTIA OCCURS IN APPROXIMATELY 0.03% OF live births, affecting boys more commonly than girls, and it is estimated that half of these patients are syndromic. There is currently no universal precise classification scheme that is clinically useful in a statistical sense.¹ Most surgeons rely on autologous rib grafts for ear reconstruction. The use of rib reconstruction was pioneered by Tanzer² and perfected by Brent.³ Observation is recommended until the child is at least 5 to 8 years old. This allows both growth of the donor rib cartilage and development of the contralateral normal ear.⁴ The classic reconstruction popularized by Brent³ uses the 6 to 8 contralateral ribs and consists of 4 stages: (1) fabrication of the auricular framework with contralateral costal cartilage; (2) lobule transposition; (3) framework elevation with postauricular grafting; and (4) tragus reconstruction. A major point of criticism is the number of stages required with additional points of lack of definition of the conchal bowl, the intertragic notch, and the contour of the anti-tragus and effacement of the postauricu-

lar sulcus due to contraction of the skin grafts.

In an attempt to reduce the number of stages, Nagata⁶ suggested a 2-stage technique. In addition to the helix, crura, antihelix, and conchal elements, this technique provides for the incisura intertragica and the tragus as key elements in the reconstruction. In the first stage, the rib cartilage framework, which incorporates a tragal component, is placed in a subcutaneous pocket, and the lobule is transposed. Nagata uses the skin of the posterior lobule and mastoid to cover the conchal aspect of the construct. By converting the V-shaped posterior lobule incision used by Tanzer⁷ into a W, Nagata⁶ also increases the surface area of skin available to cover the framework. This also permits lobule transposition, obviating the need for a conchal skin graft or a switchback procedure for lobular transposition, as necessitated in Tanzer's technique. The skin incision separates the lobule into 3 skin flaps: the 2 posteroanterior lobular skin flaps and an anterior tragal skin flap. Six months after the first stage, the construct is elevated using a crescent-shaped piece of cartilage harvested from the fifth rib through the

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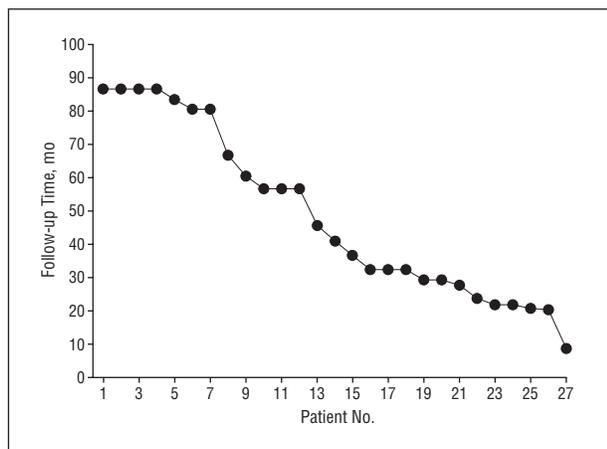


Figure 1. Patient follow-up time.

previous chest wall incision. Nagata⁶ also recommends that the operation not be performed on patients younger than 9 years owing to the smaller cartilage available in younger children.

The growth of the reconstructed framework was an issue first addressed by Tanzer.⁸ He conducted a survey with results from subjective impressions of the patients and concluded that growth of the framework was possible with a growth of 3.6 mm. The same issue was addressed by Brent,⁹ who conducted a survey in the same manner but with a larger number of participants. Brent reported that 41% of the ears grew larger. However, no firm statistical data such as the number of the returned surveys or the size at the time of implantation and on final measurement were supplied. In addition, in a 4-stage procedure, new cartilage could be added.

The first researchers to address the growth of the reconstructed framework relative to the contralateral ear (and not relative to the template of the reconstructed ear) were Thomson and Winslow,¹⁰ who showed growth rates of 8%. The most significant study, yet still small-scale (only 10 patients), was conducted by DellaCroce et al,¹¹ who identified growth of 5 mm, reflecting 10% in height and 7% in width.

METHODS

Our multiple case studies evaluated 27 patients who underwent reconstruction of microtia according to the Nagata technique. The patients selected represented successful reconstruction cases on the first attempt. The measurements for the height and width were taken from the original template. The second measurement was taken after the second and final stage. The age of the patients was also recorded, and the time factor was addressed by subtracting an arbitrary date set (May 2006) from the original date of the first stage of the operation for each patient.

Comparisons using 2-tailed *t* tests were conducted to compare the size of the template with the final result. An *F* test was performed to compare the group before maturity (set as boys younger than 13 years, girls younger than 12 years) and after maturity. The first half of the reconstructed ear cohort was then compared with the second half. All calculations were conducted using Microsoft Excel software (Redmond, Washington; 2002).

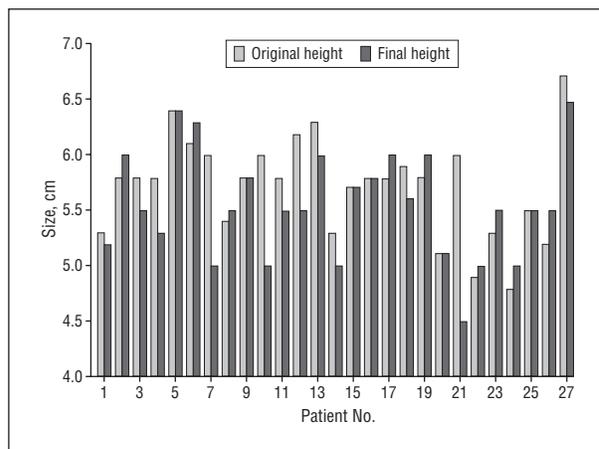


Figure 2. Implant height at the time of implantation and final height.

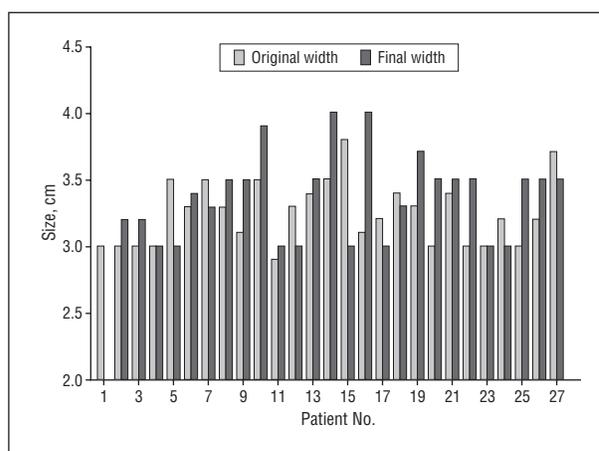


Figure 3. Implant width at the time of implantation and final width.

RESULTS

A total of 27 patients concluded the series, and follow-up time ranged from 9 to 87 months (Figure 1). There were 6 female patients and 1 bilateral repair. Eleven patients underwent the procedure before maturity. The height of the implant ranged from 4.80 to 6.70 cm at the time of implantation, and on final measurement the range was 4.50 to 6.50 cm (Figure 2). The width ranged from 2.90 to 3.80 cm at the time of reconstruction and grew to between 3.00 and 4.00 cm by final measurement (Figure 3).

The mean difference in height for the whole series was -0.18 cm (Table), which was significant ($P = .04$) and represented a 3.1% change. There was a 0.13-cm increase in width for the whole series (Table), which was significant ($P = .03$) and represented a 4.0% change. The height and width changes are illustrated in Figure 4.

The change in height comparing the adult group ($n = 17$) with the children ($n = 11$) was 0.22 cm vs 0.13 cm and was not significant ($P = .60$). Width growth was 0.12 cm for children and 0.13 cm for adults, which was significant ($P = .02$).

We checked the significance of time following the reconstruction and possible implications on framework size

Table. Comparison of Original Implant Size and Size at Final Measurement^a

Implant Measurement	Height Range	Width Range	Mean (SD) Height	Mean (SD) Width
At time of implantation	4.80-6.70	2.90-3.80	5.72 (0.45)	3.24 (0.24)
Final measure	5.50-6.50	3.00-4.00	5.54 (0.54)	3.37 (0.13)

^aAll data are reported in centimeters.

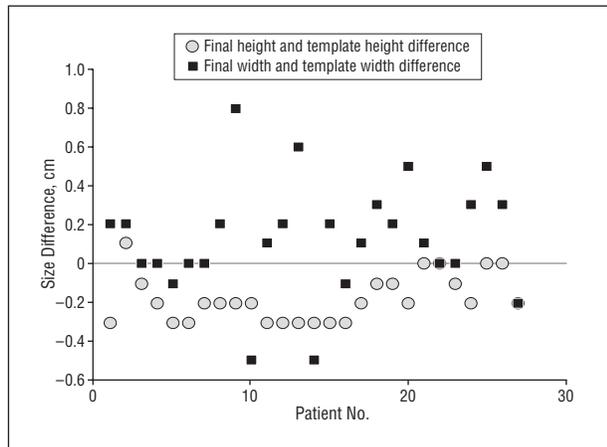


Figure 4. Implant height and width differences.

by comparing the first 14 reconstructions with the later 14. There was no statistical change ($P=.34$ for height changes and $P=.93$ for width changes).

COMMENT

We addressed the issue of framework change in the auricular reconstruction using the Nagata technique.¹¹ Our findings reveal that the framework changes its size when the parameters are height and width. We also found that the change is statistically significant: The change was a negative one, -3.1% , when considering height, and a positive one of 4.0% for width. We can also conclude that these changes were not affected by the subgroup of children selected or time factors.

Results from previous studies exclusively using the Brent reconstructive techniques have reported changes of up to 10% .^{10,11} By contrast, to our knowledge, our study is the first to address the issue of framework growth applying the Nagata technique and yielding a more predictable result.

The difference between the template and the final ear measurements could be attributed to inaccurate measurement between the template and the carved implanted framework or to a slight change in the framework due to the shearing effect of the temporal parietal fascia. Other possible explanations for our findings are local factors (such as tissue vascularity or infection) or

the amount of perichondrium harvested, which is a major factor in chest wall deformity.¹²

We conclude that no amenable framework changes can be foreseen when the Nagata technique is undertaken. The final result, as related to size, is also more accurate than with the Brent technique. We invite further investigation to corroborate these findings.

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Author Contributions: Dr Kizhner had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. **Study concept and design:** Kizhner and Barak. **Acquisition of data:** Kizhner. **Analysis and interpretation of data:** Kizhner. **Drafting of the manuscript:** Kizhner. **Critical revision of the manuscript for important intellectual content:** Barak. **Statistical analysis:** Kizhner. **Study supervision:** Barak. **Financial Disclosure:** None reported.

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