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Original Study

Postoperative Radiologic Assessment and Long-Term Clinical Results of Tegmen Mastoideum Defects

Mastoid Tegmen Defektlerinin Uzun Dönem Klinik Sonuçları ve Radyolojik Değerlendirmesi

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Ethics Committee Approval: This study was approved by Kocaeli University Ethical Committee of Non-Invasıve Clinical Research, 20 July 2016, 2016/14.4.
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ABSTRACT

Objective: *Tegmen defects occur mainly due to cholesteatoma and iatrogenic trauma, and the intervention for the related defects is still a debate. In this study, we aimed to discuss our clinical experience on the management of the tegmen defects which were revealed during the mastoidectomy surgeries.*
Methods: *This study was designed as a retrospective chart review study and patients who were operated between 2007-2017 were included. The causes of the defects, repair technics, and results of the long-term follow up were evaluated. The perioperative and postoperative defect sizes which were obtained from the radiological studies were analyzed.*
Results: *Total number of 62 patients had tegmen defects, and their etiologic factors were cholesteatoma in 31 (50%), iatrogenic factors in 29 (46.7%), and chronic infection in 2 (3.3%) patients. The number of the tegmen defects was higher in intact canal wall technic. All of the tegmen defects were repaired with different materials, and no complication was detected. The obtained data from the postoperative radiological images revealed that the related perioperative defects were significantly decreased ($p<0.001$).*
Conclusion: *The perioperative bone defects were observedly decreased significantly in postoperative period. Early detection of the defect and appropriate interventions may help to manage this problem without any complication in the long term.*

Keywords: *Chronic otitis media, tegmen tympani defects, cerebrospinal fluid leakage, mastoidectomy, encephalocel*

ÖZ

Amaç: *Tegmen kusurları esas olarak kolesteatom ve iyatrojenik travmaya bağlı olarak ortaya çıkar ve ilgili kusurlara müdahale hala tartışma konusudur. Bu çalışmada mastoidektomi ameliyatları sırasında ortaya çıkan tegmen defektlerinin yönetimi ile ilgili klinik deneyimimizi tartışmayı amaçladık.*
Yöntem: *Bu çalışma retrospektif bir dosya inceleme çalışması olarak tasarlandı ve 2007-2017 yılları arasında ameliyat edilen hastalar dahil edildi. Defektin nedenleri, onarım teknikleri ve uzun süreli takip sonuçları değerlendirildi. Radyolojik çalışmalardan elde edilen perioperatif ve postoperatif defekt boyutları incelendi.*
Bulgular: *Toplam tegmen defekti olan hasta sayısı 62 olup defekt etiyolojisi sırasıyla 31'inde (%50) kolesteatom, 29'unda (%46,7) iyatrojenik ve 2'sinde (%3,3) kronik enfeksiyon olarak izlendi. İntakt kanal duvarı tekniğinde tegmen defekti sayısı daha fazlaydı. Tüm tegmen defektleri farklı materyallerle onarıldı ve herhangi bir komplikasyon tespit edilmedi. Postoperatif radyolojik görüntülerden elde edilen veriler, ilgili perioperatif defektlerin anlamlı olarak azaldığını ortaya koydu ($p<0,001$).*
Sonuç: *Postoperatif dönem takiplerinde perioperatif kemik defektlerinin önemli ölçüde azaldığı izlendi. Kusurun erken tespiti ve uygun müdahaleler bu sorunun uzun vadede herhangi bir komplikasyon olmaksızın yönetilmesine yardımcı olabilir.*

Anahtar kelimeler: *Kronik otitis media, tegmen timpani defektleri, beyin omurilik sıvısı kaçağı, mastoidektomi, ensefalosel*

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INTRODUCTION

The removal of the air-filled mastoid cells was termed as mastoidectomy and has become a frequently performed procedure. The chronic otitis media was the most common surgical indication. In fact, cochlear implantation, facial nerve interventions, and vascular tumor resections were the less common indications for this procedure. If the defect is in close anatomical relation with critical structures, a few complications have been described so far including for example dural exposition or dural breach.

Dura is closely related with mastoid cavity or tympanic spaces, and isolated with a bony structure which was named tegmen tympani or mastoideum. Dural exposition or dural breach is a result of the defect on bony structures, and mostly come out because of chronic otitis media or iatrogenic causes. The clinical significance of the tegmen defects and dural exposition is not still clear, but these defects may cause many dramatic results like hematoma, encephalocel, meningitis, encephalitis, and cerebrospinal fluid (CSF) leakage. These complications should be managed properly due to mortality or severe morbidity[1].

Because of these challenging complications, many authors have discussed the possible predisposing factors and the management methods. Size, localization, and cause of the defect, relapsing disease, cholesteatoma, increased intracranial pressure, and patient-related factors (e.g., obesity) are some of predisposing factors discussed[2,3]. Although many reports mostly based on single center experience have been published still no consensus has been reached so far for the management of the dura exposition and tegmen defects.

In this study, we aimed to discuss and review the reasons, results, and management of the tegmen plate defects during the mastoidectomy surgery and compared postoperative radiologic defect sizes with perioperative ones.

MATERIAL and METHOD

Patient Selection

This study was designed as a retrospective chart review, and all of the data were obtained from the medical records of the tegmen mastoideum or tympani defects of the patients who had undergone mastoidectomy alone or as a part of their surgical treatment performed in Kocaeli University Otorhinolaryngology Department between the 2007-2017 noticed.

Surgical Procedure

All the operations were performed under the general anesthesia using surgical microscope and a high-speed drill by different surgeons under the supervision of a senior otologist. Different surgical interventions (canal wall up/down mastoidectomy) were preferred according to the patient's condition and spread of the disease. Gently evaluated dural defects were measured, and the etiology of the defect was recorded. The longest diameter of length of the defect named as first axis (X) and its longest diameter of width named as second axis (Y) were recorded, as well. The diameters measured were used to calculate an elliptical area to reveal the total size of the defect area. The formula of the ellipse was accepted as

$$Area = \frac{XxY}{4} \times \pi$$

All defects were repaired with autogenic or synthetic materials immediately or at the end of the surgery. The closure techniques and materials used were chosen due to the senior surgeon's personal experience. Generally, the fascia was preferred for the small defects or mastoid bone with low risk. Otherwise, relatively large defects or risky mastoids with drainage were fixed with more durable materials like cartilage or bone.

Fascia, cartilage, and bone were the preferred autogenic materials. Fascia was laid on the defect widely to cover and facilitate the epithelization

after the cartilage or bone was placed on the defect, or alone without any additional supporting material. Cartilage and bone were used after careful elevation of the dura from the borders of the defect, and settled as an inlay graft between the dura and the bony defect. Additional autogenic fat or synthetic materials like bonewax, oxidized regenerated cellulose (Surgicell®, Ethicon, Johnson and Johnson, USA), collagen-based dural patch (Duragen®, Integra Life Science, NJ, USA), and fibrin sealant (Tisseel® Lyo, Baxter International, IL, USA) were also used depending on the surgeon's preference, and characteristics of the defect.

Postoperatively, all patients were monitored in case of CSF leakage and frequently asked for the presence of symptoms which were associated with central nervous system infection. Patients who had relatively large defects also received antibiotics postoperatively in case of any infection.

Long-term Follow-up

All patients were recalled for the routine control visits at postoperative 3rd, 6th and 12th months. Patients were questioned for the presence of rhinorrhea or otorrhea. Patients with no problem were followed up every year and controlled according to the spread of the disease or type of the surgery applied. Patients with open cavity had been inspected with otomicroscope, and/or evaluated especially with angled endoscopes for the presence of any complication due to the dura defect. Patients with intact canal were evaluated with otomicroscope in case of presence of effusion or pulsation. Patients with additional complaints or clinical suspicion of the recurrence were evaluated with computerized tomography (CT) and/or magnetic resonance imaging (MRI). In the light of the radiological images, the presence of herniation was checked, and the size of bony residual defects were calculated with above-mentioned formula. Postoperative dimensions, and sectional values of the defects estimated during follow-up were compared with corresponding perioperative values. Radiological evaluations were not required from the patients with normal clinical features.

Statistical Analysis

SPSS v.20.0 (IBM®, Chicago, IL, USA) was utilized for all the statistical analysis. The distribution of the obtained data was tested via Kolmogorov-Smirnov test. Operative and postoperative radiological sectional values reflecting the dura defect size were compared with Wilcoxon test.

Ethics Statement

This study was conducted after the approval of local ethics committee of the Kocaeli University Faculty of Medicine (KU GOKAEK 2016/218).

RESULTS

A total of 62 patients, who had tegmen defect detected during the mastoidectomy operation, were included in this study. The study population consisted of 34 females (55%) and 28 males (45%) with an age range between 12-74 years (mean: 40.1, median:38.5). Mean follow-up period was 51.8 months (min:14, max:109).

Surgical Procedure

The performed surgeries were canal wall down (CWD) mastoidectomy with tympanoplasty in 30 (48.3%), canal wall up (CWU) mastoidectomy with tympanoplasty in 11 (17.7%), revision mastoidectomy in 11 (17.7%), radical mastoidectomy (RM) in 4 (6.5%), simple mastoidectomy in 4 (6.5%), and petrosectomy in 2 (3.3%) cases (Table 1). Thirty-one (50%)

Table 1. Distribution of the performed surgical procedures in the patients.

Operation	Number of Cases: 61 (100%)
CWD	30 (48.3%)
CWU	11 (17.7%)
Revision mastoidectomy	11 (17.7%) (9 CWD, 1 CWU, 1 RM)
Radical mastoidectomy	4 (6.5%)
Simple mastoidectomy	4 (6.5%)
Petrosectomy	2 (3.3)

surgeries were performed in the right 31 (50%) in the left ears. Sixteen (26%) patients had intact ear canal, and 46 (74%) patients had open cavity. The revision procedures were nine CWD, one CWU, and one RM.

Etiology

The etiology of defect was cholesteatoma in 31 (50%), iatrogenic in 29 (46.7%), and chronic infection without cholesteatoma formation in two (3.3%) cases (Table 2). The iatrogenic tegmen defect was seen in cases who had undergone intact canal (n:15; 52%) or open cavity technics (n:14; 48%). Sixteen patients were operated with intact canal technic due to iatrogenic factors (n: 15; 93%) or infection (n:1; 7%). Total number of 46 patients had open cavities, and the related etiologies were cholesteatoma in 30 (66%), iatrogenic in 14 (31%), and infection in one (3%) case.

Table 2. Etiology of the tegmen defect in the patients.

Etiology	Number of Cases: 62 (%100)
Cholesteatoma	31 (50%)
Iatrogenic	29 (46.7%)
Infection	2 (3.3%)

Closure of the defect

All tegmen defects were repaired with autogenic or synthetic materials using a single or combination of different techniques. Bone was used in 16 (25%), cartilage in 37 (59%), fascia in 23 (38%), bonewax was in 3 (5%), small bone pâté in 2 (3%), oxidized regenerated cellulose in 2 (3%) cases, and fat, fibrin sealant, and collagen based dural patch were used once for each (2%) case. The main reconstructive material was bone in 16 (25%), cartilage in 34 (56%), fascia in 11 (18%) c, and bone wax in 1 (2%) case. The distribution of the preferred closure methods, and age, sex, defect size and cause, CSF leakage, and the performed surgeries is given in Table 3.

CSF Leakage

Cerebrospinal fluid leakage was revealed in six (10%) patients intraoperatively. The performed surgeries were CWU in three (%50), CWD in two (%33), and revision surgery in one (%17) case. The surgical indications were iatrogenic factors in four (%67), and cholesteatoma in two (%33) cases. There was only one case with dura defect which was repaired with collagen-based dural patch in a watertight manner. The bony defect of this case was supported with bone, cartilage, fascia, oxidized regenerated cellulose, and some bone wax.

Follow-up

In the postoperative follow up period, 45 (74%) patients with open cavity were inspected with otomicroscope, 11 cases were also evaluated with endoscopes, and the dehiscent area could be seen by the more bluish reflection of the dura over the bone or as a less dense area of tegmen (Figure 1). None of the related complications with tegmen defect (encephalocele, meningitis, encephalitis, CSF leakage, etc.) was observed in the postoperative period. Sixteen (26%) patients who had undergone CWU procedures were evaluated with otomicroscope and otoscopy. No evidence for the effusion, pulsation, rhinorrhea or otorrhea was detected in all related patients.

Defects and Radiology

The intraoperative defects were recorded, and the mean diameter of length was 9.25 mm (min:2 mm max:30 mm). The mean diameter of width was 6.45 mm (min:2 mm max:20 mm). The mean area of the defects was 63.2 mm^2 (min:3.14 mm^2, max:471 mm^2).

Postoperatively, size of the dural defects of 26 (42%) patients were assessed with radiological methods. Fourteen patients were evaluated with CT, six patients with MRI, and five patients using both CT and MRI (Figure 2). An average of 32.7 months (min:4 months, max:195 months elapsed until the patient's evaluation with radiological methods. The measured defect area varied from 3.14 mm^2 to 150,7 mm^2 (median 30.35 mm^2).

Table 3. Distribution of the all patients.

Patient	Sex	Age	Operation	Side	Etiology	Defect	Area	CSF	Repair	FU time	Radiology	R defect	R area
1	F	59	CWD	R	cholesteatoma	4x3	9,42	+	C+F	43	-		
2	M	30	CWD	R	iatrogenic	3x3	9,1	-	C	52	-		
3	F	18	Rev CWD	L	cholesteatoma	6x5	21,98	-	F	44	-		
4	F	40	CWD	R	cholesteatoma	4x3	9,42	-	F	48	-		
5	M	15	CWD	R	cholesteatoma	5x4	3,14	-	C	47	CT	3x3	7,1
6	F	51	CWD	L	iatrogenic	10x5	37,68	-	C	46	-		
7	F	61	Rev CWD	L	iatrogenic	10x10	78,5	-	C	46	-		
8	M	61	CWD	R	cholesteatoma	30x20	471	-	B+C+F	45	-		
9	F	58	CWU	L	iatrogenic	20x10	157	-	C	58	CT	6x4	18,84
10	F	53	CWU	L	iatrogenic	4x4	12,56	-	C	50	CT	4x3	9,42
11	M	34	CWD	R	cholesteatoma	5x4	15,7	-	C+F	44	-		
12	M	18	P	L	cholesteatoma	16x12	150,72	-	B	57	MRI	8x5	31,4
13	M	47	CWD	L	cholesteatoma	10x10	78,5	+	C+T+Fat	109	CT	3x3	7,1
14	M	51	Rev CWD	L	iatrogenic	20x10	157	-	B	83	CT	13x9	91,06
15	F	22	CWD	R	iatrogenic	5x4	15,7	-	C	97	-		
16	M	48	P	R	cholesteatoma	20x15	235,5	-	B	96	MRI	15x13	150,72
17	M	60	CWD	L	iatrogenic	4x3	9,42	-	C	76	-		
18	F	19	Rev CWD	L	iatrogenic	5x3	11,8	-	B	69	-		
19	F	35	Rev CWD	R	cholesteatoma	5x4	15,7	-	B+F	59	MRI	3x2	4,74
20	F	26	CWD	L	cholesteatoma	10x5	37,68	-	B	90	CT	8x4	25,12
21	F	22	CWD	L	cholesteatoma	10x5	37,68	-	C	88	-		
22	F	31	Rev CWD	R	cholesteatoma	6x5	21,98	-	C	68	-		
23	M	60	Rev CWD	L	iatrogenic	6x4	18,84	-	C	83	-		
24	F	50	CWU	R	iatrogenic	7x5	25,12	-	C	82	-		
25	M	13	CWD	R	iatrogenic	22x12	207,24	-	B+F	81	MRI	8x6	37,68
26	M	43	SM	R	iatrogenic	3x3	7,1	+	F	34	-		
27	F	72	RM	R	cholesteatoma	14x10	109,9	-	C+W	33	-		
28	F	42	CWU	R	iatrogenic	5x5	18,84	-	C	31	CT+MRI	5x4	15,7
29	M	12	CWD	R	cholesteatoma	3x3	7,1	-	F	28	CT	0	0
30	M	37	CWU	R	iatrogenic	7x6	31,4	-	C	26	-		
31	F	40	CWD	L	cholesteatoma	20x10	157	-	C+F	43	CT+MRI	9x5	34,54
32	M	65	Rev CWU	R	iatrogenic	20x10	157	+	B+D+F+S+W	34	CT	9x7	47,1
33	M	30	Rev RM	L	cholesteatoma	15x12	141,3	-	B	40	-		
34	F	27	RM	L	cholesteatoma	21x12	197,82	-	B	40	CT	2x2	3,14
35	F	41	Rev CWD	L	iatrogenic	4x4	12,56	-	B	38	-		
36	F	48	CWD	L	cholesteatoma	20x8	125,6	-	C+F	37	-		
37	F	58	CWD	L	infection	5x4	15,7	-	B+C	35	CT+MRI	6x4	18,84
38	F	70	CWD	R	iatrogenic	3x3	7,1	-	C+S	22	-		
39	F	34	CWD	L	iatrogenic	4x4	12,56	-	C	20	-		
40	F	28	SM	R	iatrogenic	2x2	3,14	-	W	21	-		
41	M	26	CWD	L	iatrogenic	3x4	9,42	-	F	20	-		
42	F	25	CWD	R	cholesteatoma	3x3	7,1	-	C	19	CT	3x2	4,74
43	M	54	CWU	R	iatrogenic	7x6	31,4	+	C+F	19	CT	6x4	18,84
44	F	46	CWU	L	iatrogenic	4x3	9,42	-	F	19	-		
45	M	35	RM	R	cholesteatoma	7x6	31,4	-	C	18	CT	4x4	12,56
46	F	41	CWU	L	iatrogenic	4x3	9,42	-	C	18	-		
47	F	18	SM	R	infection	6x5	21,98	-	C	18	-		
48	M	34	CWD	L	cholesteatoma	10x10	78,5	-	F	77	CT+MRI	8x6	37,68
49	M	25	CWD	R	cholesteatoma	5x4	15,7	-	C	75	MRI	3x2	4,74
50	F	33	CWU	L	iatrogenic	5x5	18,84	-	B	75	MRI	4x3	9,42
51	F	31	CWD	L	cholesteatoma	12x6	56,52	-	B+F	74	-		
52	F	65	Rev CWD	L	cholesteatoma	3x4	9,42	-	C	45	-		
53	M	64	CWU	L	iatrogenic	8x6	37,68	+	C+F+S+BP	81	-		
54	F	18	RM	R	cholesteatoma	12x10	94,2	-	C	106	-		
55	F	37	CWD	R	iatrogenic	7x6	31,4	-	C	60	CT	5x2	7,9
56	M	47	CWD	L	cholesteatoma	6x4	18,84	-	F	99	-		
57	M	30	CWD	R	cholesteatoma	4x3	9,42	-	F	86	-		
58	M	34	CWD	L	cholesteatoma	8x8	50,24	-	C	58	-		
59	F	45	CWU	R	iatrogenic	20x10	157	-	F	17	CT	6x4	18,84
60	M	74	SM	L	iatrogenic	10x10	78,5	-	F+BP	15	CT+MRI	7x6	31,4
61	M	42	CWD	R	cholesteatoma	15x12	141,3	-	C+F	14	-		
62	M	35	CWD	R	cholesteatoma	20x10	157	-	B+C	60	CT	5x3	11,8

(FU: Follow up, R defect: radiologic defect, R area: radiologic area, C: cartilage, F: fascia, B: bone, T: tisseel, S: surgicel, D: duragen, W: bone wax).

The postoperative bony defect sizes, which were measured from radiological images were found to be statistically significantly smaller than the intraoperative defect size in these related 26 patients ($p<0.001$).

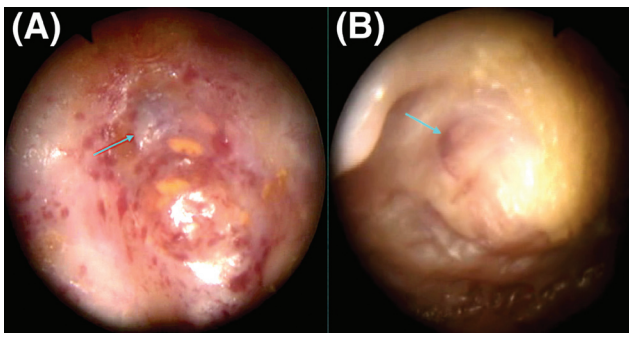

Figure 1. The endoscopic view of the defect of two patients at physical examination with angled endoscopes in postoperative follow up period; (A) grafted with fascia, (B) grafted with cartilage.

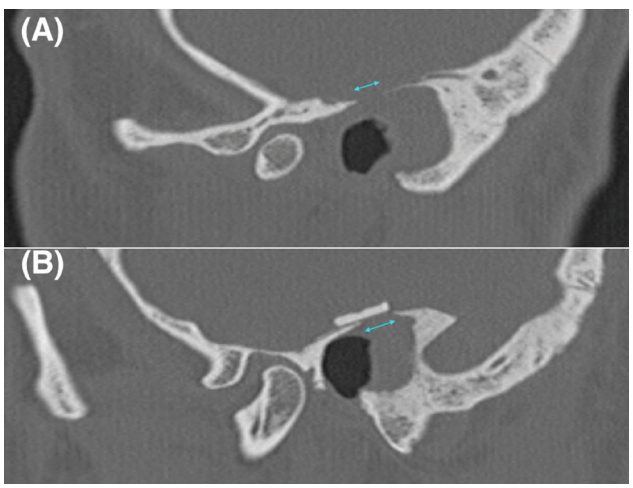

Figure 2. (A) The postoperative bony defect of a patient whose defect was repaired with fascia; Sagittal CT image. (B) The postoperative bony defect of another patient whose defect was repaired with bone and fascia; Sagittal CT image. The graft can be see.

DISCUSSION

The bone defects are associated with various etiologies, but they can be discussed in three categories as patient, disease, and surgical intervention-related etiologies. Patient-related etiologies are anatomical variations (poor mastoid aeration, inferiorly settled dura, etc.), increased intracranial pressure, ectopic arachnoid granulations on temporal bone, and obesity[4-6]. The chronic ear disease especially with cholesteatoma may spread widely and disrupt the bony structures. Disease recurrence may also increase the risk of the tegmen defect occurrence, as well. Traumatic injuries, neoplastic formations, and irradiation are other etiologic factors[1,7,8].

Surgical intervention is another important factor associated with the tegmen defects. The wide surgical excision of the cholesteatoma is required in advanced cases and in such cases tegmen defects can be easily induced. Moreover, in some of the techniques like middle fossa approach, the removal of the bony tegmen strongly requires repair of the defect. Perhaps the most important factor for avoiding the tegmen defect is the experience of the surgeon. Unexperienced or inattentive disciples can breach the bony limits. In fact, the radiology knowledge and the anatomical awareness during the operation are the other key points to avoid the tegmen defects. The poor microscopic or endoscopic visualization and improper surgical equipment may be other factors.

In this study, we followed the patients with clinical assessment, physical examination, and radiological imaging techniques. Follow-up of the patients with open cavity was evaluated via otomicroscopy and endoscope. Related patients were controlled for the herniation, CSF otorrhea, and disease recurrence. None of the defect related complications were detected in our patients. Although defect related areas could be detected with endoscopes postoperatively; epithelized cavity, durability of repair material hardened to detect the borders of the defect and made the measurement of exact defect size unfeasible. After all, we considered that the measurement of the defect size using radiological means might be more accurate, but physical examination of cavity was sine qua non for the control of possible complications.

The follow-up of the patients with closed cavity could be more challenging than the open cavity. The extraordinary humidity on ear dressing or continuous postnasal dripping should alert us about CSF leakage in early postoperative period. The very limited CSF leakage and spontaneous recovery might avoid displaying the defect; despite occurrence of CSF otorrhea and rhinorrhea[1]. In long-term follow-up; the physical examination was limited with the observation of the graft status, pulsation, effusion presence, and posterior rhinoscopic examination. Radiological techniques, especially CT, could help to detect the possible complications. We revealed no complication in our patients with closed cavity.

In this study, some of the patients who required further examination were evaluated with radiological techniques postoperatively, and we found that although the defect sizes were decreased, the bony defect persisted and did not disappear totally. The tegmen defect sectional areas were decreased about a half but only one patient did not show any decline. With a basic and a little careful radiological evaluation, the bony defects could be seen despite reconstruction.

Decrement rate of the defect may depend on several reasons, and individual's wound healing ability may be the first factor. Moreover, the osteitis due to prolonged effect of chronic otitis media or cholesteatoma may also disrupt the healing. The thermal injury due to the powered high-speed instruments (e.g., diamond burr) or inappropriate surgical field irrigation might cause unfavorable effects on bone healing process. It is wise to remember that postoperatively revealed infection in the cavity or middle ear may adversely influence the bone healing and complicate the condition[9]. In this study, we found no critical cavity problem and we considered that he cavity management technique had a significant role in this regard.

The early radiological evaluation could be helpful to identify early complications in the major dural injury. Presence of intracranial hematoma or CSF accumulation might be monitored in early postoperative period. We needed the early monitoring protocol for a patient who had a dural injury and no unexpected complication was revealed.

The related complications of tegmen defect are encephalocel, meningitis, and CSF leakage, and urgent intervention is required. The reinforcement of bony structures may reduce the glial or meningeal tissue prolapses, and the watertight closure of dura is strongly recommended for the patients with coexistent CSF leakage[1]. In fact, proper antimicrobial administration may also reduce the infective complications. In our case series, we encountered none of related complications. All tegmen defects were observed by an experienced surgeon. The detected dural injuries and CSF leakage were fixed meticulously as watertight with above-mentioned autologous and synthetic materials. We couldn't compare the success rates obtained using different repair materials because of the small number of heterogenic materials used according to the size of the defects, bone or cartilage grafts were used in 81% of the patients and proper antimicrobial administration was done perioperatively. Patients were also informed to avoid from behaviors increasing the intracranial pressure.

In this study, we found that more than half of the iatrogenic tegmen defects had been operated with close cavity technique. In addition, the most common etiology of the patients who were operated with the closed cavity technique was iatrogenic tegmen defect. If we consider these results, the number of the tegmen defects was slightly higher than current literature and we tried to explain this fact with the heterogenic status of the clinic[1]. Complicated cases, like advanced cholesteatoma were operated by experienced clinicians and less severe cases were operated by less-experienced residents. For the mastoidectomy surgery, it is vital to be familiar with the anatomical

landmarks and satisfactory skills in manipulating the instruments; but recognizing the borders of the tegmen might be difficult for newly trained residents. For this reason, adequate experience in temporal bone or cadaver dissections and good knowledge of relevant anatomy are needed before performing this surgery.

Although a relatively long follow-up period was an advantage for the study, we observed some limitations. Firstly, we were not able to check all of the remained defects radiologically because of the ethical issues (no indication, economic facts, and radiation exposure of the patients); so, we evaluated the limited number of patients retrospectively. The imaging times were discrete, but it was difficult to conduct a prospective study by taking the images for all patients at the same time because of the above-mentioned facts. Secondly, heterogeneity of the materials used and defect sizes restricted our ability to arrive at a precise conclusion. It was a retrospective study, so we couldn't define a selection criteria for patients, types of defects or materials used. On the other hand, planning such kind of prospective study would be difficult and may have some medical and ethical concerns.

As a result, both iatrogenic and disease-related tegmen defects are common problems in otology practice. Although they looked not so important according to the results the present study, they have of course, critical significance, and should be avoided. Treating the primary disease as soon as possible and performing the surgeries more carefully will decrease the number and size of these defects. When the bone defect occurred, early and exact detection of the defect, its proper repair, and postoperative follow-up are major criteria to manage the complications encountered. It can be said that these defects will not cause serious problems for the patients if proper theraupetic approaches are applied.

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