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ORIGINAL ARTICLE

Island cartilage myringoplasty. Anatomical and functional results in 122 cases

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Abstract
Introduction and objectives: In certain situations ("high risk perforations") such as large perforations, revision cases, middle ear pathology, eustachian tube dysfunction and atelectatic ears, the failure rate for myringoplasty is high. Some authors have suggested that the materials most frequently used for myringoplasty (fascia and perichondrium) may play a role in this failure rate. Cartilage myringoplasty, however, achieves good results in these "high risk" cases. The purpose of this study was to analyse our results and describe the technique.
Methods: A retrospective study of all consecutive patient charts for cartilage myringoplasties performed in a 5-year period (2002-2007) was carried out.
Results: During the study period, cartilage was used in 99 patients (122 cases). More than 66%of the cases were large perforations and 26%of the cases were revision cases. Successful closure was achieved in 92%of the cases and the functional results showed improvement in the air-bone gap average with statistical significance for type I tympanoplasty.
Discussion: The reconstruction of tympanic membrane perforations with cartilage is recommended in certain cases ("high risk" perforations). The results described here show that the anatomical and functional results are good and we consider the technique easy to learn.
Conclusions: We consider cartilage myringoplasty to be a technique that can be used in "high risk" perforations where a technique using fascia or perichondrium may have a higher risk of failure.

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PALABRAS CLAVE
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Cartílago;
Otitis media

Miringoplastia con cartílago "en isla". Resultados anatómicos y funcionales de 122 casos

Resumen
Introducción y objetivos: En las perforaciones timpánicas con "alto riesgo" de fracaso como son perforaciones grandes, anteriores y/o peritubáricas, reperforaciones, patología de mucosa de oído medio, disfunción tubárica, atelectasia, etc., el porcentaje de fracaso de las miringoplastias es más elevado. Se ha descrito que los materiales que clásicamente se emplean en las miringoplastias (fascia y pericondrio) pueden jugar un papel en este hecho y la miringoplastia con cartílago ofrece mejores resultados. En este trabajo exponemos nuestra experiencia con la miringoplastia con cartílago y describimos la técnica empleada.
Métodos: Estudio retrospectivo donde se revisan las historias clínicas de miringoplastias con cartílago realizadas de forma consecutiva durante un periodo de 5 años (2002-2007).
Resultados: Se estudia una muestra de 99 pacientes y 122 intervenciones. Más del 66% de los casos son perforaciones que afectan a más de 3 cuadrantes de la membrana y el 26% de los casos fueron cirugías de revisión tras fracasos previos. A pesar de estos datos a priori desfavorables, la tasa de cierre de perforación de esta serie de 122 casos es del 92%. Los resultados funcionales en los casos de timpanoplastia tipo I muestran una mejoría de la transmisión aérea media con valores estadísticamente significativos.
Discusión: Consideramos que la reconstrucción de los defectos timpánicos con cartílago es una alternativa recomendable en determinados casos que denominamos casos de "alto riesgo". Los resultados de esta serie ponen de manifiesto este hecho y además consideramos que son reproducibles de forma sencilla.
Conclusiones: Creemos que la miringoplastia con cartílago debe ser tenida en cuenta en los casos que a priori sean desfavorables y donde una miringoplastia con uso de fascia o pericondrio puede fracasar.

Introduction

The aim of this study was to review the anatomical results obtained from using cartilage in the myringoplasties performed at our centre over a period of 5 years.

Over the years, various materials have been used for the closure and reconstruction of tympanic perforations but, as of today, temporal fascia is the most commonly used material, followed by tragal perichondrium. The success rate of the intervention in terms of closure of the perforation with fascia is estimated to be around 80%-90% for primary myringoplasties.[1] However, these results decrease in some specific cases, such as larger perforations, as well as in cases of pathology of middle ear mucosa, active suppuration at the time of surgery, tympanic atelectasis, altered tube ventilation, review surgery for previous failures or major tympanic sclerosis, among others.[2] In these circumstances, the temporal fascia can suffer atrophy or not be vascularised, with the consequent failure in the closure of the perforation; in these cases, the success rate decreases considerably.[3-5]

These facts, on the one hand the possibility of atrophy, non-vascularisation and contraction of the donor tissue and, on the other hand, the variables that depend on the receiving area described previously, have led otologists to try other more rigid, resistant materials, such as cartilage. Due to its rigidity, cartilage is resistant to resorption and retraction, which offers advantages in selected cases. In addition, nutrition of the cartilage occurs by diffusion and is not dependent on neovascularisation, as in the cases described previously.[6] Due to its characteristic rigidity and its thickness, there has been controversy regarding the audiological aspect; however, various studies have demonstrated that audiological results are good.[6-10] Thus, cartilage is the tissue of choice in myringoplasties in certain cases, such as large tympanic perforations, anterior or supratubal perforations, repeated perforations, pathology of the middle ear mucosa, as well as in cases of persistent tube pathology, cases that have been described as "at high risk" of myringoplasty failure.[11-14]

The aim of this study was to review our results for myringoplasty with cartilage and to share this technique so that it can be considered in those less favourable cases mentioned previously.

Materials and methods

Technique employed

There are two possibilities for the use of cartilage in reconstructing the tympanic membrane. One is the use of cartilage in palisade as described by Heerman[15] and popularised in Spain by Bernal et al.[6,8]; the other one, which is the one we use at our centre and which has been used in all the patients presented in this series, is the graft of cartilage with perichondrium in a single piece, in "island", similar to that described by Dornhoffer et al.[11] In addition,

the cartilage employed can be obtained from the cymba or from the tragal margin. In all cases of this series, the cartilage was obtained from the tragal margin.

The first step of our technique is therefore obtaining the cartilage graft and tragal perichondrium. To do this, an incision is made in the medial part of the tragal cartilage, leaving a lateral cartilaginous bridge of about 2 mm for aesthetic reasons. The cartilage with the perichondrium is dissected from the surrounding fibrous tissue in the medial direction on both sides (front and back) and then cut below and above, using as much of the tragal cartilage as possible. Next, we separate the perichondrium from the periphery of the cartilage until it is attached just by the central part. The cartilage is then cut and carved to the size necessary to cover the perforation being treated, always maintaining the perichondrium wider, in the shape of butterfly wings or a fried egg.

All cases in this series were intervened using a retroauricular approach and mastoidectomy was not performed on any of them. Whenever possible, we preferred to carry out the graft in a lateral direction (overlay), which requires the tympanum to be de-epithelialised, and this was done together with the cutaneous meatal flap from the upper base. In certain cases, usually due to impossibility caused by tympanic atelectasis, some cases of previous surgery or of marginal perforations, the technique performed was the medial (underlay), placing the graft in a medial direction to the tympanic remnant.

When necessary, the ossicular chain was reviewed and, if possible, reconstructed using various ossiculoplasty techniques and materials not within the scope of discussion of this publication.

The middle ear was filled with Gelfoam® to a greater or lesser extent depending on each case and each surgeon. When the tympanic-meatal flap was replaced, sheets of silicone (silastic) were generally placed in the external auditory canal (EAC), which was then plugged either with padding soaked in antibiotic ointment or with ear Merocel®. The tragal stitches and retroauricular stitches were removed after one week and the blocking after 2 weeks from the surgery.

Generally, the next visit took place two months after surgery, another visit after 5-6 months and another one year after the intervention. A control audiometry was performed during each of these visits.

Sample studied

We performed a retrospective study of the myringoplasties or tympanoplasties without mastoidectomy carried out at our institution with cartilage between the years 2002 and 2007 consecutively. The study was done by reviewing the medical records of these patients.

Our centre is a centre that trains residents; surgeries were therefore performed by a diverse group of supervised surgeons in training (residents), as well as by trained otologists.

The data shown in Table was collected in all cases. The tonal audiometry (audiometer Ampla 455, Amplifon, Italy) collected the bone and air pathway frequencies 512, 1,024, 2,048 and 4,096 Hz. In the postoperative audiometry, we took the last audiometry performed on the patient before ending monitoring. When comparing functional results, we considered only the results in cases in which no ossicular reconstruction technique had been performed, that is, only in type I tympanoplasties.

Table Data collected from all medical records reviewed

Age
Gender
Previous otologic surgery
Preoperative tonal audiometry
Impedance testing
Type of tympanic perforation: location and size
Procedure performed and surgical data
Postoperative tonal audiometry
Monitoring and results

As for perforation type, we took into account the location, observing whether the perforation was central or marginal, as well as the quadrants of the tympanic membrane affected. Taking into account perforation size, we considered it a big perforation if it affected three tympanic quadrants or more. As for the surgical data, we recorded whether the intervention was performed under general anaesthesia or with local anaesthesia and sedation, the type of technique employed (lateral or medial), as well as if there had been any type of ossicular reconstruction and, finally, we observed what percentage of patients were discharged on the day of the operation itself. Monitoring was handled as explained in the section on technique employed, and it noted potential surgical complications, success or failure of the technique and the causes of failure, time at which this failure occurred, etc. We also performed an audiometry, in all cases, at each of the visits made by the patient after surgery. When monitoring was less than a year, we telephoned the patient for a further review.

For the statistical analysis, we used the Student's t-test in the case of quantitative variables and considered significant values those lower than $P<.01$.

Results

In the period from 2002 to 2007, we carried out in our centre 122 myringoplasties with cartilage on 99 patients. Sixty-one cases were right ears and 61 cases were left ears, representing 50% for each anatomical side. The average age of the sample studied was 42 years (SD 16 years), with a minimum of 13 years and a maximum of 73. The predominant gender was the female, with 67 women (68%) contributing 72 cases to be operated on and 32 males (32%) contributing 50 ears to be operated on.

When reviewing the previous otologic surgeries performed on the patients studied, we observed that of the 99 patients, there had been some sort of previous intervention in 52 cases. In 35 cases, the histories of ear interventions were on the same ear that had been operated on with myringoplasty with cartilage: 3 cases of transtympanic drainages and 32 cases (26%) of myringoplasty (not

performed with cartilage). The remaining 17 patients with prior otologic operations were treated with myringoplasty in the contralateral ear.

Figure 1 shows the graph of the audiometries in the ear that was going to be intervened. It also shows that the average bone conduction of the 4 frequencies measured preoperatively was 21 dB and the air pathway was 42 dB, with an average differential hearing threshold (DHT) for the 4 frequencies of 21 dB.

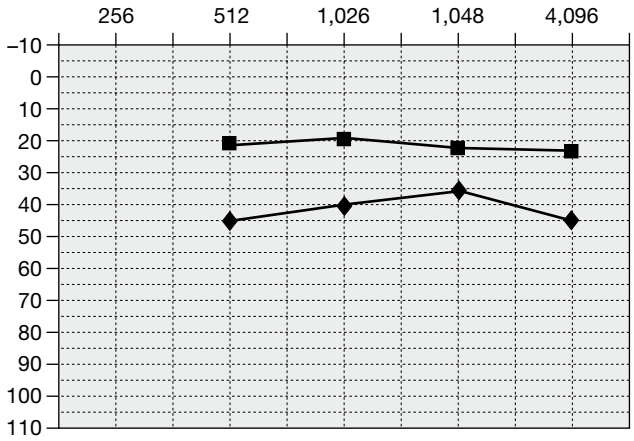
The bioelectrical impedance analysis was collected in only 64 cases, or was only transcribed to the patient clinical history in 64 cases. Therefore, despite considering it as a useful preoperative tool for assessing which technique to employ, as well as for forecasting the result to be obtained, conclusions cannot be drawn in this series with this variable.

As for perforation type, it was a central perforation in 117 cases and only in 5 cases was the perforation marginal. It was a subtotal or pantympanic perforation in 43 cases (35%) and it was a large perforation in another 40 patients (33%). The perforation was small, that is, affecting only one quadrant of the tympanic membrane, in only 4 cases.

In 100 of the 122 intervened cases, the anaesthesia used was local infiltration with lidocaine (2%) and adrenaline (1:50000) with sedation; in 22 cases, the intervention was performed under general anaesthesia. The technique used was lateral (overlay) in 104 cases (85%) and medial (underlay) in the remainder, that is, in 18 cases. There was some type of ossicular reconstruction in 21 of the 122 cases. Of the 122 cases reviewed, the patient was discharged on the same day of the surgery in 111 cases. From the 11 cases that could not leave the hospital on the same day of surgery, in one case the reason was vomiting and food intolerance, one case for pain and the remaining 9 were scheduled admissions due to how far their homes were from the centre where they underwent surgery.

There were no major intraoperative or perioperative complications. In one case, there was evidence of bleeding within three days of the intervention, so the patient went to the ER and was treated conservatively with a compressive dressing. Surgical wound infection was observed in one case, forcing the ear to be uncovered ahead of schedule to apply topical treatment to the wound.

Regarding monitoring, the average follow up was 24 months (SD 16), with a minimum of one month and a maximum of 63 months. The median was calculated using

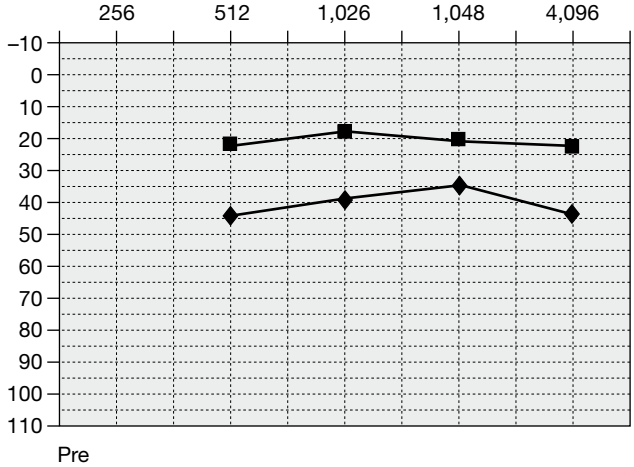


	512	1,024	2,048	4,096
Bone pathway	21	19	22	23
Air pathway	45	40	36	46

Figure 1 Preoperative audiometry in the ear to be intervened for the 122 cases operated.

Preoperative data

	512	1,024	2,048	4,096
Bone pathway	22	19	21	23
Air pathway	44	39	35	44



Preoperative data

	512	1,024	2,048	4,096
Bone pathway	21	19	21	24
Air pathway	32	31	27	38

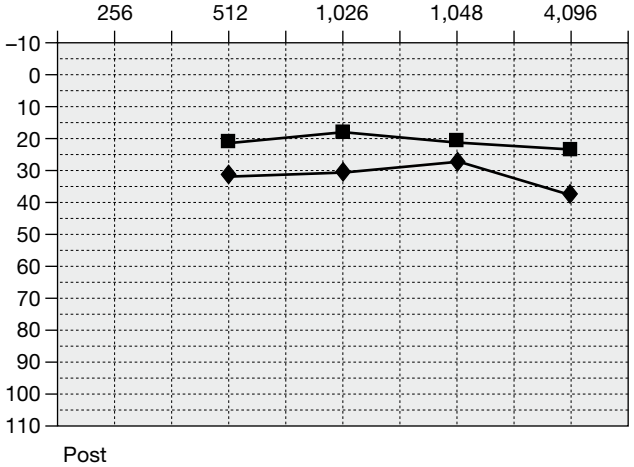


Figure 2 Preoperative and postoperative audiometry in the intervened ear in the 101 cases of type I tympanoplasty.

the results of the sample and the result was 18 months. After calling the 28 patients for whom follow-up time was less than one year, the number of cases in which this follow-up time was higher than a year was 108; that is, for 89% of the cases, the monitoring was at least 12 months.

Figure 3 shows images of postoperative results at 3 months and 12 months after surgery. In 10 of the 122 cases, a postoperative perforation was observed; that is, the closure of the perforation was not achieved, and this happened in all cases before 6 months' follow up. In 2 of these 10 cases, the perforation epithelialised spontaneously, while the perforation became established in the remaining 8 cases. Therefore, the success rate for this surgical technique regarding closure of the perforation was 92% Of these 8 patients in whom the surgical technique failed, 7 were subtotal perforations, the myringoplasty with cartilage was the first intervention in the affected ear in 6 cases and it was a reoperation in 2. In all cases, the perforation observed after cartilage surgery was small, due to graft malposition. Five of these 8 failures were reoperated successfully, the intervention consisting of a replacement of the graft covering the previous defect and, after more than one year of monitoring, there was no reperforation. Thus, the final rate of perforation closure, taking into account the reoperated cases, was 97.5% The other 3 cases did not choose to be reoperated.

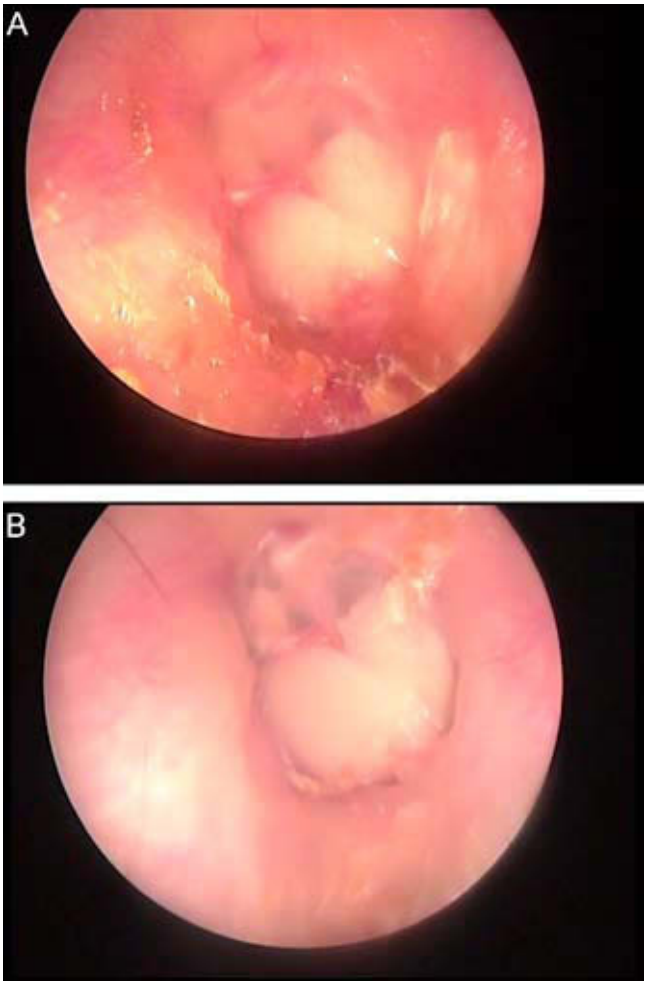


Figure 3 A and B: Images of postoperative results at 3 (Figure 3A) and 12 months (Figure 3B) of monitoring.

Lateralisation of the graft or blunting was observed in one case and no surgical measure was performed to correct it.

The results of the postoperative audiometry of the type I tympanoplasties (that is, excluding those cases where there had been some kind of ossicular reconstruction), can be seen in Figure 2. The average of the bone pathway, which was 21 dB, did not vary between the preoperative and postoperative audiometries, while the average of the air pathway improved from 41 to 32 dB. The postoperative DHT therefore also improved and was 11 dB. Looking at the statistical significance, it can be noted that the overall improvement observed for the average of the 4 frequencies reached statistical significance for these data (P=.037). Furthermore, conducting the study separately for each frequency, we observed that it is at high frequencies (2,048 and 4,096 Hz) that the best results were found, with an improvement of the air pathway that changed from 35 dB to 27 dB at the 2,048 Hz (P=.0005) and from 44 dB to 38 dB at 4,096 Hz (P=.048), both values being statistically significant.

There was a case of postoperative cophosis that did not recover despite treatment with high-dose oral corticosteroids.

Discussion

We studied 122 cases of myringoplasty with cartilage with an average follow-up over 12 months in 90% of patients, observing a rate of perforation closure of 92% in the first instance and of 97.5% after reoperation in 5 out of 8 cases of failure. These anatomical results were accompanied by the functional, especially in average conversational frequencies, in which there was improvement of airborne transmission with statistically significant differences in the frequencies 1,024 and 2,048 Hz.

The reconstruction of tympanic defects with cartilage is a highly recommended alternative, especially in certain cases, which we can label as "high risk" cases,[11] such as large perforations, anterior or peritubal perforations, cases of review after previous failures, atrophic and atelectatic membranes, membranes with abundant sclerosis that may affect revascularisation of the graft used, and in cases where the middle ear mucosa is inflamed or oedematized.[11-14] Many of the cases presented here meet these characteristics and we believe that tympanic reconstruction with a method other than cartilage would have failed in many of them.

In this series, the number of subtotal or pantympanic perforations was 35% and the perforation was large (that is, affecting 3 or more quadrants of the tympanic membrane) in another 33% This means that over two thirds of cases had perforations affecting more than three-quarters of the eardrum; it has been described that the success rate of myringoplasties with fascia or perichondrium decreases in these cases,[2-5] mainly due to defects in graft revascularisation. In addition, 26% of the cases presented are reoperations of

cases that had previously failed with different myringoplasty techniques and the rate of closure in these cases also tends to be less than in primary myringoplasties.[14] Despite these data, which are *a priori* unfavourable, the rate of closure of the primary perforation obtained after 2 years follow-up was 92% on average, and 97.5% taking into account the reintervention. This is comparable to other published series that used this technique of myringoplasty with cartilage in "island" as well as with cartilage in palisade,[7,8,12,16-18] in which the success rates are around 90-95%

Comparing the historical results at our institution (Landa et al.[19]), in which a success rate of 80% was obtained using temporal fascia, we note that the percentage of closure is significantly better for the myringoplasties carried out with cartilage. This is true despite this second series of patients being, *a priori*, a more unfavourable group, with "high risk" perforations.

Regarding functional outcomes, there are currently abundant references showing that the use of a rigid material such as cartilage does not worsen outcomes; there are also extensive series published with excellent results.[6,7,9-11] Figure 2 shows that the average of the bone pathways did not decreased and the average of the postoperative air pathway and the DHT improved, even reaching statistically significant values.

With regard to cases of failure of the technique, it is noted that they are mainly due to poor technique rather than to factors specific to the patient. Furthermore, this failure is due more to persistence of a portion of the perforation, usually from graft displacement, than to a reperforation from patient factors.

It is important to know the preoperative factors that warrant the use of a material such as cartilage for the closure of the perforation. These factors are (besides size) recurrent cases, the condition of the tympanic remnant and the middle ear mucosa, tube function. There are preoperative methods that can help to measure this function and make this decision,[11,20,21] although this study does not have enough data to make this correlation.

Conclusions

In summary, we believe that myringoplasty with cartilage in "island" offers good anatomical and functional results for cases at "high risk" of failure with the most commonly-used materials (fascia or perichondrium), such as large perforations, anterior and peritubal perforations, reperforations, pathology of the middle ear mucosa, tube dysfunction, tympanic atelectasis, etc. In addition, we believe that it is a simple technique that is easy to learn, so the results described here could be easily reproducible.

Conflict of interests

The authors declare no conflict of interests.

References

1. Sheehy JL, Glasscock ME. Tympanic membrane grafting with temporalis fascia. Arch Otolaryngol. 1967;86:391-402.
2. Booth JB. Myringoplasty: The lessons of failure. J Laryngol Otol. 1974;88:1223-35.
3. Indorewala S. Dimensional stability of the free fascia grafts: an animal experiment. Laryngoscope. 2002;112:727-30.
4. Buckhingam RA. Fascia and perichondrium atrophy in tympanoplasty and recurrent middle ear atelectasis. Ann Otol Rhinol Laryngol. 1992;101:755-8.
5. Utech H. Ueber diagnostische und therapeutische Moeglichkeiten der Tympanotomie bei Schalleitungsstoerungen. Laryngol Rhinol. 1959;38:212-21.
6. Menendez Colino LM, Bernal Sprekelsen M. Reconstrucción tímpano osicular. Resultados funcionales de timpanoplastia con cartílago en empalizada y prótesis de titanio. Estudio piloto. Acta Otorrinolaringol Esp. 2002;53:718-24.
7. Dornhoffer JL. Hearing results with cartilage tympanoplasty. Laryngoscope. 1997;107:1094-9.
8. Bernal Sprekelsen M, Tomás Barberón M. Indicaciones, técnica y resultados anatómicos de la timpanoplastia con cartílago en empalizada. Acta Otorrinolaringol Esp. 1997;48:279-86.
9. Gerber MJ, Mason JC, Lambert PR. Hearing results after primary cartilage tympanoplasty. Laryngoscope. 2000;110:1994-9.
10. Kirazli T, Bilgen C, Midilli R, Ogüt F. Hearing results after primary cartilage tympanoplasty with island technique. Otolaryngol Head Neck Sur. 2005;132:933-7.
11. Dornhoffer JL. Cartilage tympanoplasty: indications, techniques, and outcomes in a 1000 patient series. Laryngoscope. 2003;113:1844-56.
12. Amedee RG, Mann WJ, Riechelmann H. Cartilage palisade tympanoplasty. Am J Otol. 1995;10:447-50.
13. Duckert LG, Mueller J, Makielski KH, Helms J. Composite autograft "shield" reconstruction of remnant tympanic membranes. Am J Otol. 1995;16:21-6.
14. Boone RT, Gardner EK, Dornhoffer JL. Success of cartilage grafting in revision tympanoplasty without mastoidectomy. Otol Neurotol. 2004;25:678-81.
15. Heerman J. Autograft tragal and conchal palisade cartilage and perichondrium in tympanomastoid reconstruction. Ear Nose and Throat J. 1992;71:344-9.
16. Milewski C. Composite graft tympanoplasty in the treatment of ears with advanced middle ear pathology. Laryngoscope. 1993; 103:1352-6.
17. Amorós Sebastiá LI, Murcia Puchades V, Dalmau Galofre J, Carrasco Llatas M, Lopez Molla C, López Martínez R. Timpanoplastia con cartílago: 3 años de experiencia. Acta Otorrinolaringol Esp. 2002;53:578-82.
18. Kazikdas KC, Onal K, Boyraz I, Karabulut E. Palisade cartilage tympanoplasty for management of subtotal perforations: a comparison with the temporalis fascia technique. Eur Arch Otorhinolaryngol. 2007;264:985-9.
19. Landa Aranzabal M, Rodríguez García L, Rivas Salas A, Navarro Sampedro JJ, Camacho Arrioaga JJ, Algaba Guimera J. Miringoplastia: onlay versus underlay. Revisión de 460 casos. Acta Otorrinolaringol Esp. 1996;47:21-5.
20. Cohen AM, Schwaber MK, Anthony LS, Jerger JF. Eustachian tube function and tympanoplasty. Ann Otol Rhinol LAryngol. 1979;88:339-47.
21. Belluci RJ. Selection of cases and classification of tympanoplasty. Otolaryngol Clin North Am. 1989;22:911-26.