Efficacy of Contouring-Assisted Resection in the Crus of Helix Cartilage Region for Congenital Preauricular Fistula

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Jichan Wang[1], Juntian Lang[1]

[1]E.N.T. Department, Ruijin Hospital, Shanghai Jiao Tong University School of Medicine, 201801 Shanghai, China

AIM: This study comparatively evaluates the efficacy and safety of contouring-assisted resection versus traditional fistula tract excision in the crus of helix cartilage region for the treatment of congenital preauricular fistula (CPF).
METHODS: This retrospective cohort study recruited 198 CPF patients who underwent surgical treatment at Ruijin Hospital between January 2018 and June 2024. Based on surgical technique, patients were divided into a contouring group (n = 98), who underwent contouring-assisted resection involving systematic dissection along the anterior and deep surfaces of the crus of helix cartilage while preserving the cartilage framework, and a traditional surgery group (n = 100), who underwent conventional fistula tract identification and excision. Baseline characteristics, recurrence rate, operative time, postoperative complications, and patient satisfaction were statistically compared between the two groups.
RESULTS: The recurrence rate was significantly lower in the contouring group than in the traditional group (2.0% vs. 18.0%, $p < 0.001$). Patients in the contouring group experienced significantly longer operative time ($p < 0.001$), while intraoperative blood loss did not differ significantly between groups. The overall complication rate was significantly lower in the contouring group (4.1% vs. 20.0%, $p < 0.001$), with a particularly reduced rate of incision-related infection in this group (1.0% vs. 8.0%, $p = 0.044$). Patient satisfaction scores were significantly higher in the contouring group ($p < 0.001$).
CONCLUSIONS: The contouring-assisted resection approach was associated with a significantly lower recurrence rate and higher patient satisfaction compared with traditional fistula tract excision, without an increase in specific complications such as chondritis, hematoma requiring intervention, or persistent sensory abnormality. These observations suggest this method is an effective and safe surgical option for patients with CPF in the crus of the helix region.

Keywords: congenital preauricular fistula; crus of helix cartilage; contouring; recurrence

Introduction

Congenital preauricular fistula (CPF) is a common congenital malformation of the ear resulting from abnormal development of the first and second branchial arches [1]. Its incidence shows significant geographical variation, with higher rates observed in Asian and African populations, with reported rates of 1.2% to 2.5% in China and about 2.2% in African populations [2,3,4,5,6]. In most patients, it remains asymptomatic and presents only a small opening located anterior to the crus of the helix. However, once infection occurs, the condition becomes clinically significant, presenting with repeated episodes of redness, swelling, pain, and even abscess formation in the preauricular region. In some severe cases, it may develop into complex sinuses, which can significantly impair the patient's quality of life [7].

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Correspondence to: Juntian Lang, E.N.T. Department, Ruijin Hospital, Shanghai Jiao Tong University School of Medicine, 201801 Shanghai, China (e-mail: langjuntian@126.com).
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Surgical excision remains the definitive treatment option for symptomatic or recurrently infected CPF. The traditional surgical intervention primarily involves intraoperative identification, careful dissection, and excision of the fistula tract along with its branches. However, due to the tortuous course, multiple branches of the fistula, and its frequent close adhesion to the perichondrium of the crus of the helix, the traditional technique often fails to ensure complete resection, resulting in relatively high rates of postoperative complications and recurrence [8,9,10]. The condition becomes even more challenging in those with a history of recurrent infection, as chronic inflammation results in fibrosis and scarring, further increasing the difficulty of complete excision and posing a clinical challenge [9].

Anatomically, CPF is predominantly located anterior to the crus of the helix, with the tract often extending around the helix cartilage [11,12]. To achieve more thorough removal of affected tissues, surgical approaches emphasizing wider resection in the crus of the helix region have gained attention. Histopathological analyses confirming the intimate relationship between the sinus tract and the helical cartilage support the rationale for ensuring complete resection in this region [13]. Alongside reports of improved outcomes after partial cartilage excision, further supporting this concept [8], forming the theoretical basis for the contouring resection technique employed in the present study.

However, the integrity and morphology of the helix are crucial for the overall shape of the ear, especially in pediatric patients. Therefore, an optimal surgical technique should balance between radical cure and aesthetic preservation. Consequently, we propose the technical concept of crus of helix cartilage contouring. This approach involves fully separating the tissue posterior to the parotid gland from the anterior and deeper aspects of the crus of helix, enabling removal of all potentially diseased tissue while preserving the integrity of the auricular cartilage.

Unlike previous approaches that primarily focused on wide cartilage excision to reduce recurrence, often at the cost of auricular integrity, the present study systematically evaluates a cartilage-preserving contouring strategy. To the best of our knowledge, this is the first study to systematically evaluate a cartilage-preserving contouring technique specifically designed to clear high-risk perichondrial tissue while maintaining auricular framework integrity, and to directly compare it with traditional fistula tract excision in a large patient cohort. This technique aims to achieve radical lesion clearance along the high-risk perichondrial zones while maintaining the overall structural framework of the auricle. By directly comparing contour-assisted resection with traditional fistula tract excision, this study seeks to clarify whether thorough surface-based cartilage contouring can improve outcomes in terms of recurrence rates, postoperative complications, and patient-reported satisfaction, thereby addressing a key gap in current surgical practices.

Methods

Study Subjects and Grouping

This single-center retrospective cohort study assessed the medical records of consecutive CPF patients (n = 198) who underwent surgical treatment in the Department of Otorhinolaryngology-Head and Neck Surgery at Ruijin Hospital between January 2018 and June 2024. The selection of surgical technique was primarily based on surgeon preference alongside evolving institutional practice guidelines. Both surgical approaches were performed throughout the entire study period (from 2018 to 2024), which helped to reduce potential confounding related to changes in surgical practice over time. Patients were enrolled consecutively, regardless of the technique used.

Study participants were divided into two groups based on the surgical approach. The contouring group (n = 98) underwent contouring resection in the crus of the helix cartilage region, whereas the traditional group (n = 100) received traditional fistula tract track identification and excision.

Inclusion criteria for patient selection were as follows: (1) a clinically diagnosed congenital preauricular fistula based on typical physical findings, such as the presence of a preauricular pit or sinus opening, along with a relevant medical history; and (2) surgical intervention performed during a quiescent stage, defined as no acute infection episodes occurring within one month before the operation. However, patients with an active or uncontrolled infection at the time of the procedure, concurrent major ear malformations or a prior history of ipsilateral ear surgery, and those with incomplete clinical records, were excluded from the final analysis. Although the present cohort included pediatric and adolescent patients, the clinical presentation and surgical principles of CPF in this age group are largely similar to those in adults.

This study was approved by theby the Ruijin Hospital Ethics Committee, approval number: (2026) No. 19. Informed consent was obtained from all patients or their legal guardians, and all surgical procedures were performed in compliance with the principles of the Declaration of Helsinki.

Surgical Methods

In the traditional group, local infiltration anesthesia was administered around the fistula opening using epinephrine hydrochloride saline (concentration 1:200,000). A fusiform incision was then made in the skin surrounding the fistula opening. The subcutaneous tissue was carefully dissected to expose the stained fistula tract. Meticulous dissection was performed along the fistula course to carefully identify and remove all visible branches while avoiding residual tissue. The fistula tract was excised. In cases where the fistula penetrated the cartilage, the involved fistula tissues and auricular cartilage were excised together. The surgical field was cleaned, adequate hemostasis was achieved, and the incision was closed layer by layer with efforts to minimize dead space. The wound was dressed in alcohol-soaked gauze and secured with a pressure bandage.

In the traditional group, surgical excision primarily focused on carefully tracing and removing the methylene blue–stained fistula tract and any visible branches. The surface of the crus of the helix cartilage was not routinely explored or systematically dissected. When the perichondrium was found intraoperatively to be grossly inflamed or clearly involved, only limited and localized excision of the affected perichondrium was performed, without circumferential or systematic stripping of tissue along the cartilage surface.

In the contouring group, the surgical incision was designed based on the relative positions of the preauricular fistula and the inflammatory scar area, typically a straight or gently curved "shallow U-shaped" incision. Areas of damaged skin and scar tissue were partially excised according to the condition of the inflammatory scar and skin lesions. After skin incision and elevation, the junction between inflammatory scar tissue and normal subcutaneous tissue was identified and dissected anteriorly to the anterior margin of the lesion.

All suspicious diseased and inflammatory tissues were elevated posteriorly along the surface of the parotid fascia until reaching the crus of the helix cartilage. The soft tissue was carefully separated along the surface of the crus of the helix cartilage, following its anterior and deep surfaces of the cartilage, and the dissection continued deeply. The upper part of the tragus cartilage was exposed and partially contoured. Tissues within the incisura intertragica, including the fistula and inflammatory tissue, were excised en bloc. The extent of resection included soft tissue between the crus of the helix and the tragus cartilage, bounded anteriorly and deeply by the parotid fascia, with care taken superiorly to avoid injury to the superficial temporal artery. Deep to the crus of the helix cartilage, tracking could proceed according to the fistula condition up to the external auditory canal wall or mastoid region.

In contrast to the traditional approach, contouring-assisted resection involves systematic dissection along the anterior and deep surfaces of the crus of helix cartilage to clear all potentially diseased soft tissue while preserving the integrity of the cartilage framework.

All surgical procedures were performed by two senior otorhinolaryngology surgeons with comparable clinical experience in CPF excision. The contouring technique was conducted by surgeons specifically trained in this method, ensuring procedural consistency across patients. All patients received the same anesthesia modality, local hemostatic measures, perioperative antibiotic prophylaxis, and postoperative compression dressing protocols, regardless of surgical technique.

Observation Indicators

Recurrence was defined as the postoperative appearance of a sinus tract, localized redness or swelling, or abscess formation at the original surgical area [8]. Recurrence was primarily assessed based on clinical examination during follow-up visits. In cases of unclear diagnosis or suspected recurrence, ultrasonography was performed to confirm the presence of any residual or recurrent sinus tracts. For recurrence, the primary evaluation point was set at 12 months after the procedure.

Baseline characteristics, including sex, age, affected side, fistula type (primary vs. recurrent) and preoperative infection history (yes/no), were collected for each patient. Observation indicators included the one-year postoperative recurrence rate, overall complication rate, patient satisfaction, operative time, and intraoperative blood loss. The overall complication rate was defined as the proportion of patients who experienced at least one postoperative event within 12 months, including incision infection, hematoma formation, scar hypertrophy, sensory abnormality, or chondritis. Patient satisfaction was assessed at the 12-month postoperative follow-up using a self-designed scale. This scale contained 6 items: symptom improvement, scar appearance, recovery experience, auricular sensation, impact on daily life activities, and overall satisfaction. Each domain was graded on a 5-point Likert scoring method ranging from 1–5 (1 = very dissatisfied, 2 = dissatisfied, 3 = neutral, 4 = satisfied, 5 = very satisfied) [14]. The individual scores from all 6 items were summed to calculate a total score ranging from 6 to 30, with higher total scores indicating greater satisfaction.

Statistical Analysis

Statistical analysis was conducted using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Normality of continuous variables was assessed using the Shapiro–Wilk test. Non-normally distributed variables were presented as medians with interquartile ranges (Q_1, Q_3) and were compared using the Mann-Whitney U test. Count data (categorical variables) were reported as numbers and percentages (%) and compared using either the χ^2 test or Fisher's exact test, as appropriate. A p-value of <0.05 was considered statistically significant.

Results

Comparison of Baseline Characteristics Between Groups

There were no significant differences between the two groups in gender, age, affected side, or history of preoperative infection ($p > 0.05$), indicating comparability between groups (Table 1).

Comparison of Perioperative Indicators Between Groups

Analysis of perioperative measures (Table 2) revealed that patients in the contouring group experienced longer operative time compared to those in the traditional group ($p < 0.001$). However, there was no significant difference between the two groups regarding the intraoperative blood loss ($p > 0.05$).

Comparison of Recurrence Rate Between Groups

The postoperative recurrence rate at the 12-month time point was significantly lower in the contouring group (2.0%) than that in the traditional group (18.0%). However, this difference was statistically significant ($p < 0.001$, Table 3).

Incidence of Postoperative Complications Between Groups

A significant difference in the overall complication rate was observed between the two groups ($p < 0.001$), with the contouring group demonstrating a substantially lower rate than the traditional group. Specifically, incision-associated infection was observed less frequently in the contouring group ($p = 0.044$) (Table 4).

Treatment Satisfaction Between Groups

There was a significant difference in treatment-related satisfaction between the two groups, with the contouring group scoring significantly higher than the traditional group ($p < 0.001$) (Table 5).

Table 1. Comparison of baseline characteristics between the traditional and contouring groups.

Variable	Total (n = 198)	Traditional group (n = 100)	Contouring group (n = 98)	Statistic	*p*-value
Age (years), M (Q_1, Q_3)	18.50 (14.00, 31.75)	18.00 (13.75, 33.25)	20.00 (14.25, 28.75)	Z = –0.33	0.745
Gender, n (%)				χ^2 = 0.10	0.752
Female	117 (59.09)	58 (58.00)	59 (60.20)		
Male	81 (40.91)	42 (42.00)	39 (39.80)		
Preoperative infection history, n (%)				χ^2 = 0.09	0.763
No	36 (18.18)	19 (19.00)	17 (17.35)		
Yes	162 (81.82)	81 (81.00)	81 (82.65)		
Affected side, n (%)				χ^2 = 0.02	0.879
Left ear	106 (53.54)	53 (53.00)	53 (54.08)		
Right ear	92 (46.46)	47 (47.00)	45 (45.92)		
Fistula type, n (%)				χ^2 = 0.18	0.671
Primary	98 (49.49)	48 (48.00)	50 (51.02)		
Recurrent	100 (50.51)	52 (52.00)	48 (48.98)		

Table 2. Comparison of perioperative indicators between the two groups.

Variable	Total (n = 198)	Traditional group (n = 100)	Contouring group (n = 98)	Statistic	*p*-value
Operative time (min), M (Q_1, Q_3)	31.00 (23.00, 43.00)	23.00 (20.00, 26.00)	43.00 (37.00, 51.75)	Z = –12.11	<0.001
Intraoperative blood loss (mL), M (Q_1, Q_3)	5.00 (4.00, 6.00)	5.00 (4.00, 6.00)	5.00 (4.00, 6.00)	Z = –1.51	0.130

Table 3. Comparison of the recurrence rate between the two groups.

Variable	Total (n = 198)	Traditional group (n = 100)	Contouring group (n = 98)	Statistic	*p*-value
Recurrence rate, n(%)				χ^2 = 13.88	<0.001
No	178 (89.90)	82 (82.00)	96 (97.96)		
Yes	20 (10.10)	18 (18.00)	2 (2.04)		

Table 4. Comparison of postoperative complication rates between the two groups.

Variable	Total (n = 198)	Traditional group (n = 100)	Contouring group (n = 98)	Statistic	*p*-value
Overall complication rate, n (%)				χ^2 = 11.77	<0.001
No	174 (87.88)	80 (80.00)	94 (95.92)		
Yes	24 (12.12)	20 (20.00)	4 (4.08)		
Incision infection, n (%)				χ^2 = 4.06	0.044
No	189 (95.45)	92 (92.00)	97 (98.98)		
Yes	9 (4.55)	8 (8.00)	1 (1.02)		
Hematoma, n (%)				-	0.244
No	196 (98.99)	100 (100.00)	96 (97.96)		
Yes	2 (1.01)	0 (0.00)	2 (2.04)		
Scar hypertrophy, n (%)				χ^2 = 2.53	0.112
No	188 (94.95)	92 (92.00)	96 (97.96)		
Yes	10 (5.05)	8 (8.00)	2 (2.04)		
Sensory abnormality, n (%)				-	0.498
No	196 (98.99)	98 (98.00)	98 (100.00)		
Yes	2 (1.01)	2 (2.00)	0 (0.00)		
Chondritis, n (%)				χ^2 = 2.24	0.135
No	194 (97.98)	96 (96.00)	98 (100.00)		
Yes	4 (2.02)	4 (4.00)	0 (0.00)		

Note: Patients may experience more than one complication; consequently, the total number of complications across all categories may exceed the number of affected patients. -: Fisher's exact test.

Table 5. Comparison of satisfaction between the contouring and traditional groups.

Variable	Total (n = 198)	Traditional group (n = 100)	Contouring group (n = 98)	Statistic	p-value
Satisfaction (scores), M (Q_1, Q_3)	25.00 (23.00, 26.00)	23.00 (23.00, 25.00)	26.00 (25.00, 27.00)	Z = –9.97	<0.001

Discussion

This study compared contouring-assisted resection with traditional fistula tract excision, without including a direct comparison to cartilage excision techniques, which limits the generalizability of our findings. Through one-year postoperative follow-up, the contouring-assisted resection approach demonstrated significantly lower recurrence and overall complication rates, along with higher patient satisfaction compared to traditional surgery. Although operative time was longer due to the need for meticulous dissection, intraoperative blood loss and overall complication risk were not increased.

To the best of our knowledge, this is the first study to systematically evaluate a cartilage-preserving contouring technique specifically designed to clear high-risk perichondrial tissue while maintaining the auricular framework integrity, and to directly compare it with traditional fistula tract excision in a relatively large cohort. A previous histopathological and anatomical study has reported that recurrence foci are more commonly distributed along the perichondrium of the crus of helix and within the soft tissue of the crus of helix–tragus groove, rather than forming within the cartilage core itself [10]. Therefore, contouring focuses on thoroughly clearing the tissue along the cartilage surface while preserving the integrity of the cartilage structure. This differs from cartilage excision techniques, which involve partial sacrifice of anatomical structure.

Although operative time was prolonged due to more meticulous dissection, the contouring group showed significantly lower rates of incision infection and total complications compared to the traditional group. This suggests that a clearly defined, anatomically thorough surgical field provides a more favorable tissue-healing environment compared to one with a seemingly smaller wound but potentially containing residual epithelium. Particularly, a significant improvement in patient satisfaction is noteworthy and likely indicates both the lower recurrence rate and better preservation of auricular contour. Preserving the integrity of the cartilage framework is crucial for maintaining the natural protrusion of the crus of helix and the three-dimensional structure of the concha, thereby minimizing potential contour collapse or deformity due to cartilage defect [15]. The relatively high recurrence rate observed in the traditional group (18.0%) may be partly attributable to the high proportion of patients with a history of recurrent infection (81.0%) and recurrent fistula type (52.0%) in the overall cohort, reflecting the challenging nature of the patient population typically referred to our tertiary center.

Although a longer operative time in the contouring group indicates that meticulous and systematic dissection is required to achieve thorough clearance of diseased tissue along the cartilage surface. Despite the extended operative duration, this did not translate into higher intraoperative blood loss or increased complication rates, suggesting that the additional time is clinically justified by the significantly improved recurrence control and patient satisfaction.

The systematic dissection along the surface of the crus of the helix and the tragus cartilage in this technique aims to completely remove all potentially involved tissue, tiny branches, and other diseased components tightly adherent to the perichondrium, which is a rational choice based on anatomical evidence [16]. Our study results confirm that this technique can achieve a low recurrence rate (2.0%) comparable to that of cartilage excision techniques [8]. This further supports the idea that effective prevention of recurrence depends on thorough clearance of affected tissue rather than removal of cartilage itself.

On the contrary, the contouring group also demonstrated better control of incision-related infections, potentially attributable to the complete clearance of inflamed and potentially contaminated tissue. The significantly higher patient satisfaction reported in the contouring group likely indicates not only improved clinical outcomes due to the psychological benefit of the low recurrence rate but also results from better preservation of the natural contour and symmetry of the auricle, achieved by maintaining the structural cartilage framework, leading to better aesthetic and functional outcomes [17,18]. These findings align with broader surgical principles in modern otologic and auricular reconstruction, where precise dissection along anatomical planes and meticulous tissue handling have been shown to improve symptom control, reduce complications, and enhance patient-reported outcomes, even in confined surgical fields [19,20].

Recent evidence from a case-control study utilizing Propensity Score Matching (PSM) suggests that refined surgical excision for CPF can achieve excellent recurrence rates in the range of 2%–4% [21]. The contouring-assisted technique in the crus of the helix region employed in the present study yielded a recurrence rate of 2.0%, which is consistent with these reports and demonstrates significant superiority over the traditional method. To elucidate the rationale for the core step of "cartilage contouring" in our technique, we reference the spectrum of evidence regarding cartilage management in otoplasty. Aggressive cartilage excision techniques, while providing durable outcomes, may carry an increased risk of aesthetic revision [22]. In contrast, suture-only techniques face challenges related to relapse and suture-associated complications [23]. The technical approach presented here can be viewed as an innovative balance between these two strategies: it ensures a low recurrence rate through complete excision while aiming to mitigate the risk of contour deficit associated with mere resection via immediate intraoperative contour reconstruction.

As a retrospective cohort study, this research inevitably carries inherent limitations such as selection bias. Potential selection bias related to surgeon preference for the contouring technique, particularly in more complex cases, cannot be excluded. Second, the patient satisfaction scale was self-designed and, although reviewed by local experts, has not been validated across multiple centers. Third, the Coronavirus Disease 2019 (COVID-19) pandemic may have influenced surgical volume and follow-up. Fourth, the follow-up duration was limited to 12 months, which may be insufficient to capture very late recurrences occurring beyond the first postoperative year. However, early to mid-term recurrence within one year is commonly used as a primary endpoint in the existing literature and is considered most reflective of surgical completeness. Future studies with extended follow-up periods of 2–3 years are warranted to further evaluate long-term recurrence patterns. Furthermore, due to the very low number of recurrence events in the contouring group (n = 2), multivariable logistic regression analysis was not performed, as this would violate the events-per-variable principle and risk model overfitting. Therefore, the independent protective effect of the surgical technique could not be statistically confirmed and should be interpreted with caution. Finally, the comparison was limited to the traditional fistula tract excision, and a direct comparison with broader cartilage excision techniques was not performed, which limits the generalizability of our findings. Although the results are encouraging, to ultimately establish the comprehensive advantage of the contouring technique in terms of radical cure and functional-aesthetic preservation, future prospective, multicenter randomized controlled trials are urgently needed to compare it directly with classic cartilage excision techniques. Such studies should incorporate more objective auricular morphometric measurements and validated patient-reported outcome scales to provide higher-quality evidence-based clinical data.

Conclusions

The contouring-assisted resection approach significantly reduces recurrence and complication rates and improves patient satisfaction, representing an effective and safe surgical option for the treatment of congenital preauricular fistula in the crus of the helix region. Additionally, this strategy offers an effective balance between complete disease clearance and aesthetic outcomes.

Availability of Data and Materials

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions

JCW and JTL designed the research study. JTL performed the research. JCW analyzed the data. JCW and JTL drafted the article. Both authors contributed to the critical revision of the manuscript for important intellectual content. Both authors read and approved the final manuscript. Both authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The study was approved by the Ruijin Hospital Ethics Committee, approval number: (2026) No. 19, and all procedures followed the principles of the Declaration of Helsinki. Informed consent was obtained from all patients or their legal guardians.

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Conflict of Interest

The authors declare no conflict of interest.

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