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ORIGINAL ARTICLE

Result of Mastoid Obliteration According to the Graft Materials: Autogenous Bone, Allogeneic Bone, Hydroxylapatite

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Objective: Outcomes of surgery for otitis media and cholesteatoma according to the graft materials for mastoid obliteration were compared, and their compatibility as mastoid obliteration materials was examined.

Materials and Methods: Among patients performed mastoid obliteration during the first surgery or revision for otitis media or cholesteatoma from January 2007 to April 2010, 191 patients, 196 ears, whose follow-up observation period was longer than 6 months were selected. The male was 72 patients (74 ears), and the female was 119 patients (122 ears). The age distribution was 9 - 78 years, and the mean age was 45.5 years. The follow-up observation period was average 15 months. Used for mastoid obliteration surgery were autogenous bone, allogeneic bone and hydroxylapatite (HA) and we divided patients into three groups according to graft materials. The rate of graft failure and complications were examined. Complications were divided into mastoid and tympanic cavity complications.

Results: The rate of graft failure in HA group was highest in both CWU and CWD surgery. In autogenous bones group was 0.8 %, which was lowest and allogeneic bone group, it was 3.1 %, and good results comparable to autogenous bone group. In regard to mastoid and tympanic cavity complication, HA group also showed highest rate (10% and 16.7% respectively).

Conclusion: In mastoid obliteration, HA was high rate of graft failure and complications. Thus it was determined to be not compatible any more. In contrast, allogeneic bone hardly induced problems comparable to autogenous bone. Therefore, it is judged that for cases whose autogenous bone for mastoid obliteration is not sufficient or available, allogeneic bones could be used as safe substitute materials.

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Introduction

In surgery for chronic otitis media, mastoid obliteration plays a role of reducing air burden of the Eustachian tube and preventing the retraction of the postauricular area in canal wall up(CWU) surgery[1]. In canal wall down (CWD) surgery, mastoid obliteration is performed for reduction chronically draining cavity, retention of debris, and the prevention of the deterioration of quality of life.

Several kinds of autogenous tissues (i.e. bone chips, bone pates, cartilages, musculoperiosteal flaps, fats), allogeneic tissues and biosynthetic materials (i.e hydroxylapatitie (HA)) have been used for mastoid obliteration[2-7]. As the materials for mastoid obliteration, autogenous tissues are most ideal, nonetheless, if the mastoid is big and revision cases, the volume of obtainable autogenous tissues is limited. Therefore, for such cases, allogeneic graft materials or biosynthetic materials can be used, and their use is already approved in craniofacial reconstruction surgery[8,9]. In otologic surgery, studies used HA have been reported from a long times ago. However, cases used allogeneic tissues for mastoid obliteration is rare.

We compared and analyzed the results of mastoid obliteration surgery used autogenous bone, allogeneic bone and HA.

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Materials and Methods

Among patients performed mastoid obliteration as the first surgery or revision for chronic otitis media or cholesteatoma from January 2007 to April 2010, 191 patients, 196 ears, who were able to be followed-up for longer than 6 months were selected, and their medical record was analyzed retrospectively. 72 patients were male (74 ears), and 119 were female.(122 ears). The age distribution was 9 - 78 years, and the mean age was 45.5 years. The follow-up observation period was average 15 months.

Obliteration material

(1) Autogenous bone

Autogenus bone were obtained from the mastoid cortex using a chisel, and they were ground to 1 - 3 mm in size, and used.

(2) Allogeneic bone

The cancellous bone chip®(Korea Bone Bank) was ground to 1-3 mm size and used.

(3) Hydroxylapatite(HA)

The Mimix®(HA cement, tetracalcium phosphate and α-tricalcium phosphate) was used. We used cement itself or ground it to 1 - 3 mm in size and used.

Autogenous and allogeneic bone chips were soaked in antibiotics solution for 10 minutes before being placed into the mastoid cavity. In the first surgery, allogeneic bones or HA were used in combination with a small amount of autogenous bone chips in some cases, nonetheless, the accurate amount was not recorded.

Surgical Techniques

(1) CWU surgery

The conchal cartilages were harvested, an anterior based musculoperiosteal flap was elevated, and mastoidectomy was performed. If possible, all mastoid mucosa were removed. After the completion of mastoidectomy, the cartilage plate was inserted over the aditus and covered with the perichondrium. Subsequently, a part of the antrum was closed using cartilage chips. Afterward, the mastoid was filled completely with anterior based musculoperiosteal flap and graft materials. For cases which epitympanoplasty was performed, the scutum was drilled, and the malleus head, incus, and epitympanic mucosa were removed, and the epitympanum was obliterated with cartilage chips and covered with perichondrium (Fig .1A).

(2) CWD surgery

The conchal cartilages were harvested, an anteroinferior based musculoperiosteal flap was elevated. Then mastoidectomy was performed by drilling posterior canal wall and epitympanectomy were performed and the facial ridge was lowered. After completely removing the diseased tissues, posterior canal wall was reconstructed using the anteroinferior based flap and the conchal cartilage plate. Remaining mastoid cavity was obliterated with graft materials(Fig .1B).

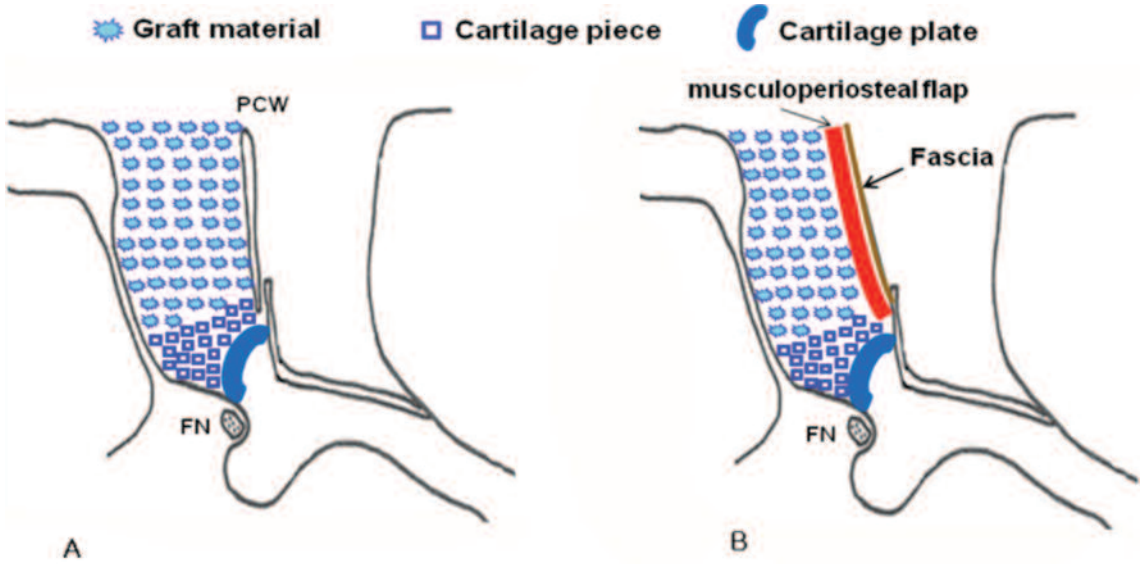

Figure 1-The schematic figures of mastoid obliteration technique. **A.** canal wall up surgery. **B.** canal wall down surgery. FN : facial nerve, PCW : posterior canal wall.

The cases were divided to three groups according to the type of graft materials, autogenous bone group, allogeneic bone group, and HA group. And demographic findings, the rate of graft failure and complications were compared and analyzed. The definition of the graft failure was cases required revision surgery for the removal of mastoid obliteration materials, and they included persistent otorrhea, persistent granulation in the posterior canal wall and the mastoid, destruction of the posterior canal wall and uncontrolled infection. We divided complication to the tympanic cavity and mastoid complication.

For statistical analysis, Chi-square test and Fisher's exact test were applied.

Results

(1) Demographic finding

Among 196, 134 cases received autogenous bone, 32 cases allogeneic bone and 30 cases HA. In regard to the underlying disease for mastoid obliteration, regardless of obliteration materials, the type of diseases affecting the temporal bone is mentioned in Table 1.

(2) Graft failure

The rate of graft failure in autogenous bones group was 0.8 %, which was lowest. On the other hand, in HA group, the rate was 20 %, and in allogeneic bone group, it was 3.1 %. The difference was statistically significant between autogenous bone and HA group(p=0.000) (Table 2).

(3) Complications

1) Mastoid Complications

Complications of the mastoid in HA group was 10 %, it was higher than autogenous bone(3.8%) and allogeneic bone(3.1%) group. Nonetheless, it was not statistically significant (Table 3).

2) Tympanic cavity complications

Complications of the tympanic cavity in HA group was 16.7 %, which was higher than other groups. Nevertheless, it was not statistically significant(Table 4).

Table 1. The number of cases of diseases according to the graft materials.

Disease	Case (N)		
	Autogenous bone	HA	Allogeneic bone
COM	13	5	5
Cholesteatoma	101	23	23
Adhesive OM	17	2	1
Cavity problem	2	·	1
Cholesterol granuloma	1	·	1
TB otitis media	·	·	1
Total	134	30	32

HA : hydroxylapatite

Table 2. The rate of graft failure according to the surgical methods.

	% (n)				
	CWU	rev.CWU	CWD	rev.CWD	Total
AuBG	0.9 (1/110)	·	·	·	0.8(1/134)
HAG	6 (1/18)	25 (1/4)	·	57.1 (4/7)	20(6/30)
AlBG	·	·	·	14.3 (1/7)	3.1(1/32)

AuBG : autogenous bone group. HAG : hydroxylapatite group. AlBG : allogeneic bone group.

Table 3. The rate of mastoid complication according to surgical methods.

	% (n)				
	CWU	**rev.CWU**	**CWD**	**rev.CWD**	**Total**
AuBG	4.5 (5/110)	·	·	·	3.8(5/134)
HAG	5.6 (1/18)	·	33.3 (1/3)	14.3 (1/7)	10(3/30)
AlBG	·	12. 5 (1/8)	·	·	3.1(1/32)

AuBG : autogenous bone group. HAG : hydroxylapatite group. AlBG : allogeneic bone group.

Table 4. The rate of tympanic cavity complication according to surgical methods.

	% (n)				
	CWU	**rev.CWU**	**CWD**	**rev.CWD**	**Total**
AuBG	21.8 (14/110)	27.3 (3/11)	·	14.3 (1/7)	13.4(18/134)
HAG	22.2 (4/18)	·	·	14.3 (1/7)	16.7(5/30)
AlBG	15.4 (2/13)	·	·	14.3 (1/7)	9.4(3/32)

AuBG : autogenous bone group. HAG : hydroxylapatite group. AlBG : allogeneic bone group.

Discussion

For obliterating the mastoid; bone chips, bone powder, fats, muscle flaps and other autogenous tissues have been used widely[2-6]. However, these methods have problems such as long healing periods, redevelopment of the cavity problem due to the resorption of graft materials, complications in the donor area, the limit of the available amount, etc. Therefore, allogeneic bones, xenogeneic bones, and biosynthetic materials were developed, and some of them are currently used in several clinics.

As biosynthetic materials for mastoid obliteration, HA has been used for a long time. Hydroxyapatite is the main constituent of living bone and, because of its excellent biocompatibility, has become popular as an alloplastic material not only in the middle ear, it was also used widely in plastic surgery and craniofacial reconstruction[8,9]. The Mimix®(HA cement), used in our study, is lacking ototoxicity and immunity, and thus biocompatibility is good[10]. In addition, it is hardly resorbed, and thus it has been used widely as materials for postsurgical reconstruction of the translabyrinthine, middle and posterior cranial fossa and other surgery for the middle ear[11]. However, Mahendran have reported that in 8 patients grafted HA cement for mastoid obliteration, the rate of infection was high and it is not suitable as mastoid obliteration materials[12]. Park et al. have reported that in white rats, mastoid obliteration was performed using the Mimix®, the resorption of graft materials was small, and the formation of mucoceles was hardly detected, but inflammation was much developed[13]. Recent studies proposed that in contrast to HA cement, HA granule induces less inflammation and infection because of its abundant porous structure and thus its osteoinduction is good[12,14,15].

In our experiments, Mimix® was mixed with citric acid, and used as cement types. Also, alternately, it was mixed with saline, then hardened and ground it as small pieces 1 - 3 mm, and used. The results show that in comparison with autogenous bone group or allogeneic bone group, complications such as infection were developed much more.

Allogeneics bones were usually obtained from the cancellous bone of the femoral head of cadavers. It is not used frequently in the otorhinolaryngology field yet. Allogeneic bones are treated chemically, lyophilized and sterilized. Demineralized bone matrix (DBM) additionally elevates the osteoinduction capacity. Concerning studies used allogeneic bones, Shea et al. have reported that in 43 patients, mastoid obliteration was performed using allogeneic bone, and

89 % success rate was obtained[16]. Leatherman have reported that in 8 patients, mastoid obliteration was performed using DBM, and 100 % success rate was obtained[17]. Seo have reported cases that mastoid obliteration and the reconstruction of the posterior canal wall were performed successfully using the tutoplast®(allograft cancellous bone chip)[18]. In our study, we used cancellous bone chip®(Korean Bone Bank) obtained from the femoral head of cadavers.

Xenogeneic bones are obtained from bovine or porine bone and its use for mastoid obliteration has not been reported yet. Reviewing animal studies, Punke used HA and bovine bones for mastoid obliteration in guinea pigs and reported that results of the two groups were not different14. Ahn et al. have reported that in the mastoid of rats, bone fragments harvested from the femoral head of rats and the Lubboc®(bovine cancellous bone) were grafted, and the new bone formation and osteoinduction of allogeneic bones were faster[19]. According to the literature, this is due to that during the treatment process of xenogeneic bones, the osteoinduction protein BMP was destroyed by 8M urea[20, 21].

In comparison with CWD surgery, CWU surgery maintains the physiological external auditory canal, and thus it has several advantages that the ambulatory treatment period after surgery is short, cavity problems are absent, hearing aid fitting is easy, and restrictions in routine life are less. Nevertheless, in CWU surgery, the incidence of retraction pocket or the recurrence of cholesteatoma is high[22]. Therefore, if the air burden of the eustachian tube is lessened by mastoid obliteration, development of retraction pocket could be minimized, and if cholesteatoma recurs, its spread to the mastoid could be prevented.

As CWD surgery secures good surgical view, lesions could be removed completely, nonetheless, its shortcomings are cavity problems, difficulties in the fitting of hearing aids, etc[23]. To reduce such shortcomings, attempts have been made by reconstruction of posterior canal wall and obliteration of mastoid cavity. In studies examined the quality of life after mastoid obliteration felt by patients, it has been reported that self-confidence was improved, embarrassment or inconvenience was felt less, and self-consciousness was lessened. In addition, mastoid obliteration prevents and minimized changes of resonance of external auditory canal after CWD surgery[24].

The technique obliterating empty spaces surrounded by bones has been performed initially in frontal sinus surgery and improved substantially[25]. In frontal sinus obliteration, if the mucosa of inner wall is not removed completely, mucocele may be developed. In mastoid obliteration, air cells and the mucosa should be removed as much as possible to prevent the recurrence of mucoceles. Ahn et al. have reported the presence of tall columnar metaplastic cells secreting mucus, and cysts containing the mucus among the group of white rats that are obliterated without the removal of mucosa19. Fibroblasts surrounding such cysts produce bone resorption factors, prostaglandin E2 and collagenase, in most cases[26]. Therefore, bone tissues surrounding mucosal cysts show bone destruction activity associate with the osteoid and sclerosis together with active bone destruction findings. Finally the mastoid obliteration could not be performed for cases that the mastoid is well pneumatized and thus air cells could not be removed completely. In addition, it should not be performed for cases that the removal of inflammation is not complete or it is not clear whether cholesteatoma is removed.

Conclusion

This study is significant as it confirmed the safety of the use of allogeneic bones in mastoid obliteration. HA used for mastoid obliteration induces high incidences of complications, and thus it is determined to be not suitable as obliteration materials any more. On the other hand, allogeneic bones hardly induce complications, and it does not cause problems even if it is used in combination with autogenous bones, and thus it is determined to be mostly appropriate graft materials. Additionally, if autogenous bones are not sufficient or available in mastoid obliteration, allogeneic bones may be used as safe substitution materials.

Acknowledgments

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References

1. Kang MK, Han CS, Kim BM, Boo SH, Park HS, Hur J. Results of epitympanoplasty with mastoid obliteration technique. Korean J Otolaryngol 2001; 44:476-84.

2. Mosher HP. A method of filling the excavated mastoid with a flap from the back of the auricle. Laryngoscope 1911;21:1158–63.

3. Ringenberg JC, Fornatto EJ. The fat graft in middle ear surgery. Arch Otolaryngol 1962; 75:329-34.

4. Moffat DA, Gray RF, Irving RM. Mastoid obliteration using bone pate. Clin Otol 194;19:149–57.

5. Turner JL. Obliteration of mastoid cavities by musculoplasty. Laryngoscope 1966; 76:456–81.

6. East CA, Brough MD, Grant HR. Mastoid obliteration with a temporoparietal fascial flap. J Laryngol Otol 1991; 105:417–20.

7. Shea MC Jr, Gardner G Jr, Simpson ME. Mastoid obliteration using homogenous bone chips and autogenous bone paste. Trans Am Acad Ophthalmol Otolaryngol. 1972; 76(1):160-72.

8. Verret DJ, Ducic Y, Oxford L, Smith J. Hydroxyapatite cement in craniofacial reconstruction. Otolaryngol Head Surg. 2005; 133(6):897-9.

9. Neigel JM, Ruzicka PO. Use if demineralized bone implants in orbital and craniofacial reconstruction and a review of the literature. Ophthal Plast Reconstr Surg. 1996; 12(2):108-20.

10. Dornhoffer J, Simmons O. Canal wall reconstruction with mimix hydroxyapatite cement: Results in an animal model and case study. Laryngoscope 2003;113(12):2123-8.

11. Kvton JF, Friedman CD, Constantino PD. Indications for hxydroxyapatite cement reconstruction in lateral skull base surgery. Am J Otol 1995; 16(4):465-9.

12. Mahendran S, Yung MW. Mastoid obliteration with hydroxyapatite cement: the Ipswich experience. Otol Neurotol. 2004 Jan; 25(1):19-21.

13. Park JH, Gu TW, Park BG, Jang YS, Kang MK. Histologic Serial Changes of Obliterating Materials in the Rat Temporal Dorsal Bullae. Korean J Otolaryngol 2009; 52:220-7.

14. Punke C, Zehlicke T, Boltze C, Pau HW Experimental studies on a new highly porous hydroxyapatite matrix for obliterating open mastoid cavities. Otol Neurotol. 2008; 29(6):807-11.

15. Matic D, Phillips JH. A contraindication for the use of hydroxyapatite cement in the pediatric population. Plast Reconstr Surg. 2002; 110(1):1-5.

16. Shea MC Jr, Gardner G Jr, Simpson ME. Mastoid obliteration using homogenous bone chips and autogenous bone paste. Trans Am Acad Ophthalmol Otolaryngol. 1972; 76(1):160-72.

17. Leatherman BD, Dornhoffer JL. The use of demineralized bone matrix for mastoid cavity obliteration. Otol Neurotol. 2004; 25(1):22-6.

18. Seo JO, Lee WS, Yang JW, Jung SH. A case of repair of retroauricular skin defect and mastoid cavity with posterior wall reconstruction using Tutoplast®(Allograft Cancellous Bone Chip) and bone dust after canal wall down mastoidectomy. Korean J Otorhinolaryngol-Head Neck Surg 2008; 51:80-3.

19. Ahn JK, Kang MK, Park HS. Histopathologic evaluation of obliterating materials in the temporal dorsal bullae of rat. Korean J Otolaryngol. 2007; 50:391-8.

20. Hartl A, Bitzan P, Wanivenhaus A, Kotz R. Faster integration of human allograft bone than of the bovine substitute Lubboc: Non-randomized evaluation of 20 cases with benign tumors or tumor-like conditions. Acta Orthop Scand 2004; 75(2):217-20.

21. Urist MR, Lietz A, Mizutani H, Takagi K, Triffitt JT, Amstutz J, et al. A bovine low molecular weight bone morphogenetic protein (BMP) fraction. Clin Orthop 1982; (162):219-

22. Sade J. Treatment of retraction pockets and cholesteatoma. J Laryngol Otol 1982; 96:685-704.

23. Meuser W. The exenterated mastoid: A problem of ear surgery. Am J Otol 1985; 6:323-5.

24. JJang CH, Lee JS. The effect on acoustic characteristics of surgical modification of the external ear. Korean J Otolaryngol 1999; 42:1501-4.

25. Michel TJ, Rohrich RJ, Robinson JB. Frontal sinus obliteration: A comparison of fat, muscle, bone and spontaneous osteoneogenesis in the cat model. Plast Reconstr Surg 1995; 95:586-92.

26. Lund VJ, Harvey W, Meghji S, Harris M. Prostaglandin synthesis in the pathogenesis of fronto-ethmoidal mucoceles. Acta Otolaryngol 1988; 106(1-2):145-51.