

Systematic Review

The Auricular Elevation Stage in Microtia Reconstruction

Dini W. Widodo,^{1*} Trimartani,¹ Febby Shabrina,¹ Respati W. Ranakusuma²

¹Department of Ear Nose Throat-Head Neck Surgery,

²Clinical Epidemiology and Evidence-Based Medicine Unit,
Faculty of Medicine Universitas Indonesia-Dr. Cipto Mangunkusumo General Hospital,
Jakarta, Indonesia

*Corresponding author: dini_pancho@yahoo.com

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Abstract

Microtia is a congenital hypoplastic malformation of the auricle that can cause hearing impairment, cosmetic, and psychosocial problems. The auricular elevation in stage two is one of the most challenging procedures of autologous ear reconstruction. This article aims to determine whether the use of posterosuperior auricular fascia flap (PSFF), temporoparietal fascia flap (TPF), or retroauricular fascia flap (RFF) in stage 2 auricle reconstruction. A literature search was conducted in public databases and registries (PubMed/Medline, EBSCOhost, ProQuest, CENTRAL, ICTRP, Clinicaltrial.gov). Patients with unilateral or bilateral microtia were included in this study. The validity rating was assessed using the guideline from CEBM Oxford University. All these studies were analyzed for the systematic review of outcome studies of each surgical technique. PSFF is superior by reducing surgical time compared to RFF ($p < 0.01$) with less risk of scarring ($p = 0.03$) and less incidence of partial skin graft necrosis ($p = 0.01$). RFF offered superior aesthetic results compared to TPF. PSFF is a preferable technique for stage two reconstruction surgery in congenital microtia due to its ease of use, shorter operating time, and reduced complications compared to RFF. RFF may still be considered for better aesthetic outcomes, while TPF can be a suitable option in challenging cases.

Keywords: congenital microtia, esthetics, surgical flaps, transplants.

Tahap Elevasi Aurikular dalam Rekonstruksi Mikrotia

Abstrak

Mikrotia adalah malformasi hipoplasia kongenital di daun telinga yang dapat menyebabkan gangguan pendengaran, masalah kosmetik dan psikosial. Elevasi aurikuler pada tahap kedua merupakan salah satu prosedur yang paling sulit dalam rekonstruksi telinga autologus. Artikel ini bertujuan untuk menentukan apakah penggunaan flap fascia aurikularis posterosuperior (PSFF), flap fascia temporoparietal (TPF), atau flap fascia retroaurikularis (RFF) pada rekonstruksi daun telinga tahap 2. Pencarian literatur dilakukan di database dan registrasi publik (PubMed/Medline, EBSCOhost, ProQuest, CENTRAL, ICTRP, Clinicaltrial.gov). Pasien dengan mikrotia unilateral atau bilateral diikutsertakan dalam penelitian ini. Peringkat validitas dinilai menggunakan pedoman dari CEBM Oxford University. Data yang diperoleh dianalisis untuk tinjauan sistematis studi hasil dari setiap teknik bedah. PSFF lebih unggul dengan mengurangi waktu pembedahan dibandingkan RFF ($p < 0,01$) dengan risiko jaringan parut yang lebih kecil ($p = 0,03$) dan lebih sedikit kejadian nekrosis cangkang kulit parsial ($p = 0,01$). RFF memberikan hasil estetika yang lebih unggul dibandingkan dengan TPF. PSFF adalah teknik yang lebih disukai untuk operasi rekonstruksi tahap dua pada mikrotia kongenital karena mudah digunakan, waktu operasi lebih singkat, dan komplikasi lebih sedikit dibandingkan RFF. RFF masih dapat dipertimbangkan untuk hasil estetika yang lebih baik, sedangkan TPF dapat menjadi pilihan yang sesuai untuk kasus-kasus sulit.

Kata kunci: mikrotia kongenital, estetika, flap bedah, transplantasi.

Introduction

Microtia is a congenital malformation of the outer ear, manifested by hypoplasia of the auricle with an incidence of 1 to 10 per 10,000 births, and is associated with specific syndromes.^{1,2} Management of microtia is difficult and complex, making it essential to choose the most optimal treatment with minimal complications.^{1,3} Auricle reconstructive surgery is the only treatment available to correct this deformity. Autologous cartilage is the most frequently used material in ear reconstruction surgery and is considered the gold standard for auricular reconstruction in patients with microtia.⁴ The cartilage framework offers excellent durability and aesthetic results. There are several methods of ear reconstruction. Historically, three to four stages were necessary for ear reconstruction. Researchers are discussing the selection of surgical techniques, which have evolved to reduce the number of steps required.⁵⁻⁶ The surgical technique for ear elevation has undergone many changes, ranging from the simple elevation of the auricle using a cartilage graftsupport, fascia flap and skin graft.⁵

Good ear elevation involves adequate ear projection and a pleasing posterior aspect. Several methods to cover posterior aspects have been used, including the posterosuperior auricular fascia flap (PSFF), temporoparietal fascia flap (TPF), and retroauricular fascia flap (RFF). However, complications such as skin graft necrosis, surgical wound infection, scarring, skin contractures in the skin graft area, and resorption of the cartilage framework can later lead to inadequate projection of the auricle and decreased auriculocephalic angle. Therefore, selecting the surgical technique used for ear elevation can determine the aesthetic and reconstruction outcome.¹

Methods

Study Eligibility

The systematic review was conducted in accordance with Preferred Reporting Items for

Systematic Reviews and Meta-analysis (PRISMA) guidelines. Randomized clinical trials (RCTs) and non-randomized studies of interventions (e.g., comparative cohorts) were included to investigate the clinical outcome in the form of aesthetics by comparing three different surgical techniques: TPF, PSFF, and RFF. Inclusion criteria include patients with unilateral or bilateral type three microtia, cartilage usage as a framework in the first stage, stage two of microtia reconstruction, and flap usage with skin grafts. Exclusion criteria comprise one-stage surgical reconstruction, porous polyethylene framework (medpor), free flap, and tissue expander usage, articles not in English and not available in full text.

Clinical Questions

Based on the microtia reconstruction surgery technique described above, the authors would like to explore which technique for the second stage of ear reconstruction can achieve the most aesthetically satisfying results. Clinical questions are formulated using population, intervention, comparison, outcome (PICO) as follows, patients with congenital microtia undergoing ear reconstruction surgery (P): Stage 2 microtia reconstruction technique using temporoparietal fascia flap, posterosuperior auricular fascia flap (I); Stage 2 microtia reconstruction technique with retroauricular fascia flap (C): Clinical outcome in the form of aesthetics, e.g. skin necrosis, contracture, minimal scarring, ideal proportion and projection of the ear (O).

Search Strategy

Literature searches were conducted through public databases such as PubMed/Medline, EBSCOhost, ProQuest, Cochrane Central Register of Controlled Trials (CENTRAL) and public registries namely International Clinical Trials Registry Platform (ICTRP) and Clinicaltrial.gov. A manual search was also done through Google Scholar. The search strategy can be seen in Table 1.

Table 1. Search Strategy

Database/Registry and Date	Search Terms	Hit
PubMed [06-June-2023]	((Congenital Microtia[MeSH Terms]) OR (Anotia*[Text Word])) OR (Microtia*[Text Word]) AND (((((((surgical flap*[Text Word]) OR (island flap*[Text Word]) OR (pedicled flap*[Text Word]) OR (pedicle flap*[Text Word])) OR (Surgical Flaps[MeSH Terms])) OR (temporoparietal fascia flap[Text Word]) OR (posterosuperior auricular fascia flap[Text Word]) OR (retroauricular fascia flap[Text Word])) OR (fascia flap*[Text Word]))	233
CENTRAL [25-May-2023]	#1 MeSH descriptor: [Congenital Microtia] explode all trees 14 #2 (Microtia):ti,ab,kw 33 #3 (Anotia):ti,ab,kw 0 #4 #1 OR #2 OR #3 33 #5 MeSH descriptor: [Surgical Flaps] explode all trees 1592 #6 (surgical flap):ti,ab,kw 2947 #7 (island flap):ti,ab,kw 63 #8 (pedicled flap):ti,ab,kw 104 #9 (pedicle flap):ti,ab,kw 131 #10 (temporoparietal fascia flap):ti,ab,kw 0 #11 (posterosuperior auricular fascia flap):ti,ab,kw 0 #12 (retroauricular fascia flap):ti,ab,kw 0 #13 (fascia flap):ti,ab,kw 106 #14 #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 3547 #15 #4 AND #14 0	0
EBSCOhost [06-June-2023]	(TX temporoparietal fascia flap OR TX posterosuperior fascia flap OR TX retroauricular fascia flap OR MM temporoparietal fascia flap) AND (MM congenital microtia OR AB congenital microtia)	26
ProQuest [26-May-2023]	(MESH.EXACT("Congenital Microtia") AND (temporoparietal fascia flap) OR (posterosuperior fascia flap) OR (retroauricular fascia flap)) AND la.exact("English") AND (publication.exact("PQDT-Global") OR "Aesthetic Plastic Surgery" OR "The Journal of Laryngology and Otology" OR "ProQuest Dissertations and Theses" OR "Surgical and Radiologic Anatomy" OR "Surgical Endoscopy" OR "The Annals of Otology, Rhinology & Laryngology" OR "Indian Journal of Otolaryngology & Head and Neck Surgery" OR "Indian Journal of Otology" OR "Indian Journal of Plastic Surgery" OR "Journal of Clinical Medicine" OR "ORL: Journal for Oto - Rhino - Laryngology and Its Related Specialties" OR "The Egyptian Journal of Otolaryngology" OR "The Journal of International Advanced Otology" OR "BMC Surgery" OR "Ear, Nose & Throat Journal" OR "Journal of Otolaryngology - Head & Neck Surgery" OR "World Journal of Surgery" OR "BioMed Research International" OR "European Surgical Research" OR "Laryngoscope Investigative Otolaryngology" OR "Plastic Surgery" OR "PLoS One" OR "PQDT - UK & Ireland" OR "SICOT-J" OR "American Journal of Rhinology" OR "Annals of the Royal College of Surgeons of England" OR "BMJ Open" OR "Cureus" OR "Experimental and Therapeutic Medicine" OR "Head & Face Medicine" OR "Medicina" OR "Online Journal of Otolaryngology" OR "Oral and Maxillofacial Surgery" OR "The American Surgeon" OR "The Journal of Otolaryngology" OR "Turkish Journal of Surgery") AND at.exact(("Article" OR "Dissertation/ Thesis" OR "Evidence Based Healthcare" OR "Literature Review" OR "Review") NOT ("General Information" OR "Case Study" OR "Report" OR "Undefined" OR "News" OR "Conference" OR "Commentary" OR "Conference Proceeding" OR "Correspondence" OR "Recipe")) AND stype.exact("Scholarly Journals" OR "Dissertations & Theses") AND la.exact("ENG")) AND stype.exact("Scholarly Journals" OR "Dissertations & Theses")	195
Clinicaltrials.gov [25-May-2023]	Microtia	19
ICTRP [25-May-2023]	Microtia	41
Hand searching (Google Scholar) [30-May-2023]	second stage microtia surgery AND temporoparietal fascia flap AND posterosuperior fascia flap AND retroauricular fascia flap	483

Study Selection

The initial search yielded 997 studies. After duplicates were removed, 973 articles underwent title and abstract screening. Six articles were assessed in full text and three articles were selected according to the eligibility criteria. The selection process was done independently by two authors. No studies were excluded after critical appraisal (Figure 1).

Critical Review Method

The appraisal review process used the Risk of Bias 2 (RoB 2) tool for RCTs and ROBINS-I for non-randomized studies of interventions. We used the five GRADE considerations (study limitations, consistency of effect, imprecision, indirectness, and publication bias) to assess the quality of a body of evidence and planned to summarize our primary outcomes in the Table 2.

Results

Table 2 shows the characteristics of the selected studies. These studies investigated the results of posterosuperior auricular fascia flap (PSFF), temporoparietal fascia flap (TPF), and retroauricular fascia flap (RFF) procedures. The subjects ranged from children (above 6 years old) to adults (35 years old) with type 3 microtia. Data from all studies was collected by 2 authors together.

This literature investigates different techniques of reconstructive surgery to provide better outcomes for patients. Li et al⁷ found that PSFF was easier to harvest and significantly decreased operative time ($p < 0.01$). PSFF has a minimal incidence of postauricular hypertrophic scarring ($p = 0.03$) and partial skin graft necrosis ($p = 0.01$). All 244 PSFF groups and 162 RFF groups were analyzed in the group that they were assigned. All patients were

followed up between 6 months and ten years after the final operations, and the surgeon’s satisfaction scores for postoperative outcomes were reviewed. Similar to the study conducted by Li et al⁷ patients and surgeons in our center prefer the technique to have an overall excellent result, especially in terms of the aesthetic outcome.

According to Jin et al⁸ RFF resulted in an overall better aesthetic result compared to TPF. RFF resulted in more excellent fascia flap and skin flap. No patient who had undergone RFF showed severe hair thinning at the donor site or obvious scars. Duvdevani et al⁹ concluded that there were no statistically significant differences in auricular projection results among patients operated with all three techniques (PSFF, RFF, and superficial muscular aponeurotic system (SMAS) advancement flap).

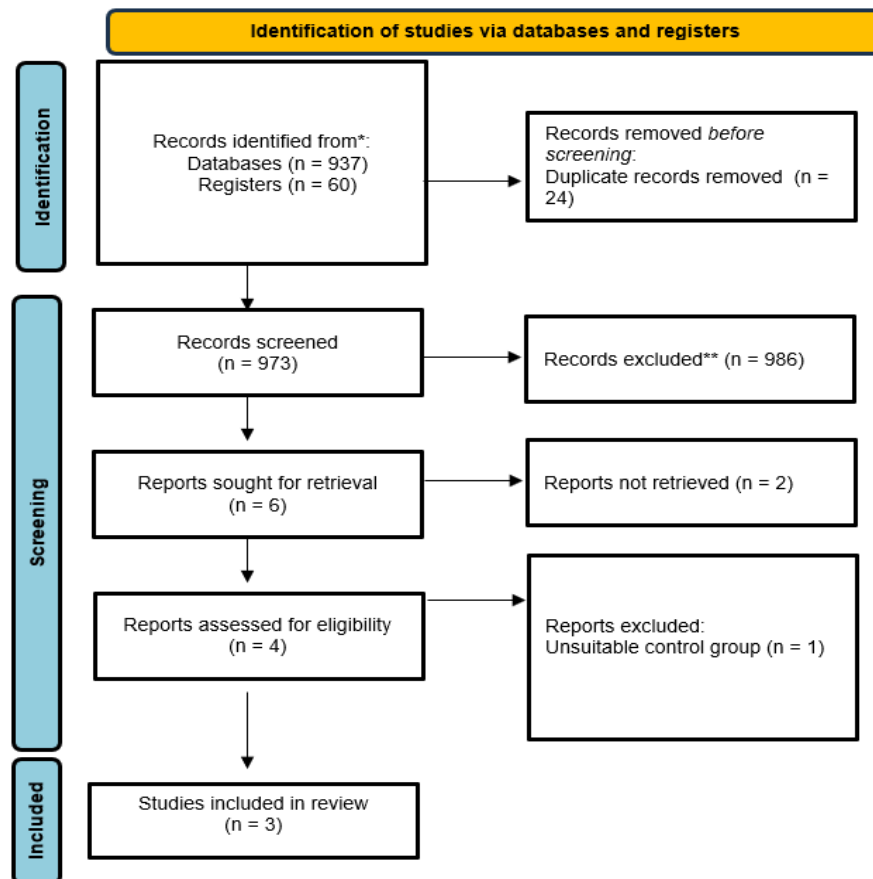


Figure 1. PRISMA Flow Diagram

Table 2. Included Studies Characteristic

Author	Title	Study Design	Sample Size	Age (Year)	Participants	Type	Intervention	Comparison	Outcomes
Li et al ⁷	An alternative postero-superior auricular fascia flap for elevation during microtia reconstruction	Comparative cohort	306	10.9 (6-47)	Patients with microtia	Sausage-type 174 patients, lobule-type 9 patients, concha-type 67 patients	Postero-superior auricular fascia flap 244 patients	Retroauricular fascia flap 162 patients	Posterosuperior auricular fascia flap was easier to harvest, and the operative time significantly ($p < 0.01$) decreased the incidence of postauricular hypertrophic scarring increased from 24.7% to 13.2% ($p = 0.03$) and partial skin graft necrosis from 43.4% to 31.2% ($p = 0.01$).
Jin et al ⁸	A comparative study of temporo-parietal fascial flap and postauricular fascial flap in the ear elevation	Comparative cohort	72	12 (5-28)	Patients with microtia	Lobule-type 56 patients. concha-type 16 patients	Temporoparietal fascia flap 29 patients	Retroauricular fascia flap 43 patients	55 patients had excellent fascia flap and skin flap (22 in intervention, 33 in control group), 15 patients had darker epidermis healed in 1 month postoperatively (6 in intervention, 9 in control group), 2 cases had partially grafted skin and fascia flap necrosis (1 in intervention, 1 in control group), 47 patients had flat scars (19 in intervention and 28 in control), 18 patients had hyperplastic scars (7 in intervention and 11 in control), 7 patients had severe scars with aulocephalic angles draw-off (3 in intervention and 4 in control group). Severe hair thinning at the donor site and obvious scars in the intervention. Retroauricular fascia flap offered superior aesthetic results.
Duvdevani et al ⁹	Sulcus construction in microtia repair	Comparative retrospective cohort	60	15.5 (9-35)	Patients with microtia	Lobule-type 45 patients, concha-type 15 patients.	Temporoparietal fascia flap 16 patients	Retroauricular fascia flap 7 patients, SMAS advancement flap 40 patients	Auricular projection is calculated by subtracting the length of the outer edge of the ear from the length of the medial edge of the ear and dividing it by the length of the horizontal line between the pupils. No significant differences in the auricular projection resulted from the 3 techniques

Discussion

Microtia reconstruction is carried out in two stages in Nagata technique. In the first stage, the costal cartilage framework is fabricated and inserted into the skin pouch at the ear, with the remaining costal cartilage stored in the chest wall for later use in the second stage. The second stage is conducted at least 6 months afterwards.¹⁰ Before surgery, a flap transfer plan is carried out using Doppler ultrasound to assess the recipient's vessels, the superficial temporal artery (STA) the superficial temporal vein (STV), and the medial temporal vein (MTV) in the preauricular area.¹⁰



Figure 2. Planning for Ear Reconstruction (Modified from Duvdevani et al⁹)

In the first stage, the cartilaginous framework was implanted (Figure 2). In the second stage, the ear was separated from the head using a local flap and skin graft. This process defined the posterior margin of the ear and created an auriculoscaphic sulcus. Brent et al⁶ made the incision several millimetres away from the embedded framework. (Figure 3) and then raises the ear carefully from its layer of connective tissue while ensuring the preservation of the tissue that nourishes the graft on the underside of the framework.⁶ The remaining costal cartilage was then used to support as a buttress in the cartilaginous framework, which was elevated in the projection of the normal ear.¹⁰



Figure 3. Posterosuperior Fascial Flap Design A. Posterior Pole; B. Superior Pole; C. Anterior Pole; D. Inferior Pole; L. Inferior Otobasion. Modified from Li, et al⁸)

The flap was removed to reconstruct the skin defect at the retro auricular sulcus and cover the cartilage framework and surrounding scalp. In posterosuperior auricular fascia flap technique, a skin incision is made 5 mm laterally from the posterior border of the auricle. The framework is then elevated by dissection between the framework and fascial planes, and extensive subcutaneous undermining is performed to prepare for the PSFF. The selection of STA, STV, and MTV branches that match the vessel diameter of the PAAP (Posterior Auricular Artery Perforator) flap for microsurgical anastomosis can be conducted (Figure 4). Microvessel anastomosis and vascularization of the flap are both usually confirmed by angiography.¹⁰



Figure 4. Posterior Auricular Artery Perforator Flap Design (Modified from Li, et al⁷)

An incision starts from the preauricular area extending to the superior temporal line to harvest the TPF. (Figure 5) After detailed elevation of the flap with the protection of the pedicle of the superficial temporal artery, the flap is then draped over the recipient bed area. The flap's flexibility enables coverage of frameworks and bones, and coupled with its excellent blood supply, the TPF offers a range of advantages.



Figure 5. Illustration of The Temporoparietal Fascia Flap (Modified from Li, et al⁷)

Modifying the RFF to PSFF resulted in a fascia flap that was technically easier to dissect (Figure 6), thereby reducing surgical time compared to conventional RFF ($p < 0.01$), the incidence of postauricular hypertrophic scarring was less than conventional RFF ($p = 0.03$) and less incidence of partial skin graft necrosis than conventional RFF ($p = 0.01$). However, further research should be conducted to determine the histologic characteristics and blood supply patterns of PSFF. A detailed assessment of postsurgical complications is also needed for further research.⁷

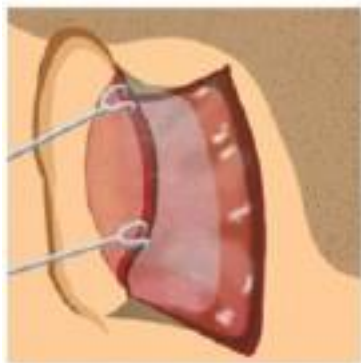


Figure 6. Retroauricular Fascia Flap Technique (Modified from Duvdevani et al⁹)

According to Park et al¹¹ framework resorption reduced the aesthetic results significantly more than TPF in cases performed with the tissue expansion technique ($p = 0.004$). Poor vascular coverage can cause resorption in this technique. The authors assume that the tissue expansion technique makes the skin layer too thin, which causes poor vascular supply to the framework in the long term. The SMAS advancement flap is safe, easy to perform, and does not produce secondary defects. In addition, this technique can be used in combination with auricle and middle ear reconstructive surgery (Figure 7 and 8). With the SMAS advancement flap, the TPF will be available for complicated cases or revisions.⁵



Figure 7. A. Pre Stage-Two Reconstruction Surgery Using Temporoparietal Fascia Flap Technique; B. Post Stage-Two Reconstruction Surgery Using Temporoparietal Fascia Flap Technique



Figure 8. A. Pre Stage-Two Reconstruction Surgery Using Retroauricular Fascia Flap Technique; B. Post Stage-Two Reconstruction Surgery Using Retroauricular Fascia Flap Technique

Conclusion

This systematic review reveals that the use of PSFF in stage two reconstruction surgery for congenital microtia is superior to TPF and RFF. PSFF is well-defined, highly vascularized, thinner, easier to perform, less time consuming, improves ear elevation, and results in less hypertrophic scarring and less partial skin necrosis compared to RFF. In comparison to TPF, RFF may offer better aesthetic results. Even though TPF is well vascularized, the harvesting process can cause obvious scarring and hair thinning at the donor site. Furthermore, TPF is more time-consuming, causes more bleeding, and decreases in auriculocephalic angle. No significant difference in auricular projection resulted from TPF and RFF. However, RFF cannot be performed in patients who need canaloplasty, while TPF can be conducted in difficult cases, for instance, low hairline microtia, cases with framework necrosis, or cartilage resorption.

Conflict of Interest

The authors declare no conflict of interest.

References

1. Bly RA, Bhrany AD, Murakami CS, Sie KCY. Microtia reconstruction. *Facial Plast Surg Clin N Am*. 2016;24:577-91. doi: 10.1016/j.fsc.2016.06.011.
2. Andrews J, Hohman MH. Ear microtia [Internet]. Treasure Island (FL):StatPearls Publishing;2022 [cited 2022 Jul 4]. Available from <https://www.ncbi.nlm.nih.gov/books/NBK563243/>.
3. Helwany M, Tadi P. Embryology, ear. Treasure Island (FL):StatPearls Publishing;2022 [cited 2022 Jul 4]. Available from <http://www.ncbi.nlm.nih.gov/books/NBK557588/>.

4. Yamada A. Autologous rib microtia construction: Nagata technique. *Facial Plast Surg Clin North Am.* 2018;26:41-55. doi: 10.1016/j.fsc.2017.09.006.
5. Baluch N, Nagata S, Park C, Wilkes GH, Reinisch J, Kasrai L, et al. Auricular reconstruction for microtia: a review of available methods. *Plast Surg.* 2014;22:39-43.
6. Brent B. Microtia repair with rib cartilage grafts: A review of personal experience with 1000 cases. *Clin Plast Surg.* 2002;29:257-71. doi: 10.1016/s0094-1298(01)00013-x.
7. Li Y, Zhang R, Zhang Q, Xu Z, Xu F, Li D. An alternative posterosuperior auricular fascia flap for ear elevation during microtia reconstruction. *Aesthetic Plast Surg.* 2017;41:47-55 doi: 10.1007/s00266-016-0743-5.
8. Jin P, Xu F, Zhang R, Zhang Q. A comparative study of temporoparietal fascial flap and postauricular fascial flap in the ear elevation. *CJPRS.* 2008;22:1421-5.
9. Duvdevani S, Ralp M, Ralf S. Sulcus construction in microtia repair. A retrospective comparison of different techniques. *JAMA Facial Plast Surg.* 2013;15:17-20. doi: 10.1001/2013.jamafacial.7.
10. Banda CH, Narushima M, Mitsui K, Danno K, Fujita M, Furuya M, et al. Posterior auricular artery free flap reconstruction of the retroauricular sulcus in microtia repair. *J Plast Reconstr Aesthetic Surg JPRAS.* 2021;74:2349-57. doi: 10.1016/j.bjps.2020.12.047.
11. Park JY, Park C. Microtia reconstruction in hemifacial microsomia patients: three framework coverage techniques. *Plast Reconst Surg.* 2018;142:1558-70. doi: 10.1097/PRS.0000000000005063.