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Original Article

Clinical effect evaluation and complication analysis of different auricle reconstruction of congenital microtia

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Abstract: This study compared the clinical efficacy and complications of autogenous rib cartilage stent and Medpor stent auricle reconstruction in patients with congenital microtia. A total of 300 patients with congenital microtia were selected as the research objects. 150 patients in the auricle reconstruction group with autologous rib cartilage stent and 150 patients in the auricle reconstruction group with Medpor stent were selected. Postoperative follow-up was conducted to observe whether the shape, color, size, and position of the reconstructed auricle were good, and to compare whether the cranial auricle Angle was consistent with the healthy lateral auricle, so as to judge whether the reconstructed auricle was successful. The incidence of postoperative complications, such as infection and stent exposure was recorded. The postoperative satisfaction and quality of life scores were compared between the two groups. Two operation methods of the auricle reconstruction effect showed no obvious difference ($P>0.05$), but the incidence of auricle reconstruction scaffold exposing Medpor stenting was significantly higher than those of autologous rib cartilage auricle reconstruction. The satisfaction and quality of life scores of patients in the autologous rib cartilage group were significantly higher than those in the Medpor stent group ($P<0.05$). Although there was no significant difference between auricle reconstruction with autologous rib cartilage scaffold and Medpor stent implantation in the improvement rate of microtia, there were fewer complications after autologous rib cartilage stent implantation, but higher patient satisfaction and quality of life. (The registry of clinical trial is: Chinese Clinical Trial Register, ChiCTR2100052010, https://www.chictr.org.cn/).

Keywords: Auricle reconstruction of congenital microtia, autologous rib cartilage stent, Medpor stent

Introduction

Congenital microtia is the second most common craniofacial birth defect in newborns, only lower than cleft lip and palate, and the prevalence varies among regions, from 0.83 to 17.4 per 10,000 births [1]. Congenital microtia can occur either alone or in a complex disease [2, 3]. Both genetic and environmental factors are related to the occurrence of microtia, but research has found that besides inappropriate medication during pregnancy and contact teratogenesis, genetic factors have a greater impact on the occurrence of microtia [4-6]. At present, auricle reconstruction is the main method to treat this defect. Children with congenital microtia are often accompanied by atresia of the external auditory canal and dysplasia of the middle ear. The clinical symptoms are the disappearance or partial disappearance of the basic structure of the auricle, only residual ear cartilage and part of the earlobe, or even no such structure at all. At the same time, there may be other malformations, which bring serious psychological burden to the patients and their families [7]. Therefore, how to reconstruct the realistic auricle so that patients and their families can be accepted by society and return to normal social life is very important. Auricle reconstruction is an operation to reconstruct part or all of the defect auricle of patients. The initial use of allogeneic cost cartilage for auricle reconstruction is not recommendeddue to the absorption of allogeneic rib cartilage in the later period. Until Tanzer [8] completed auricle reconstruction with autologous rib cartilage as a scaffold material, this was the pioneer and modern auricular reconstruction method. Many

auricle reconstruction methods currently used in the clinical treatment of congenital microtia are basically based on the principle of Tanzer auricle reconstruction. It uses carved and stable ear brackets, skin covered brackets, and fascia flaps to reconstruct the auricle, which has demonstrated good surgical results [9].

Reconstruction of the auricle often requires a certain material as a stent to ensure the reconstruction of the shape of the auricle. Some uses the patient's own rib cartilage, while others use silica gel blocks for reconstruction. Because the autologous rib cartilage is the patient's own tissue, it is non-antigenic and easy to shape, and there are generally no postoperative complications [10]. Selection of auricle reconstruction stent is the key to the success of the operation. Although autologous rib cartilage is the preferred material for auricle bracket fabrication [11, 12], artificial materials, including Medpor, which are commonly used at present, have the advantage of avoiding the collection of autologous cartilage and causing additional damage [13-15]. However, the influence of different auricle reconstruction stents on the surgical effect is still in debate. Various complications after auricle reconstruction affect the effect of surgery [16] and increase the burden on patients. Analyzing the causes of related complications and taking active and effective countermeasures are conducive to improving the effect of surgery and reducing the burden of patients. In this study, we mainly compared specific clinical curative effects of the application of autologous rib cartilage auricle reconstruction and application of Medpor stenting of auricle reconstruction. The specific influence of different surgical methods on the surgical effect was clarified, the occurrence of postoperative complications was observed and recorded, the specific causes of related complications were analyzed, and the relevant risk factors were summarized, which may provide reference for the selection of clinical surgical methods.

Materials and methods

General information

This is a prospective study. Three hundred patients with congenital microtia who admitted to Hunan Provincial Children's Hospital from 2017 to 2019 were selected as the research objects. All the patients underwent auricle reconstruction. There were 150 cases in the auricle reconstruction group with autologous rib cartilage stent and 150 cases in the auricle reconstruction group with Medpor stent. There were 76 males and 74 females in autogenous rib cartilage group. The patients were 6-16 years old, with a mean age of 12.0±2.5 years old. There were 62 cases of left malformation, 59 cases of right acute malformation, and 29 cases of bilateral malformation. There were 78 males and 72 females in the Medpor stent group. The patients were 6-17 years old, with a mean age of 12.3±2.4 years old. There were 65 cases of left malformation, 58 cases of right acute malformation, and 27 cases of bilateral malformation. There was no statistically significant difference in the basic data between the two groups ($P>0.05$), suggesting the comparability. This study was approved by the Ethics Committee of Hunan Provincial Children's Hospital (approval number: HCHLL-2020-28).

Inclusion and exclusion criteria

Inclusion criteria: (1) Patients with microtia type II or above and patients undergoing auricle reconstruction. Type I: no ear deformity. Type II: complete auricle dysplasia/microtia (IIa with external auditory atresia, IIb without external auditory atresia). Type III: 1/3 of the auricle is dysplastic. Type IV: upper 1/3 of auricle dysplasia (IVa: cup ear malformation, IVb: cryptic ear malformation, IVc: total upper 1/3 of auricle malformation). Type V: protruding ears. (2) Patients with complete clinical data. (3) Patients who were aware of research related matters on the day of or after admission and signed an informed consent form.

Exclusion criteria: (1) Patients with combination of other factors that may affect the patient's psychological status. (2) Patients with incomplete collection of clinical data.

Data collection and preoperative preparation

General clinical data of patients were collected, including gender, age, defected ear, and disease classification. For patients with facial acne, 0.2% iodine tincture was used topically. For patients with external auditory canal stricture and who could not undergo simultaneous hearing reconstruction, the hearing reconstruction was performed first, followed by complete

auricle reconstruction performed 3 months later. The patients with preauricular fistula were removed at the same time during hearing reconstruction. If the CT of temporal bone showed shadow in external auditory canal, mastoid process, and tympanum, the external auditory canal tympanoplasty or mastoid radical tympanoplasty was performed first, following by complete auricle reconstruction in the second stage.

Autogenous rib cartilage stent auricle reconstruction

According to the modified Nagata method for the treatment of congenital microtia. The modified Nagata method was applied in three sessions of six months each. Period I: The 6-9 rib autogenous rib cartilage was taken to make auricle stents, and stents were buried in mastoid subcutaneous area behind ear and then remove of residual ear. Period II: The reconstructed ear was straightened and erected. Period III: The reconstructed ear was trimmed, and the ear cavity was deepened.

Auricle reconstruction with Medpor stent implantation

The operation method was divided into three stages: Period I: The kidney-shaped dilator was placed under the deep fascia of the affected mastoid region, and adequate excessive water injection was started 10 days after the operation. Period II: The stent was implanted between the expansion of regional deep fascia and periosteum Medpor. The shape and position of the stents were adjusted according to lateral auricle. The expanded fascial flap was used to wrap the stent completely. Period III: Unwanted residual ear cartilage was removed, then turn earlobe to deepen ear cavity.

Postoperative follow-up

The enrolled patients were followed up 10 days after surgery and 6-12 months. Compare the reconstructed ear with the normal ear through three-dimensional CT or three-dimensional scanning technology and digital analysis image software, such as the similarity of the structure of the bilateral auricles (external auricle, contralateral auricle, triangular fossa, tragus, auricle cavity, etc.) and the spatial symmetry between the reconstructed ear and the normal ear. The criteria for evaluating the effect of reconstructed ears depend on the size, position, and symmetry of the reconstructed auricle. Good effect: Compared with the normal ear, the reconstructed auricle, such as the external auricle, the contralateral auricle, the triangular fossa, the tragus, and the auricle cavity, have clear contours; the reconstructed ear is symmetrical in space with the normal ear. General effect: Compared with the normal ear, the reconstructed auricle, such as the external auricle, the contralateral auricle, the triangular fossa, the tragus, and the auricle cavity, have clear contours; however, the spatial position of the reconstructed ear and the normal ear is asymmetrical. Poor effect: Compared with the normal ear, the contour of the reconstructed auricle is not clear; and the spatial position of the reconstructed ear is asymmetrical with the normal ear.

The occurrence of complications such as ear infection and stent exposure during the postoperative follow-up period was recorded, and the risk factors leading to complications were analyzed.

An “Auricle Reconstruction Patient Satisfaction Questionnaire” was designed for patients. Six months after the operation, a satisfaction survey was conducted on the enrolled patients (patients’ family members) and the questionnaire survey was completed. Patients’ satisfaction with the three-dimensional contour, position, size, cranial ear angle, symmetry, function, and stability of the reconstructed auricle, as well as their satisfaction with wearing glasses correctly. For patients who were too young to complete the survey on their own, the contents and evaluation criteria of the investigation were briefed to the patients and their families to assist in completing the investigation. There are total of 8 items in the questionnaire, using a three-level scoring method, with a full score of 24 points. Satisfaction/Very helpful scores 20~24 points; Generally satisfied/Helpful scores 12~<20 points; Dissatisfied/Basically not helpful scores <12 points. Satisfaction rate (%) = (Satisfied number + Generally satisfied number)/total number *100%.

The quality of life was evaluated using the Generic Quality of Life Inventory-74 (GQOLI-74) [17], which mainly involves five dimensions of

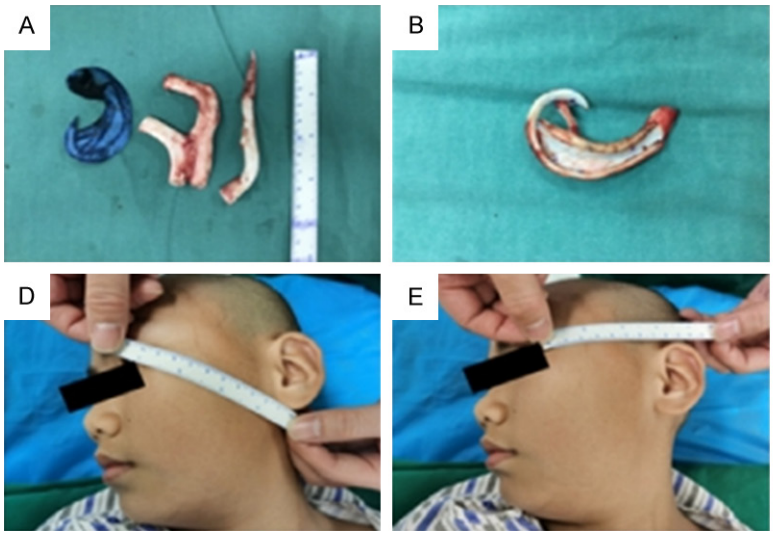

Figure 1. Materials and dimensions used in operation. A-C. Materials used in the operation, autologous rib cartilage. D, E. The distance between lateral canthus and the upper and lower poles of the lateral ear; between the lateral alar foot of the lateral alar and the upper and lower poles of the lateral ear during the operation refers to the label picture.

physical health, mental health, independence, social relations, and overall health, with a total of 100 points for each dimension. The higher the score, the better the quality of life. The quality of life of the two groups was compared before and 6 months after the operation.

Statistical methods

SPSS 20.0 software was used to process the data. The counting data was represented by n (%), Chi-square (χ^2) test was used for comparison between the two groups; When $1 \leq T < 5$ and total sample size ≥40, continuous corrected Chi-square test was used for comparison between the two groups; When $T < 1$ or total sample size <40, Fisher's exact test was used for comparison between the two groups. The measurement data were expressed by ($\bar{x} \pm s$), t test was used for comparison between the two groups. Spearman correlation analysis was conducted for the correlation among the variables following the normal distribution. $P<0.05$ was considered as statistically significant.

Results

Materials and dimensions used in the operation

The materials and dimensions used in the operation are shown in **Figure 1**.

Comparison of auricle of children before and after surgery

The contrast before and after the reconstruction of the auricle of microtia is shown in **Figure 2**. The shape, similarity, and size of auricle were improved effectively.

Treatment effect of the two types of auricle reconstruction

Chi-square test was used to compare the treatment effect of patients between the two groups. As shown in **Table 1** and **Figure 3**, there was no significant difference in the effect of autologous rib cartilage stent and Medpor stent implantation.

Comparison of complications of auricle reconstruction with autologous rib cartilage stent and Medpor stent implantation

Continuous corrected Chi-square test and Fisher's exact test were used to compare the complications of patients in the two groups. As shown in **Table 2**, there was no significant difference in the probability of infection and skin rupture between the two groups, but the incidence of exposing auricle reconstruction stent implanted with Medpor was significantly higher than that of auricle reconstruction with autologous rib cartilage stent.

Satisfaction scores of the two types of auricle reconstruction

Chi-square test was used to compare the satisfaction of patients in the two groups. In this study, there was a significant difference in patients' satisfaction with the two kinds of reconstructed auricle. The satisfaction of patients in the autologous rib cartilage stent group was 95.33%, significantly higher than 82.67% in the Medpor stent group (**Table 3**).

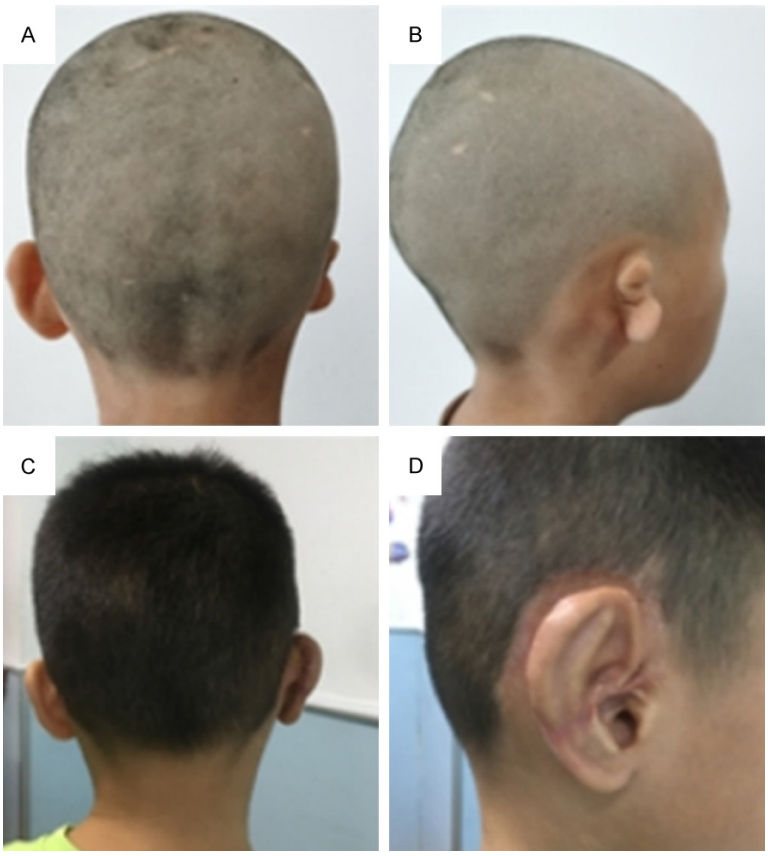

Figure 2. Comparison before and after microauricle reconstruction. A. Bilateral dorsal view before surgery. B. Defected side before surgery. C. Bilateral view of the back after surgery. D. Repaired side after surgery.

Comparison of the quality of life of patients with autologous rib cartilage stent and Medpor stent implantation

T test was used to compare the quality of life between the two groups. There was no significant difference in the quality of life scores between the two groups of patients before the operation ($P>0.05$), and there were significant differences in the quality of life of the two types of reconstructed ears after the operation ($P<0.05$). The quality of life score of patients in the autologous rib cartilage stent group was significantly higher than that of the Medpor stent group (**Table 4**).

Discussion

Congenital microear malformation is a group of maxillofacial malformations caused by the abnormal development of the first branchial groove and its adjacent first and second branchial arches during the embryonic period, and the incidence of which is related to the race and region [6, 18]. The incidence is higher in male than in female with a ratio of 2:1. Right-sided malformations are more common, with bilateral malformations accounting for about 10% of the cases. The clinical features of congenital microtia patients are external ear malformation, external auditory canal lockup, and middle ear malformation, and many patients are accompanied by ipsilateral mandibular and facial soft tissue dysplasia [19]. Congenital microtia seriously affects the appearance of patients. Currently, the methods to improve the appearance of auricle include auricle reconstruction, ear prosthetics, and genetic engineering [20, 21]. Some studies have achieved the growth of bovine cartilage tissue through tissue engineering experiments. Human auricle cartilage stent was successfully obtained on the artificial biodegradable ear model and transplanted under the skin of guinea pigs and succeeded [22]. However, there are still many problems to be solved for successful application of this technique in clinical auricle reconstruction. The clinical application of artificial ear is limited, so auricle reconstruction remains a better treatment method at present [23, 24].

In this study, we investigated the clinical efficacy of auricle reconstruction with autologous rib cartilage stent and auricle reconstruction with Medpor stent implantation and analyzed its complications. We found that both kinds of auricle reconstruction can effectively improve the condition of auricle deformity in children, the reconstructed ear has the correct position and size, the auricle angle is basically symmetrical, the shape is realistic, and the effect is good. In this study there was no significant difference in the treatment effect of autologous

Table 1. Comparison of auricle reconstruction effect

	Good	General	Poor	χ^2	*P*
Autologous rib cartilage stent (n=150)	75 (50.0%)	46 (30.67%)	29 (19.33%)	0.573	0.449
Medpor stent (n=150)	69 (46.0%)	57 (38.0%)	24 (16.0%)		

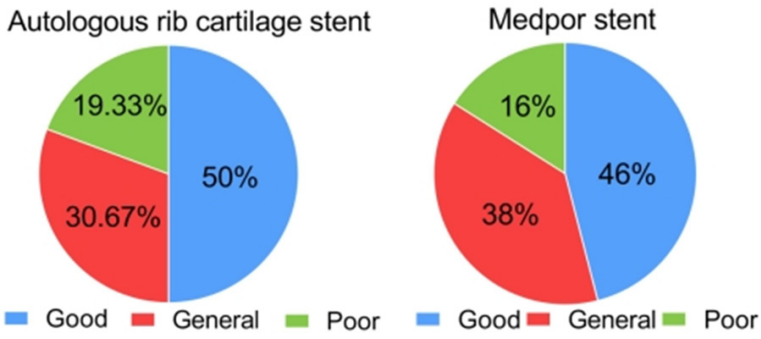

Figure 3. Comparison of auricle reconstruction effect.

rib cartilage stent and Medpor stent implantation. At present, the commonly used surgical materials for reconstruction of microtia include two types: autologous rib cartilage stent and Medpor stent. Autogenous rib cartilage is the most commonly used ear stent material, which is widely used as it has no rejection after implantation, easy to be obtained and sculpted, and has low infection rate [25, 26]. Compared with autologous rib cartilage, the greatest advantage of Medpor stent is to reduce trauma and avoid the pain of rib cartilage removal. In addition, the operative period is short, with little pain, and it is not easy to be absorbed and denatured [27, 28].

Although clinical applications have demonstrated the superiority of the Medpor material. But it also has its disadvantages. In this study, it was found that Medpor stent has more overall complications than autologous rib cartilage stent, with the main complication of stent exposure, which may be related to the material characteristics of Medpor stent. Medpor material is hard, poor compliance, often caused by oppression exposure. Once the skin ruptures and the stent is exposed, the wound is difficult to self-heal. In order to repair large wounds, local flap transfer or local fascial flap transfer and skin flap transfer are usually needed [29-31]. In this study, it was also found that patients were less satisfied with Medpor stent auricle reconstruction, which may be related to more complications of Medpor stent. Although the two surgical methods have little effect on the patient's recovery, postoperative complications have become an important factor affecting the degree of surgical satisfaction. Therefore, optimization of the techniques, such as the use of a stent with good blood flow to cover the superficial temporal fascia, may significantly reduce the incidence of complications [25]. In addition, we have also observed that patients with autologous rib cartilage stent auricle reconstruction have higher quality of life scores than patients with Medpor stent auricle reconstruction. This may be because autologous rib cartilage is the patient's own tissue, which is non-antigenic, easy to shape, and generally has no complications after surgery, which improves the patient Quality of Life. Therefore, autologous rib cartilage stent auricle reconstruction should be recommended should the patients are eligible for autologous transplantation.

In addition to the two materials mentioned above, a variety of tissue materials have been proposed for auricle reconstruction, including allogenous cartilage, heterogenous cartilage, and other artificial materials. Direct allograft cartilage transplantation can cause rejection, and scholars have tried to treat it in various ways, but its feasibility has not been determined due to the lack of long-term follow-up reports [32].

Auricle reconstruction surgery is a complicated operation that requires the cooperation of patients and doctors to complete it well and have satisfactory results. Therefore, it is particularly important to choose the timing of surgery. This study still has some shortcomings that it didn't study the therapeutic effects of different age on different auricle reconstruction procedures, so our next study will analyze the impact of patients' surgical age on postoperative psychology, in order to achieve the

Table 2. Comparison of complications between the two groups

	Infection	Stent exposure	Skin collapse	Other complications
Autologous rib cartilage stent (n=150)	1 (0.67%)	2 (1.33%)	3 (2%)	0
Medpor stent (n=150)	1 (0.67%)	25 (16.67%)	4 (2.67%)	3 (2%)
χ^2	0.000	19.699	0.000	-
P value	1.000	0.000	1.000	0.247*

Note: *Fisher's exact test were used for comparison between the two groups.

Table 3. Satisfaction scores of the two kinds of auricle reconstruction

Group	Satisfied	Generally satisfied	Dissatisfied	Satisfaction rate (case,%)
Autologous rib cartilage stent (n=150)	73	70	7	143 (95.33)
Medpor stent (n=150)	64	60	26	124 (82.67)
χ^2				12.291
P				0.000

Table 4. Life quality score of the two kinds of auricle reconstruction

Group		Physical health	Mental health	Independence	Social relations	Overall health
Autologous rib cartilage stent (n=150)	Preoperative	67.46±8.67	65.22±9.44	66.87±9.67	66.12±9.58	68.59±9.26
	Postoperative	86.87±10.54[a]	87.46±11.12[a]	85.43±9.39[a]	86.24±10.42[a]	88.62±11.35[a]
Medpor stent (n=150)	Preoperative	67.89±8.52	64.35±9.21	67.18±10.11	65.28±9.54	68.24±9.64
	Postoperative	77.12±9.68[a,b]	80.16±10.23[a,b]	80.53±10.62[a,b]	81.71±10.53[a,b]	82.15±10.08[a,b]

Note: [a]P<0.05, indicating the comparison of the quality of life scores of patients in this group before and after surgery. [b]P<0.05, indicating the comparison of the quality of life scores between Autologous rib cartilage stent and Medpor stent.

effect that the postoperative physical and psychological development of patients with auricle reconstruction surgery will not be affected.

In summary, autologous rib cartilage has no immune rejection and sufficient material, which can maintain long-term stability. Patients have high satisfaction with this treatment, and it should be the first choice if there are no contraindications. Medpor can be used as an alternative material, but the incidence of complication stent exposure is high, so it is necessary to ensure a good blood supply to the flap during the operation and to take quality care after the operation.

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Disclosure of conflict of interest

None.

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