

Original Article

A Prospective Study on Changes in Auricular Protrusion after Chronic Otitis Media Surgery with the Postauricular Approach

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OBJECTIVES: Some patients complain of apparent auricle protrusion after chronic otitis media (COM) surgery with the postauricular approach. This study investigates whether auricular protrusion could be restored to the preoperative state after COM surgery; if so, the time needed after surgery and whether the degree of auricular protrusion differed according to the surgical procedure.

MATERIALS and METHODS: Forty-seven patients who underwent tympanoplasty and canal wall up and canal wall down mastoidectomy between July 2016 and July 2017 were prospectively studied. To examine the degree of auricular protrusion, the longest distance from the head to the helical rim and the distance from the mastoid process to the helical rim in the plane along the level of the upper margin of the tragus were measured 1 day before surgery and 1 day; 2 weeks; and 1, 2, 4, and 6 months, postoperatively.

RESULTS: The superior aspect of the auricle returned to the preoperative state within 2 months of surgery, irrespective of the surgical procedure. The middle aspect was restored to the preoperative state within 4 months of tympanoplasty or canal wall up mastoidectomy, and within 2 months of canal wall down mastoidectomy.

CONCLUSION: Postoperative auricular protrusion is a transient phenomenon.

KEYWORDS: Auricular protrusion, chronic otitis media, mastoidectomy, tympanoplasty

INTRODUCTION

Some patients complain that their auricle appears protruded after chronic otitis media (COM) surgery with the postauricular approach (Figure 1a), which results from an increased auriculocephalic angle for a certain period of time after the surgery.^[1,2] Sometimes, the auriculocephalic angle actually decreases beyond the preoperative angle, a long time after canal wall down mastoidectomy. In such cases, patients state that their auricles have tilted backward and are sometimes not clearly visible from the front (Figure 1b). Therefore, this study aimed to investigate whether the postoperatively protruded auricle could be restored to the preoperative state, and if so, the time required for the restoration to the preoperative state and whether the changes in the protrusion of the auricle differed according to the type of surgery.

MATERIALS AND METHODS

Forty-seven patients who underwent surgery for COM (tympanoplasty, canal wall up mastoidectomy, or canal wall down mastoidectomy) with the postauricular approach between July 2016 and July 2017 at the Department of otorhinolaryngology of Daegu Catholic University Medical Center were included in this prospective study. The degree of auricular protrusion was measured using the following method^[3]. First, the distance from the mastoid process to the helical rim, along the plane at the level of the superior portion of the tragus was measured, which was defined as the mid-auricle area (MD). Second, the farthest distance from the head to the helical rim was measured, which was defined as the upper auricular area (UP) (Figure 2). The two distances described above were measured by one person (the author) 1 day before; 1 day; 2 weeks; and 1, 2, 4, and 6 months after surgery. Surgeries were performed by one surgeon (author), and all patients who underwent surgery were given a mastoid compression

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dressings, which was removed the day after the surgery. Mastoid obliteration was performed using an inferior-based musculosubcutaneous flap for all canal wall down mastoidectomy procedures. Patients with a history of COM surgery on the ipsilateral ear or a congenital or acquired auricular deformity and patients below the age of 18 years were excluded. We obtained written consent from all the participants included in this study, which was approved by the institutional review board (IRB) of the Daegu Catholic University Medical Center (IRB No. CR-16-093).

Statistical Analysis

Statistical analysis was performed using the Statistical Packages for the Social Sciences (SPSS) Statistics 25.0 (IBM Corp., Armonk, NY, USA). MD and UP measurements made over time points after surgery were compared using the Repeated Measures ANOVA. A $p < 0.05$ was considered statistically significant.

RESULTS

Clinical Data of the Participants

The study included 47 participants, of which 22 were men and 25 were women. The mean age was 56.3 ± 8.88 years. Thirty-two patients had COM without cholesteatoma and 15 patients had COM with cholesteatoma. Right-sided lesions were observed in 24 patients and left-sided lesions were observed in 23 patients. Seven patients underwent tympanoplasty, 17 patients underwent canal wall up mastoidectomy, and 23 patients underwent canal wall down mastoidectomy. The MD and UP measured on the first day before surgery in 47 participants were 16.9 ± 5.17 mm and 24.1 ± 5.16 mm, respectively (Table 1).

Measurements of MD and UP at Different Time Points After Surgery

The MD and UP measurements made over different time points were analyzed using data from 30 patients, who were followed up for 6 months after surgery. The present study was a prospective study, and because patients who participated in the latter 6 months of the study period could not be postoperatively followed up for 6 months, only 30 out of 47 patients were included in the analysis of MD and UP measurements, based on the time period after surgery. Of the 30 patients, 13 were men and 17 were women. The mean age was 55.8 ± 7.53 years. The specific diagnosis was

COM without cholesteatoma for 23 patients and COM with cholesteatoma for 7 patients. The right ear was affected in 14 patients and the left ear was affected in 16 patients. Tympanoplasty, canal wall up mastoidectomy, and canal wall down mastoidectomy were performed for 3, 13, and 14 patients, respectively. The MD measurement 1 day before surgery (day of admission) was 16.2 ± 3.82 mm. The MD measurements were 19.2 ± 4.67 mm ($p=0.000$), 19.9 ± 4.54 mm ($p=0.000$), 18.1 ± 3.69 mm ($p=0.000$), 17.2 ± 4.40 mm ($p=0.060$), 16.4 ± 4.47 mm ($p=0.666$), and 15.9 ± 4.35 mm ($p=0.563$) on postoperative day (POD) 1 (at the time of removing mastoid compression dressing), 2 weeks after surgery, 1 month after surgery, 2 months after surgery, 4 months after surgery, and 6 months after surgery, respectively. The UP measurements were 23.7 ± 4.56 mm 1 day before surgery, 27.4 ± 4.40 mm ($p=0.000$) on POD 1, 28.1 ± 4.45 mm ($p=0.000$) 2 weeks after surgery, 26.5 ± 4.45 mm ($p=0.000$) 1 month after surgery, 24.9 ± 4.14 mm ($p=0.075$) 2 months after surgery, 23.9 ± 4.16 mm ($p=0.656$) 4 months after surgery, and 23.5 ± 4.09 mm ($p=0.690$) 6 months after surgery. The postoperative MD and UP measurements were analyzed, based on the time point. Both MD and UP measurements were statistically significantly different from the baseline values for 1 month after surgery, but MD and UP measurements made 2 months to 6 months after surgery were not statistically significantly different from the baseline values. Furthermore, both MD and UP measurements were the highest 2 weeks after surgery, irrespective of the type of surgery (Figure 3).

Changes in MD and UP Measurements by Type of Surgery

Patients were divided into two groups, based on the type of surgery, for comparing their postoperative MD and UP measurements. Three types of surgeries were performed: tympanoplasty, canal wall up mastoidectomy, and canal wall down mastoidectomy. Tympanoplasty and canal wall up mastoidectomy were classified as group 1, and canal wall down mastoidectomy was classified as group 2. Group 1 showed statistically significant differences in MD measurements compared with the baseline values for 2 months after surgery, while MD measurements made from 4 to 6 months after surgery were not

Table 1. Summary of clinical data of participants

Number of participants	47
Sex	Male = 22
	Female = 25
Age	56.3 ± 8.88 years
Diagnosis	Chronic otitis media without cholesteatoma = 32
	Chronic otitis media with cholesteatoma = 15
Affected side	Right side = 24
	Left side = 23
Type of surgery	Tympanoplasty = 7
	Canal wall up mastoidectomy = 17
	Canal wall down mastoidectomy = 23
Preoperative measurements	MD = 16.9 ± 5.17 mm
	UP = 24.1 ± 5.16 mm

MD: Distance from the mastoid to the helical rim, middle portion of the auricle.

UP: Furthest distance from the head to the helical rim, upper portion of the auricle.

MAIN POINTS

- Auricular protrusion (AP) tended to be the most severe 2 weeks postoperatively.
- AP occurring after the surgery recovered to the preoperative state in 2–4 months postoperatively.
- The time required for the upper portion of the protruding auricle to recover to the preoperative state was similar, regardless of the type of surgery.
- The time required for the middle portion of the protruding auricle to recover to the preoperative state was less with canal wall down mastoidectomy than with other types of surgery.
- AP occurring after surgery with the postauricular approach for chronic otitis media was a transient phenomenon.

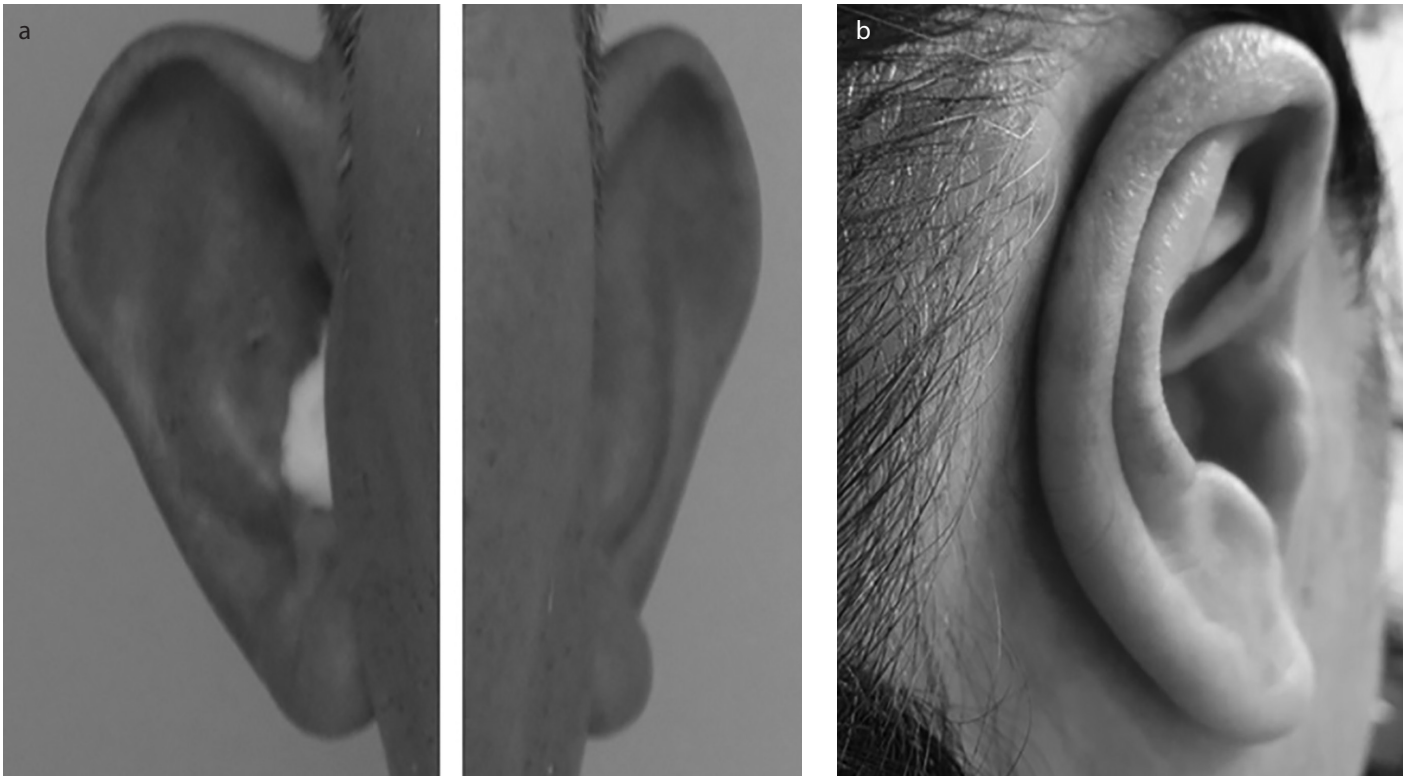


Figure 1. a, b. a) Protruded auricle observed after chronic otitis media surgery with the postauricular approach. b) A patient 10 years after canal wall down mastoidectomy. The distance from the mastoid process to the helical rim seems very short (patient was not included in this study).

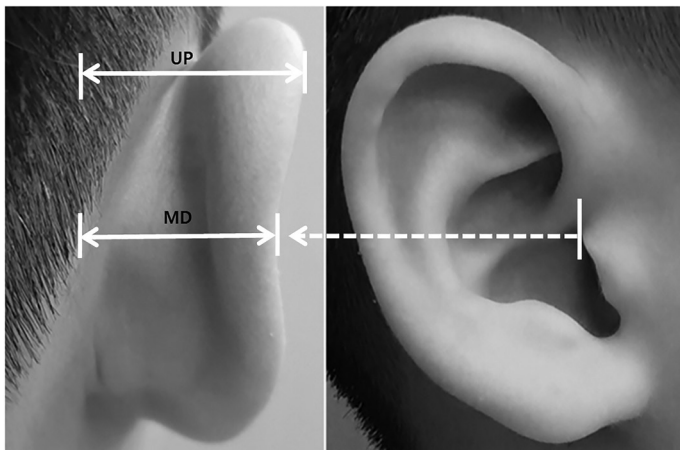


Figure 2. Method of measuring MD and UP. MD is the distance from the mastoid to the helical rim along a plane at the level of the superior point of the tragus. UP is the farthest distance from the head to the helical rim.

statistically significantly different from the baseline values. Group 2 exhibited statistically significant differences from the baseline values for 1 month after surgery, while MD measurements made from 2 to 6 months after surgery were not statistically significantly different from the baseline values (Table 2). Groups 1 and 2 showed differences in UP measurements made at baseline and those made 1 month after surgery. No statistically significant differences were observed in the measurements made from 2 to 6 months after surgery compared with the baseline values (Table 3). The MD and UP values tended to decrease when compared with the baseline values, from 4 to 6 months after surgery in group 2, which consisted of patients who underwent canal wall down surgery.

DISCUSSION

Analysis of Changes in Postoperative MD and UP Measurements by Time Point

The MD and UP values increased after surgery, reaching a peak at 2 weeks after surgery, after which they decreased over time. The measurements of MD and UP made 1 month after surgery were statistically significantly different from the baseline values, but MD and UP values between 2 and 6 months after surgery were not statistically significantly different from the baseline values. This suggests that both the mid and upper auricular aspects were most protruded 2 weeks after surgery, but the protrusion decreased over time and eventually returned to the preoperative state. The dissection of the posterior auricular muscle, elevation of the meatal skin flap, retraction of the auricle using a self-retractor during surgery, and the resulting edema in the posterior auricular area when the posterior auricular approach is used, contribute to the protruded appearance of the auricle [2]. Hence, we anticipated that the auricle would be most protruded immediately after surgery, which is the period most influenced by these factors. In other words, we expected that the MD and UP values would be the highest on POD 1, when the mastoid compression dressings were removed, but they were actually the highest on the second week after surgery in our study. We speculated that the MD and UP measurements on POD 1 would be smaller than those on week 2 after surgery, because the mastoid compression dressing pressed the auricle toward the head and temporarily suppressed the protrusion of the auricle. Thus, the ear may seem more protruded during the first follow up after discharge compared with that at the time of discharge.

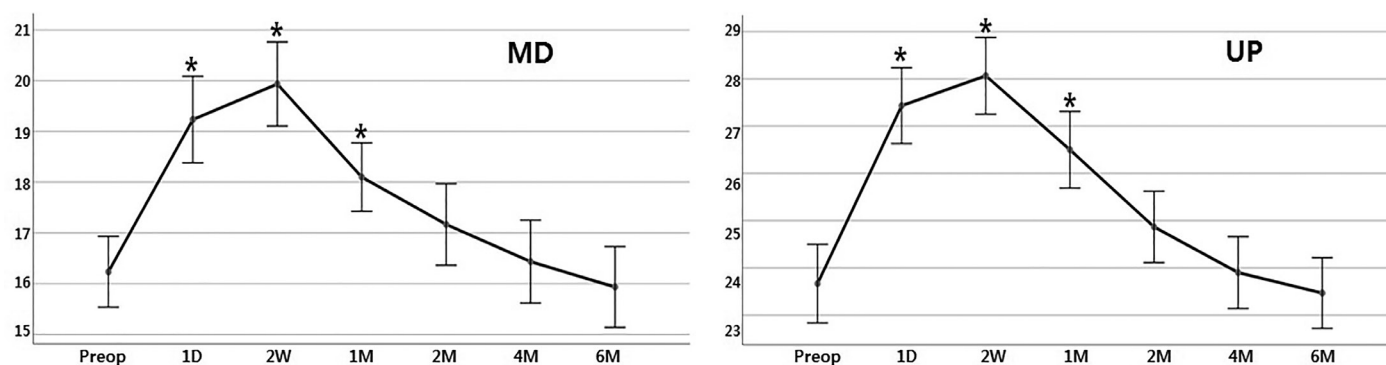


Figure 3. Postoperative MD and UP measurements according to time point (Statistical analysis: Repeated measures ANOVA). MD is the distance from the mastoid to the helical rim along a plane at the level of the superior point of the tragus. UP is the farthest distance from the head to the helical rim.

Preop: 1 day before surgery, 1D: 1 day after surgery, 2W: 2 weeks after surgery, 1M: 1 month after surgery, 2M: 2 months after surgery, 4M: 4 months after surgery, 6M: 6 months after surgery.

* denotes statistical significance ($p < 0.05$)

p: compared with the first day before surgery.

Table 2. Postoperative MD measurements according to the time point and type of surgery (Statistical analysis: Repeated measures ANOVA)

Time of measurement	Group 1 (n=16)		Group 2 (n=14)	
	MD: Mean ± SD	p	MD: Mean ± SD	p
1 day before surgery	17.1±4.48mm	-	15.3±2.76mm	-
1 day after surgery	20.1±5.25mm	0.002*	18.2±3.83mm	0.005*
2 weeks after surgery	20.3±4.62mm	0.001*	19.5±4.59mm	0.000*
1 month after surgery	19.0±4.05mm	0.023*	17.1±3.05mm	0.005*
2 months after surgery	18.6±4.97mm	0.048*	15.5±3.03mm	0.711
4 months after surgery	17.7±5.13mm	0.394	15.0±3.16mm	0.612
6 months after surgery	17.2±4.97mm	0.877	14.5±3.11mm	0.229

MD is the distance from the mastoid to the helical rim along a plane at the level of the superior point of the tragus

Group 1 included participants who underwent tympanoplasty or canal wall up mastoidectomy.

Group 2 included participants who underwent canal wall down mastoidectomy

p: compared with the first day before surgery.

* denotes statistical significance ($p < 0.05$)

Table 3. Measurements of UP according to the time point and type of surgery (Statistical analysis: Repeated measures ANOVA)

Time of measurement	Group 1 (n=16)		Group 2 (n=14)	
	UP: Mean ± SD	p	UP: Mean ± SD	p
1 day before surgery	23.6±4.82mm	-	23.8±4.42mm	-
1 day after surgery	27.5±4.12mm	0.000*	27.4±4.86mm	0.004*
2 weeks after surgery	28.1±4.84mm	0.000*	28.1±4.14mm	0.000*
1 month after surgery	26.8±5.04mm	0.003*	26.2±3.83mm	0.003*
2 months after surgery	25.3±4.98mm	0.117	24.4±3.03mm	0.435
4 months after surgery	24.1±4.49mm	0.559	23.7±3.91mm	0.905
6 months after surgery	24.1±4.73mm	0.488	22.6±3.26mm	0.050

UP is the farthest distance from the head to the helical rim

Group 1 included participants who underwent tympanoplasty or canal wall up mastoidectomy.

Group 2 included participants who underwent canal wall down mastoidectomy

p: compared with the first day before surgery.

* denotes statistical significance ($p < 0.05$)

Comparison of Postoperative MD and UP Measurements by Type of Surgery

The subcutaneous tissue, muscle, fascia, periosteum, and mastoid part of the temporal bone in the postauricular area support the auricle. Thus, these structures affect the degree of postoperative auricular protrusion. Tympanoplasty preserves these structures, while canal wall up mastoidectomy involves the removal of some part of the mastoid bone but preserves the remaining structures. On the other hand, canal wall down mastoidectomy involves the removal of most of the cortical part of the mastoid bone and includes subcutaneous tissue, muscle, fascia, and periosteum in the rotational local flap to obliterate the mastoid, which weakens the structures supporting the auricle. Based on these surgical features, we classified tympanoplasty and canal wall up mastoidectomy into group 1 and classified canal wall down mastoidectomy as group 2, to compare their postoperative MD and UP measurements, according to the postsurgical time points. In group 1, the MD values (which represent the middle aspect of the auricle) were statistically significantly different at baseline and 2 months after surgery. This suggests that the protrusion of the mid auricle increased compared with the baseline till 2 months after surgery but tended to return toward the baseline by 4 months after surgery in the case of tympanoplasty or canal wall up mastoidectomy. On the other hand, we speculated that the mid auricle would appear more protruded 1 month after surgery compared with its appearance before surgery and become similar to the preoperative state by 2 months after surgery in group 2. This suggests that the auricle returns to the preoperative state earlier in patients who undergo canal wall down mastoidectomy, which weakens the structural support for the auricle, and this may be attributed to the depression observed in surgical site of the postauricular area [2]. Moreover, we can speculate that this may be associated with the finding that both the MD and UP values decreased compared with their respective preoperative values by 4 months after surgery and tended to become smaller over time, until 6 months after surgery in group 2.

The Phenomenon of Auricular Flattening

Auricular flattening is described as a state where the auriculocephalic angle has become smaller than the normal range [2] (Figure 1b). This phenomenon is thought to occur owing to the weakened supportive structures of the auricles during mastoidectomy, as mastoid cortical bone is removed and the subcutaneous tissue, muscle, and periosteum are used for mastoid obliteration during the canal wall down mastoidectomy (CWDM). In this study, postoperative measurements collected for 6 months were analyzed. No patient developed auricular flattening within 6 months of the surgery, most likely because 6 months was an insufficient time period for auricular flattening to occur. However, in group 2 (patients who had undergone CWDM), both mean MD and UP values measured 4 and 6 months after the surgery were lower than preoperative measurements, with the values showing a decreasing trend with time (i.e., measurements were lower at 6 months than at 4 months after the surgery). More specifically, the *p*-value of the mean UP value of group 2 at 6 months after the surgery was 0.05. These outcomes imply the potential for auricular flattening to be observed if the subjects can be followed up for a longer period of time after the surgery. In our study, group 1 (including patients who had undergone canal wall up mastoidectomy (CWUM)) did not exhibit shorter MD and UP after the surgery. Moreover, Jung

et al. [4] showed that auricular depression can occur even in the patients who underwent CWUM, and titanium mesh was used to reconstruct the mastoid cortex that was removed during CWUM to prevent auricular depression [4]. Furthermore, even during CWUM, filling the mastoid cavity devoid of air cells with materials (e.g., bone pate, cartilage, hydroxyapatite, demineralized bone matrix, or bioactive glass) other than the material extracted from the supportive structures of the auricle—especially by sufficient obliteration to the height of the mastoid cortex—can support the auricle, possibly preventing auricular depression [5–7]. Therefore, to prevent auricular flattening during CWDM, reconstruction of posterior canal wall and mastoid cortex or obliteration of the mastoid cavity using the above mentioned material rather than the material collected from the supportive structure of the auricle after posterior canal wall reconstruction should be considered [8–10]. During CWUM, mastoid cavity obliteration using the above mentioned method or reconstruction of the mastoid cortex defect with titanium mesh can be considered.

CONCLUSION

Protrusion of the superior aspect of the auricle returned to the preoperative state by 2 months after surgery, irrespective of the type of surgery. On the other hand, the middle aspect of the auricle returned to the preoperative state by 4 months after tympanoplasty or canal wall up mastoidectomy and by 2 months after canal wall down mastoidectomy. Although the time required varied, depending on the aspect of the auricle involved and type of surgery, the auricle appeared protruded postoperatively, compared with its preoperative state, and returned to its preoperative state within 2–4 months after surgery, indicating that auricular protrusion after surgery is not a permanent, but a transient phenomenon.

Ethics Committee Approval: Ethics committee approval was received for this study from institutional review board (IRB) of the Daegu Catholic University Medical Center (IRB No. CR-16-093).

Informed Consent: Written informed consent was obtained from all the participants included in this study.

Peer-review: Externally peer-reviewed.

Conflict of Interest: The author has no conflict of interest to declare.

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