



# Assessment of the degree of correction of prominent ears using a standardized treatment algorithm

*Medida do grau de correção das orelhas proeminentes utilizando algoritmo de tratamento padronizado*

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## ABSTRACT

**Background:** The goal of aesthetic otoplasty is the correction of ear deformities by creating harmonious and symmetrical external ears, without visible scars. Otoplasty techniques based on the excision of postauricular skin are associated with high recurrence rates. Modern otoplasty is based on cartilage-cutting and cartilage-sparing techniques, alone or in combination, which lead to lower recurrence rates. **Objective:** We evaluated the efficacy of otoplasty combined with other techniques in the correction of ear deformities, based on a modified version of the "algorithm for otoplasty at the Craniofacial Center at Texas Children's Hospital". **Methods:** Forty patients, who underwent otoplasty for prominent ears in our institution between March and September of 2009, were prospectively assessed. The mastoid-helix distance was measured preoperatively (baseline) and at 1, 3, and 6 months postoperatively. **Results:** The most common deformities were scaphoconchal angle greater than 90° (51.3%, 41/80 ears) and conchal hypertrophy > 2.5 cm (46.3%, 37/80 ears). Recurrence occurred in 2 (5%) patients and partial stenosis of the ear canal in 1 (2.5%). Significant reductions in the mastoid-helix distance were observed at the three time points compared with baseline (P<0.001); a significant reduction was present in the immediate postoperative period (P<0.001), followed by a small increase 3 months postoperatively (P<0.005), which appeared to stabilize between 3-6 months postoperatively (P=0.520). **Conclusion:** Otoplasty performed according to the modified algorithm resulted in a significant reduction of the mastoid-helix distance, which slightly increased in the early postoperative period, and remained unchanged 6 months postoperatively.

**Keywords:** Otolologic surgical procedures. Ear, External. Deformities.

## RESUMO

**Introdução:** O objetivo da otoplastia estética é a correção de deformidades da orelha, criando orelhas externas harmoniosas e simétricas. As

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técnicas de otoplastia, baseadas na excisão da pele pós-auricular, estão associados com a recorrência elevada. A otoplastia moderna é baseada nas técnicas de ressecção e/ou modelagem da cartilagem, que levam a menores taxas de recorrência. **Objetivo:** Foi avaliada a eficácia da otoplastia com técnica combinada na correção de deformidades da orelha, baseado numa versão modificada do "algoritmo para otoplastia", no Centro Craniofacial do Hospital Infantil do Texas". **Método:** Quarenta pacientes submetidos à otoplastia por orelhas proeminentes, entre março e setembro de 2009, foram avaliados prospectivamente. A distância mastoide-hélice foi medida no pré-operatório e após 1, 3 e 6 meses após a cirurgia. **Resultados:** As deformidades mais comuns foram ângulo escafoconchal maior que 90° (51,3%, 41/80 orelhas) e hipertrofia de concha > 2,5 cm (46,3%, 37/80 orelhas). Reduções significativas na distância mastoide-hélice foram observadas nos três períodos em comparação com os valores basais ( $P < 0,001$ ). Houve uma redução desta medida no período pós-operatório imediato ( $P < 0,001$ ), seguido por um pequeno aumento após três meses da cirurgia ( $P < 0,005$ ) e subsequente tendência de estabilização entre 3-6 meses após a cirurgia ( $P = 0,520$ ). **Conclusão:** Otoplastia, realizada de acordo com o algoritmo citado, resultou em redução significativa da distância mastoide-hélice, com ligeira perda desta redução no início do período pós-operatório, e com tendência a manter-se inalterada após 6 meses de pós-operatório. **Descritores:** Orelha externa. Otoplastia. Deformidades.

## INTRODUCTION

Ear deformities are relatively common, occurring with an incidence of 5% in Caucasians. The deformity is diagnosed at birth in 60% of cases and becomes obvious during early childhood<sup>1</sup>. The most common defects in patients with prominent ears are an absent or reduced antihelical fold, conchal hypertrophy or deep conchal bowl, inadequate definition of the helical rim, and abnormalities of the lobule. Patients with prominent ears may have one or more of these defects<sup>2,3</sup>. The goal of otoplasty is the correction of ear deformities by creating harmonious and symmetrical external ears, without visible signs of the surgical procedure<sup>4</sup>. Techniques to correct prominent ears based on the excision of postauricular skin are associated with high recurrence rates. Modern otoplasty is based on cartilage-cutting<sup>2</sup> and cartilage-sparing techniques, alone or in combination, with recurrence rates ranging from 2.1% to 6.6%<sup>1,5</sup>.

The purpose of this study was to evaluate the efficacy of otoplasty combined with other techniques in the correction of ear deformities, based on a modified version of the "algorithm for otoplasty at the Craniofacial Center at Texas Children's Hospital".

## METHODS

The study was approved by the Research Ethics Committee of the Hospital do Servidor Público Municipal de São Paulo (HSPM), Brazil, and performed in accordance with the ethical standards of the 1964 Declaration of Helsinki and its succeeding revisions. Written informed consent was

obtained from all patients or their representatives prior to their inclusion in the study, and anonymity was assured.

A prospective assessment was performed in 40 consecutive patients who underwent otoplasty for prominent ears at the Plastic Surgery Unit of the HSPM between March and September 2009. The exclusion criteria were patient younger than 6 years old, previous otoplasty surgeries, another malformations of the external ear. The participants were mostly female (60%) and the mean age was 20 years (range 8-55 years). Data were collected through a standardized questionnaire and mastoid-helix distances were measured preoperatively (baseline) and at 1, 3, and 6 months after surgery (Fig. 4).



(Fig 4) Picture of the measure of the mastoid-helix distance with precision compass/caliper

The otoplasty techniques used in each case were determined based on a modified version of the "algorithm for otoplasty at the Craniofacial Center at Texas Children's Hospital" (Table 1)<sup>6</sup>, which combines cartilage cutting, rasping and scoring, and suture techniques (Fig. 5 –8)

Statistical analysis was carried out using the Statistical Package for the Social Sciences (SPSS) version 15.0 for Windows (SPSS Inc., Chicago, IL) and the Statistical Analysis System (SAS, SAS Institute Inc., Cary, NC) for repeated-measures analysis of variance. All statistical tests were performed at a significance level of 0.05 (P<0.05).

Table 1 - Modified version of the "Algorithm for otoplasty at the Craniofacial Center at Texas Children's Hospital"<sup>2,7</sup>

DEFORMITIES	PROCEDURES
<ul style="list-style-type: none"> <li>• <b>Deep concha with prominent posterior wall</b> <ol style="list-style-type: none"> <li>1) Posterior conchal wall &gt; 2.5 cm</li> <li>2) Posterior conchal wall &lt; 2.5 cm</li> </ol> </li> <li>• <b>In the case of narrowing of the external ear canal</b></li> <li>• <b>Inadequate definition of the antihelix or scaphoconchal angle &gt; 90°</b> <ol style="list-style-type: none"> <li>1) For children &gt; 5 years or stiff cartilage                             <ol style="list-style-type: none"> <li>1A) If the helical root is prominent</li> <li>1B) If the helical root is not prominent</li> </ol> </li> <li>2) For children &lt; 5 years or soft cartilage</li> </ol> </li> <li>• <b>Prominent lobule after setback</b> <ol style="list-style-type: none"> <li>1) Associated with the protrusion of the helical tail</li> <li>2) Not associated with the protrusion of the helical tail</li> </ol> </li> </ul>	<ul style="list-style-type: none"> <li>▪ Elliot's technique (excision of the postauricular muscle) + Furnas (concha-mastoid) sutures + posterior excision of the concha and skin undermining</li> <li>▪ Elliot's technique (excision of the postauricular muscle) + Furnas (concha-mastoid) sutures</li> <li>▪ Spira's posterior conchal flap technique<sup>7</sup></li> <li>▪ Anterior scoring of the cartilage with a Dingman otoabrader + Mustardé sutures (posterior U-shaped sutures to define the antihelical fold)</li> <li>▪ Hatch stitch (pexy helical root to the temporalis fascia) + Evaluation of lobule protrusion</li> <li>▪ Evaluation of lobule protrusion</li> <li>▪ Mustardé sutures (posterior U-shaped sutures to define the antihelical fold)+ Evaluation of lobule protrusion</li> <li>▪ Webster's technique (pexy helical tail to concha)</li> <li>▪ Excision of the posterior lobe skin and subcutaneous tissue (V-shaped incision)</li> </ul>



(Fig. 5.) Preoperative marking - marking of the points for conchal-helix sutures and for conchal resection



(Fig.7) Posterior resection of the conchal excess followed by simple suture



(Fig. 6) Preoperative marking - marking of the retroauricular incision



(Fig.8) Rasp is passed through the antitragohelicine fissure to the anteroauricular surface and perichondrium and cartilage are scored on the anterior surface

pared with baseline ( $P < 0.001$ ).

**Table 2** - Types of deformities present in the participants of this study (n = 80 ears).

Deformity	Right Ear	Left Ear	Total
Conchal hypertrophy > 2.5 cm	18	19	37/80 (46.3%)
Scaphoconchal angle > 90°	20	21	41/80 (51.3%)
Prominent lobule	9	9	18/80 (22.5%)
Prominent helical root	14	15	29/80 (36.3%)

**Table 3** - Otoplastic procedures performed in the participants of this study (n = 80 ears).

Otoplastic Procedures	Right Ear	Left Ear	Total
Mustardé suture	38	40	78/80 (97.5%)
Furnas suture	34	32	66/80 (82.5%)
Conchal excision	14	14	28/80 (35.0%)
Scoring of the antihelical cartilage	14	14	28/80 (35.0%)
Excision of posterior lobule skin	13	12	25/80 (31.3%)
Webster technique	12	10	22/80 (27.5%)
Hatch stitch	2	2	4/80 (5.0%)
Excision of postauricular skin	19	18	37/80 (46.3%)
Incision between the sulcus and scapha	40	40	80/80 (100%)

**Table 4** - Complications from the otoplasty (n = 40 patients)

Complications	Number	Complication rate
Pain	9	9/40 (22.5%)
Reoperation	2	2/40 (5.0%)
Suture extrusion	5	5/40 (12.5%)
Residual deformity	3	3/40 (7.5%)
Postoperative deformity	2	2/40 (5.0%)
Partial stenosis of the ear canal	1	1/40 (2.5%)
Excessive postauricular skin	5	5/40 (12.5%)
Recurrence	2	2/40 (5.0%)
Infection of the ear skin	1	1/40 (2.5%)

## RESULTS

Among the participants, 75% reported that they were ridiculed in the study/work environment because of their deformity and 40% reported low self-esteem. First-degree relatives of participants also had the same deformity in 42.5% of cases.

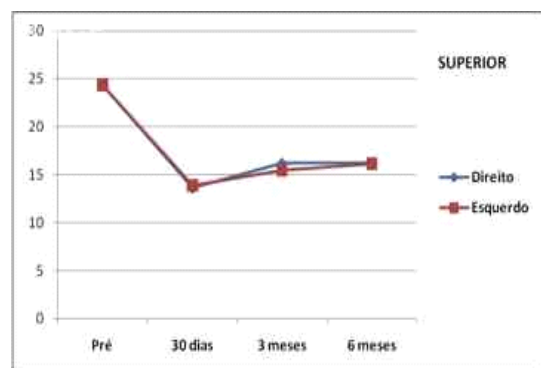
Common auricular deformities included scaphoconchal angle greater than 90° (51.3%, 41/80 ears) and conchal hypertrophy > 2.5 cm (46.3%, 37/80 ears) (Table 2). Note that some patients had more than one type of deformity.

The most frequently used procedures were the placement of Mustardé sutures to create the antihelical fold and Furnas (concha-mastoid) sutures (Table 3).

The most common postoperative complications were pain (22.5%), suture extrusion (12.5%), and excessive postauricular skin (12.5%). However, the most problematic complications were recurrence (5%), partial stenosis of the ear canal (2.5%), and residual deformities detected in the immediate, early and late postoperative periods (Table 4).

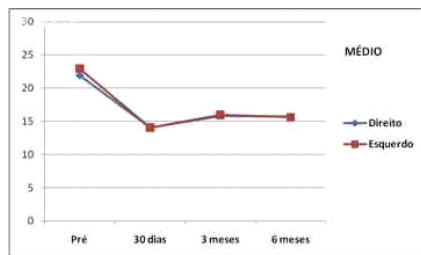
Significant reductions in the mastoid-helix distance were observed at the three time points com-

Otoplasty procedures performed based on the modified algorithm for management of prominent ears resulted in a significant reduction of the mastoid-helix distance within the first postoperative month ( $P < 0.001$ ) and a small increase in this distance 3 months postoperatively ( $P < 0.005$ ), with no significant differences between 3 and 6 months after the procedure ( $P > 0.520$ ) (Tables 5 and 6, Figs. 1-3).

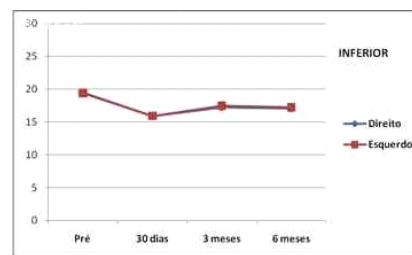


Direito = Right Ear  
 Esquerdo = Left Ear  
 Pré = Preoperative  
 30 dias = 30o. postoperative day  
 3 meses = 3o. postoperative month  
 6 meses = 6o. postoperative month

**Fig 1.** Variation of the mastoid-helix distance in the upper third of the right and left external ears in otoplasty patients.



Direito = Right Ear  
 Esquerdo = Left Ear  
 Pré = Preoperative  
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**Fig 2.** Variation of the mastoidhelix distance in the medial third of the right and left external ears in otoplasty patients.

**Fig 3.** Variation of the mastoidhelix distance in the lower third of the right and left external ears in otoplasty patients.

**Table 5 -** Mean mastoid-helix distance in the upper, middle and lower thirds of the ear at the four time points (n = 40 patients).

Ear side	Mastoid-helix distance Mean ± SD (mm)		
	Upper third	Middle third	Lower third
<b>Baseline</b>			
Right	24.35 ± 3.66	21.95 ± 3.05	19.52 ± 3.23
Left	24.32 ± 3.89	22.95 ± 4.14	19.42 ± 3.04
<b>30 days postoperatively</b>			
Right	13.65 ± 2.37	14.02 ± 2.53	15.87 ± 2.50
Left	13.87 ± 3.03	14.07 ± 2.15	15.92 ± 2.28
<b>90 days postoperatively</b>			
Right	16.2 ± 3.16	15.84 ± 2.58	17.24 ± 3.24
Left	15.44 ± 3.01	15.96 ± 1.99	17.48 ± 2.20
<b>180 days postoperatively</b>			
Right	16.23 ± 2.80	15.69 ± 2.53	17.08 ± 2.1
Left	16.15 ± 1.99	15.62 ± 2.63	17.23 ± 2.13

**Table 6 -** Estimated mean difference in the mastoid-helix distance (mm) between time points for the upper, middle, and lower thirds of the ear

Time points	Difference (mm)	SD	P-values
<b>Upper third</b>			
Baseline x 30 days	10.7	0.5	< 0.001
Baseline x 90 days	8.3	0.6	< 0.001
Baseline x 180 days	8.4	0.8	< 0.001
30 days x 90 days	-2.3	0.6	< 0.001
30 days x 180 days	-2.3	0.8	0.005
90 days x 180 days	0.0	0.8	0.960
<b>Middle third</b>			
Baseline x 30 days	8.6	0.4	< 0.001
Baseline x 90 days	6.8	0.6	< 0.001
Baseline x 180 days	7.2	0.7	< 0.001
30 days x 90 days	-1.8	0.5	< 0.001
30 days x 180 days	-1.4	0.7	0.056
90 days x 180 days	0.4	0.7	0.520
<b>Lower third</b>			
Baseline x 30 days	3.5	0.3	< 0.001
Baseline x 90 days	2.4	0.5	< 0.001
Baseline x 180 days	2.6	0.6	< 0.001
30 days x 90 days	-1.1	0.4	0.004
30 days x 180 days	-0.9	0.6	0.142
90 days x 180 days	0.2	0.5	0.653

## DISCUSSION

The prominent ear is a deformity with a relatively high prevalence in the general population, occurring in up to 5% of Caucasians<sup>1</sup>. This indicates that otoplasty is an important part of routine practice in plastic surgery. Thus, the identification of clinical parameters that may contribute to the assessment of anatomic features pre- and post-operatively and evaluation of experimental and well-established techniques and protocols is of fundamental importance.

Previous studies have used the mastoid-helix distance as an assessment parameter, with normal ranges of 10 to 12 mm at the superior helix, 16 to 18 mm at the level of the external ear canal, and 20 to 22 mm at the tail of the helix<sup>2,6</sup>. The measurement of the scaphoconchal angle may lead to inaccurate results because the precision measuring instrument have to be in contact with the cartilage in a relatively small space.

A grading system for prominent ears has been suggested based on the assessment of the mastoid-helix distance, conchal hypertrophy, and scaphoconchal angle. According to this system, external ear deformities are graded as: 1) mild, for mastoid-helix distances between 15 and 20 mm; 2) moderate, for mastoid-helix distances between 20 and 24 mm; 3) severe, for mastoid-helix distances between 24 and 28 mm; and 4) totally upfront ear, for mastoid-helix distances  $\geq$  28 mm. The antihelical fold is determined to be present or absent by visual inspection<sup>8</sup>.

Other authors have considered aesthetic aspects, such as the need to correct any protrusion in the upper third of the ear; the helix should be seen beyond the antihelix and have a smooth and regular line; the postauricular sulcus should not be reduced or distorted, ears should be symmetrically positioned and with similar shapes<sup>4</sup>, and the auriculomastoid angle should be between 20° and 30°.

Conventional treatments involve the weakening of the antihelical cartilage (through rasping, scoring or incisions), suture techniques, reduction of the conchal hypertrophy, and excision of the postauricular skin<sup>3</sup>. In the present study, combined techniques were used in the treatment of each case, according to a modified version of the "algorithm for otoplasty at the Craniofacial Center at Texas Children's Hospital" (Table 1)<sup>3,5</sup>.

The mastoid-helix distance was used as an assessment parameter to evaluate the otoplasty results in this study. This distance is a continuous reproducible measure that can be objectively assessed using a precision compass and a millimeter ruler. Other authors<sup>10</sup> reported a significant in-

crease in the mastoid-helix distance (range, 1-7.7 mm;  $\leq$  3 mm in 71.7% of cases) in the immediate postoperative period, but no significant increase in this distance was observed 12 months after surgery. Overcorrection was considered unnecessary because it would have little effect on otoplasty results<sup>9</sup>.

There were significant reductions in the mastoid-helix distance at the three time points compared with baseline ( $P < 0.001$ ). Otoplasty resulted in a marked reduction of the mastoid-helix distance in the immediate postoperative period, followed by a small increase in this distance 3 months after surgery, and a tendency to stabilize between 3-6 months postoperatively (Figs. 1-3). For example, the mastoid-helix distance in the upper third of the ear had a mean reduction of 10.7 mm one month after the procedure ( $P < 0.001$ ), followed by an mean increase of 2.3 mm at 3 months postoperatively, with no significant differences between 3 and 6 months postoperatively. The reduction in the mastoid-helix distance observed in the immediate postoperative period and maintained over the period of this study can be attributed to the use of the algorithm for otoplasty, which indicates the proper techniques to correct the prominent ear and residual deformities.

There were 2 cases of recurrence and 1 case of partial stenosis of the ear canal during the immediate postoperative period. Two surgical corrections yielded acceptable results. Spira's posterior conchal flap technique was performed in the case of partial stenosis of the ear canal. Mustardé sutures were used in case of recurrence due to the lack of definition of the antihelical fold.

## CONCLUSION

Otoplasty performed according to a modified version of the "algorithm for otoplasty at the Craniofacial Center at Texas Children's Hospital" resulted in a significant marked reduction in the mastoid-helix distance in the immediate postoperative period, followed by a slight increase in this distance 3 months after surgery, which remained stable thereafter. The sequencing of procedures, as indicated by the algorithm for management of the prominent ear, takes into account the type of deformity, ensuring that the most effective technique to reduce the mastoid-helix distance is used.

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