European Archives of Oto-Rhino-Laryngology (2019) 276:79–83
https://doi.org/10.1007/s00405-018-5198-7

OTOLOGY

Facial canal dehiscence rate: a retrospective analysis of 372 chronic otitis media cases

M. Tayyar Kalcioglu[1] · Osman Kilic[1] · Ozan Tuysuz[1] · Serkan Serifler[1] · Muhammet Tekin[1]

Received: 19 March 2018 / Accepted: 8 November 2018 / Published online: 12 November 2018

Abstract

Purpose This study aimed to investigate the rate and location of facial canal dehiscence (FCD) observed during surgery for chronic otitis media (COM) with or without cholesteatoma.

Material and method Operative details of 1296 patients who underwent chronic otitis media surgery from January 2000 to January 2017 by the same surgeon were included in this retrospective study focusing on intraoperative observations of FCD.

Results Because of the type of the surgery, the Fallopian canal could not be seen completely, so 924 of the cases which only involved performing a tympanoplasty were not included in the study. A total of 372 patients (196 males and 176 females) who had a canal wall down (CWD) or canal wall up (CWU) mastoidectomy were included in the study. A CWD mastoidectomy was performed on 250 patients, while 122 patients underwent a CWU mastoidectomy. The prevalence of FCD was 11.29% (42/372 patients). The dehiscence was more common in patients with cholesteatoma ($n=37$; 88.1%) than those with non-cholesteatoma ($n=5$; 11.9%). The tympanic segment ($n=32$; 76.19%) was the most common location for FCD. When we compared the ossicular erosion results of the cases that had FCD, erosion in three ossicles together was more statistically significantly frequent than the other possibilities.

Conclusion It is possible to see FCD because of COM, especially with cholesteatoma. FCD is most commonly seen around the oval window. If stapes or all three ossicles are eroded, the surgeons must be more careful regarding FCD to be more effective in preventing facial nerve damage.

Keywords Facial nerve · Fallopian canal · Dehiscence · Ossicles

Introduction

Iatrogenic facial paralysis, one of the causes of facial nerve paralysis, is the most uncomfortable complication encountered in the postoperative period experienced by otolaryngologists. This is because facial nerve paralysis leads to a noticeably aesthetically unpleasant change in the patient's physical appearance. This complication, which causes the patient to become socially isolated and lose self-confidence, is a serious psychological trauma for both the patient and the physician. In addition to having a good anatomical knowledge, remembering the possibility of dehiscence of the facial nerve canal (FCD) during otologic surgeries will help prevent this undesirable complication [1].

FCD may be congenital or due to bone erosion, and its occurrence depends on whether chronic otitis media is with cholesteatoma (C-COM) or chronic otitis media is without cholesteatoma (COM) [2]. In chronic otitis media with or without cholesteatoma, destruction may occur due to pressure, inflammation, or the effect of secreted enzymes on the bony canal [3]. For the otologist, it is also important to know where dehiscence is more frequent. Some studies have shown that the most common location of FCD is the tympanic segment [2]. In some clinical and anatomical studies, the frequency of FCD in C-COM or COM cases has been discussed. However, the number of cases is limited in these studies.

This study was presented in 9th Cochlear Implant, otology-neurotology Congress (National) 7–10 December, 2017, Antalya, Turkey and 31th Politzer Society Meeting, 21–24 February, 2018, Las Palmas de Gran Canaria, Spain.

✉ M. Tayyar Kalcioglu
mtkalcioglu@hotmail.com

[1] Department of Otorhinolaryngology, Head and Neck Surgery, Istanbul Medeniyet University, Goztepe Training and Research Hospital, Istanbul, Turkey

In this retrospective study, the FCD rate and location were evaluated in a large series of COM or C-COM cases in which the surgeries were performed by the same surgeon.

Material and method

After obtaining approval from the local ethics committee, intraoperative findings of 1296 patients who were operated by the same surgeon (MTK) between January 2000 and January 2017 for COM were evaluated retrospectively.

Surgical approaches involving mastoidectomy, which made it possible to see and evaluate the complete facial canal, such as canal wall down (CWD) and canal wall up (CWU) mastoidectomy approaches, were included in the study. The cases that had tympanoplasty or myringoplasty only, without any mastoidectomy, were excluded from the study.

At the same time, there were approximately 400 patients who underwent mastoidectomy during cochlear implantation, but the entire facial canal could not be assessed because a limited mastoidectomy is performed in cochlear implant surgeries. Dehiscence in the facial canal was first classified into three groups as tympanic (horizontal) segment, mastoid (vertical) segment and both tympanic and mastoid segments. Then the tympanic segment was defined to include the portion between the first genu and the second genu and dehiscences in the mastoid segment were defined as those located between the second genu and stylomastoid foramen. Dehiscence in the tympanic segment may be over the oval window, on the first genu or on entire of the segment, while one in the mastoid segment may be on the second genu, on the stylomastoid foramen or on entire of the segment.

The operations were performed under magnification using a Zeiss brand microscope (Carl Zeiss AG, Carl-Zeiss-Straße, 2273447 Oberkochen, Germany). The presence of dehiscence was noted by examining the entire facial canal with the help of an elevator. This method may be insufficient to display micro-dehiscence. However, micro-dehiscence does not make much trouble in the clinical practice anyway. So, we ignored micro-dehiscence.

Statistical analysis

Descriptive statistics of the qualitative variables were computed as count and percent frequencies. Pearson Chi-square and Fisher-Freeman-Halton exact tests were used for differences between the proportions. Significant proportions which were different from others were determined by using post hoc Bonferroni test when the results of Pearson Chi square test or Fisher-Freeman-Halton test were significant. The binary logistic regression model was used for relation between malleus, incus and stapes erosions and presence of FCD. Statistically significant level was accepted as $p < 0.05$. SPSS Statistics 23.0 (SPSS, USA) software was used for statistical analysis.

Results

Because the mastoid segment or the tympanic segment of the facial canal was not observed in some cases, 924 patients who had no mastoidectomy were excluded. Three Hundred Seventy-Two patients (196 males, 176 females) who underwent CWD or CWU tympanomastoidectomy were included in the study. In the mastoidectomy-performed group, 59 patients were in the pediatric age range (< 18) and 313 were adults (≥ 18). The ages of the patients were between 5 and 79 [mean = 33.7, standard deviation (SD) = 15.33]. In the pediatric and adult groups, the ages were between 5 and 17 (mean = 12.9, SD = 3.5) and 18 and 79 (mean = 37.6, SD = 13.4), respectively. CWD tympanoplasty was performed in 250 patients and CWU tympanoplasty was performed in 122 patients. This was 46 (78%) and 13 (22%) in the pediatric group and 204 (65.2%) and 109 (34.8) in the adult group, respectively, for CWD and CWU. The patients were divided into two groups as chronic otitis media with cholesteatoma (C-COM) and without cholesteatoma (COM) and then FCD is focused on. There was a total of 318 cases in the C-COM group and 54 in the COM group. FCD was detected in 37 (37/318, 11.6%) and 5 patients (5/54, 9.3%) in the C-COM and COM groups, respectively. The C-COM group's FCD rate was not statistically significantly higher than the COM group ($p = 0.816$). FCD rate was 24 (24/196; 12.2%) in males and 18 patients (18/176; 10.2%) in females, respectively. The difference was not statistically significant ($p = 0.539$). In addition, 19 were affected by dehiscence in the right ear and 23 in the left ear. There was no statistically significant difference between right and left ear ($p = 0.513$). FCD was found in 11.86% (7/59 patients) of the pediatric group and 11.18% (35/313 patients) of the adult group. There was no statistically significant difference between the groups ($p = 0.822$) (Table 1).

Regarding the location of the FCD, dehiscence was present in the tympanic segment in 32 (76.19%) of 42 patients who had FCD. In 8 patients, dehiscence was present in the mastoid segment. The FCD rate in the tympanic segment was statistically significantly higher than the mastoid segment ($p < 0.001$). In 2 patients, there were FCD covering both the tympanic and the mastoid segments. When we compared the tympanic segment dehiscence with the total mastoid and tympanic segment dehiscence, the difference in rates was found as statistically significant ($p < 0.001$). When we compare mastoid segment FCD with the total tympanic and mastoid segment dehiscence, the rates were not significantly different ($p = 0.481$). Of the 32 patients who had

FCD on the tympanic segment, 28 (87.5%) had oval window dehiscence. Dehiscence was found in 2 cases (6.25%) in the first genu. In 2 cases (6.25%), dehiscence involved the whole tympanic segment (Table 2). When we compare the FCD around the oval window with the first genu and also with the whole tympanic segment dehiscence, differences were statistically significant ($p < 0.001$). There was dehiscence in the second genus in 5 (62.5%) of 8 cases that FCD was detected in the mastoid (vertical) segment. In 2 cases (25%), dehiscence involved the entire mastoid segment. Dehiscence was present very close to the stylomastoid foramen in one case (12.5%). The FCD rate in the second genu was statistically significantly different compared to other locations in the vertical segment ($p = 0.024$) (Table 2).

When we focus on the ossicular erosions in 372 cases in which a mastoidectomy was performed, there were 88 only incus, 5 only stapes and 4 only malleus erosions. In 68 cases, there were both incus and stapes erosions; in 24 cases both incus and malleus erosions were observed, and 88 cases involved a combination of incus, malleus and stapes erosions. There was malleus erosion in 116 of 372 cases with or without other ossicular erosions. When we focused on stapes erosion, 160 of the 372 patients had stapes erosion alone or together with the other ossicles. When we focused on the incus erosion, 268 of the 372 cases had it with or without the other ossicles. None of the patients had only malleus and stapes erosions together. Without distinguishing between C-COM and COM, the relationship between malleus, incus and stapes erosions and probability of FCD is given in the Table 3. When the table was examined, it could be seen that FCD was present in 6 of 95 patients (6.3%) who had healthy malleus, incus and stapes, together. FCD was not observed in any of the 24 cases who had together malleus and incus erosions. FCD was present in 11 of 68 cases (16.2%) who had erosions together in incus and stapes. In 88 cases who had combined malleus, incus and stapes erosions, 17 (19.3%) had FCD. There were no FCD in 4 cases who had only malleus and in 5 cases who had only stapes erosion. FCD was observed in 8 of 88 cases (9.1%) who had only incus erosion. When we focus on the relation between ossicular chain erosion and FCD, the results of this study showed that the rate of FCD was significantly higher in the cases who had together incus and stapes erosions and also in those who have erosions all together in malleus, incus and stapes ($p = 0.036$).

Table 1 Features of facial canal dehiscence

	COM		C-COM		Male		Female		Pediatric group		Adult group	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
FCD present	5	9.3	37	11.6	24	12.2	18	10.2	7	11.86	35	11.18

FCD facial canal dehiscence, *COM* chronic otitis media without Cholesteatoma, *C-COM* chronic otitis media with Cholesteatoma

Table 2 Dehiscence segment properties

	Horizontal canal							Vertical canal							Horizontal + vertical canal	
	Oval window		1.Genu		Complete		Total	2.Genu		SMF*		Complete		Total		
	n	%	*n*	%	*n*	%	*n*	*n*	%	*n*	%	*n*	%	*n*	*n*	%
FCD	28	87.5	2	6.3	2	6.3	32	5	62.5	1	12.5	2	25	8	2	100

FCD facial canal dehiscence

*Foramina stylomastoideum

Table 3 The relation between the FCD and ossiculer erosions

	Ossicular chain erosion														Total *n*
	Only malleus		Only incus		Only stapes		Malleus + incus		Incus + stapes		Malleus + incus + stapes		None		
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
FCD (+)	0	0^{a}	8	$9.1^{a,b}$	0	0^{a}	0	0^{a}	11	16.2^{b}	17	19.3^{b}	6	6.3^{a}	42
All patients	4	1.1	88	23.6	5	1.3	24	6,5	68	18.3	88	23.6	95	25.5	372

The different letters beside the frequencies in each column indicate statistically significant differences ($^{a, b}$)

FCD facial canal dehiscence

When we performed binary logistic regression analysis, the prevalence of FCD were found 2.863 times higher ($p=0.049$) in the incus plus stapes eroded group and 3.552 times higher ($p=0.011$) in the group who had malleus, incus and stapes erosions together than the other groups (Table 4). In addition, when we focused on the C-COM and COM groups separately, it was seen that this difference was in the C-COM group.

Discussion

FCD may occur as a result of chronic otitis media with or without cholesteatoma, or it may be congenital. According to the intraoperative findings, the FCD rate was reported as 6–30%, while in the cadaver studies, FCD rates had been noted as 25–57% [2, 4–7]. This difference may be due to factors such as not being able to see all segments of the Fallopian channel during the operation, not recognizing micro-dehiscence, or not being able to observe micro-dehiscence because of granulation tissues caused by infections [4]. Dehiscence seen during cadaver dissection is usually micro-dehiscence. These micro-dehiscences rarely have risk during ear surgeries because of their size. Dehiscence that is more likely to create a risk of facial paralysis during surgery is mostly noticeable size of dehiscence. For this reason, it may be more practical to consider the rate of FCD encountered during surgery as the rate of risk for post-surgery clinical symptoms.

In 1977, Sheehy et al. found a 17% FCD rate in 1024 cases of mastoid surgery and performed their operations using the intact canal technique [8]. In 1999, Harvey and Fox reported the incidence of FCD in otologic surgery as 6% [9]. Selenick and Lynn Macrae and Moody and Lambert reported FCD rates in their series, which had 67 and 416 C-COM cases, as 33% and 18.8%, respectively [6, 10]. In the current study, the FCD rate was 11.29% of 372 cases in which CWU or CWD mastoidectomy procedures were performed. When we separated the cases as C-COM and COM, FCD rates were 11.6% and 9.3%, respectively. The two groups did not differ significantly ($p=0.816$). This result is an expected outcome of the destructive effect of cholesteatoma.

Table 4 ; Binary logistic regression analysis of the facial canal dehiscence and ossiculer erosions

Erosion on the	95% CI for OR			
	OR	Lower	Upper	p
Malleus only	0	0	0	0.999
Incus only	1.483	0.493	4.459	0.483
Stapes only	0	0	0	0.999
Malleus and incus	0	0	0	0.998
Incus and stapes	2.863	1.003	8.171	**0.049**
Malleus, incus and stapes	3.552	1.331	9.478	**0.011**
None of the ossicles	Reference category			
Constant	0.067			0.000

OR odds ratio

Moody and Lambert reported a higher FCD rate in adults than in pediatric-aged patients [10]. According to their results, FCD rates were 8% in the pediatric group (< 18 years) and 25% in the adult group (≥ 18 years), as in similar studies [11]. However, it is well known that ossification in newborns and children is not complete [12]. It is also known by ear surgeons that cholesteatoma is more aggressive in pediatric cases. In a study comparing pediatric and adult cases, it was showed that the metalloproteinase enzyme which had been responsible for the osteolytic process was higher in pediatric patients [13]. Therefore, it is expected that the probability of facial nerve dehiscence is higher in cases with cholesteatoma, especially in the pediatric group. In our study, according to these predictions, FCD was found more in the pediatric group when compared with the adults, although the difference was not statistically significant. However, in our study, when C-COM and COM cases were classified as pediatric and adult groups, the probability of detecting dehiscence in both groups was found to be significantly higher in cholesteatoma cases ($p=0.022$ and $p=0.001$, in pediatric and adult groups, respectively). These results indicate that cholesteatoma contributes substantially to dehiscence in both the pediatric and adult groups.

During a cadaver study, Baxter reported the FCD rate as 55% in 535 normal temporal bones [5]. In their study, dehiscence was found in the tympanic segment in 91% of cases and in 9% it was in the mastoid segment. Moreano et al. reported that the rate of FCD is 56% in 1000 normal temporal bone cases in cadavers [4]. The high rates found in cadaver studies may be due to a greater focus on micro-dehiscence. Additionally, removing soft tissues such as mucosa by treatment with various chemicals may be a factor that facilitates the detection of FCD at high rates. Studies performed on fresh cadavers instead of various treated temporal bones may provide more realistic results.

It was reported that dehiscence was most commonly seen in the tympanic segment in approximately 75–90% of cases [5, 14]. Our findings were similar to those reported in the literature. In the current study, 76% of the FCD was in the tympanic segment and the difference from other locations was statistically significant ($p=0.001$). In our series, FCD was found in 19% and 4.76% of cases in the mastoid segment and together in the mastoid and tympanic segments as total dehiscence, respectively. In the current study, tympanic segment dehiscence was located mostly around the oval window (93.8%) ($p=0.011$). Mastoid segment FCD was found on the second genu most frequently (80%) ($p=0.024$). Surgeons

mostly work on these areas during ear surgery; this shows us the importance of being attentive during any kind of ear surgery.

To the best of our knowledge, the relationships between FCD and ossicular erosion in the C-COM and COM cases have not been addressed in the literature. C-COM and COM, which may cause FCD by creating a destructive effect, are also expected to cause ossicular chain erosion. In our study, an absence of ossicular erosion was seen in only 6 of the dehiscence cases (14.29%). The remaining 86% had at least one ossicular erosion. Of these, a combination of malleus, incus and stapes erosion was most frequently detected (43%). This was statistically higher than the other probabilities. Both incus and stapes erosions (24%) and only incus erosion (19%) were the next most frequently detected. This result can be interpreted as the possibility of FCD should be considered more in cases of ossicular chain erosion.

When we compared the rates of FCD with respect to ossicles erosions in all the cases (372), statistically significant differences in FCD rates were seen between the patient groups having either stapes erosion or all 3 ossicles erosions and the rest of the patient groups. These results may indicate the possibility of higher FCD rates in cases with stapes erosion alone or together with malleus plus incus erosions. More attention may be needed to ascertain the possibility of FCD in these cases.

There are many reports recommending preoperative tomography before temporal bone surgery. But, micro-CT is required to examine the entire facial canal [15]. To be more objective, we recommend that the presence of dehiscence should be controlled during surgery.

Conclusion

COM, especially cholesteatoma, is a major risk factor for FCD. It is frequently seen around the oval window and second around the second genu. In the case of FCD, erosions of the incus, stapes and malleus together is observed at a significant level. If the stapes or all three of these ossicles are eroded, then surgeons must be more careful regarding FCD to more effectively prevent facial nerve damage.

Acknowledgements We thank to SY for his help on statistical evaluations of the data. We thank to Prof. HA for her revision on statistical analysis.

Funding They have no funding to disclose.

Compliance with ethical standards

This study was retrospectively data analysis study and it did not need to informed consent. This retrospective study was performed after approval of local ethic committee.

Conflict of interest The authors declare that they have no conflict of interest.

Human and animal rights statement The study has been approved by the Ethical Committee of the University Hospital and has been performed according to the ethical standards of the Helsinki Declaration. Because of it was a retrospective study, formal consent was not required. We declare that all authors have contributed to, read and approved the final manuscript for submission.

References

1. Nomiya S, Kariya S, Nomiya R, Morita N, Nishizaki K, Paparella MM, Cureoglu S (2014) Facial nerve canal dehiscence in chronic otitis media without cholesteatoma. Eur Arch Otorhinolaryngol 271(3):455–458. https://doi.org/10.1007/s00405-013-2431-2
2. Di Martino E, Sellhaus B, Haensel J, Schlegel JG, Westhofen M, Prescher A (2005) Fallopian canal dehiscences: a survey of clinical and anatomical findings. Eur Arch Otorhinolaryngol 262(2):120–126
3. Uno Y, Saito R (1995) Bone resorption in human cholesteatoma: morphological study with scanning electron microscopy. Ann Otol Rhinol Laryngol 104(6):463–468
4. Moreano EH, Paparella MM, Zelterman D, Goycoolea MV (1994) Prevalence of facial canal dehiscence and of persistent stapedial artery in the human middle ear: a report of 1000 temporal bones. Laryngoscope 104(3 Pt 1):309–320
5. Baxter A (1971) Dehiscence of the Fallopian canal. An anatomical study. J Laryngol Otol 85(6):587–594
6. Selesnick SH, Lynn-Macrae AG (2001) The incidence of facial nerve dehiscence at surgery for cholesteatoma. Otol Neurotol 22(2):129–132
7. Welling DB, Glasscock ME III, Gantz BJ (1992) Avulsion of the anomalous facial nerve at stapedectomy. Laryngoscope 102(7):729–733
8. Sheehy JL, Brackmann DE, Graham MD (1977) Cholesteatoma surgery: residual and recurrent disease. A review of 1,024 cases. Ann Otol Rhinol Laryngol 86(4 Pt 1):451–462
9. Harvey SA, Fox MC (1999) Relevant issues in revision canal-wall-down mastoidectomy. Otolaryngol Head Neck Surg 121(1):18–22
10. Moody MW, Lambert PR (2007) Incidence of dehiscence of the facial nerve in 416 cases of cholesteatoma. Otol Neurotol 28(3):400–404
11. Ozbek C, Tuna E, Ciftci O, Yazkan O, Ozdem C (2009) Incidence of fallopian canal dehiscence at surgery for chronic otitis media. Eur Arch Otorhinolaryngol 266(3):357–362. https://doi.org/10.1007/s00405-008-0748-z
12. Perez B, Campos ME, Rivero J, Lopez Campos D, López-Aguado D (1997) Incidence of dehiscences in the fallopian canal. Int J Pediatr Otorhinolaryngol 40(1):51–60
13. Dornelles Cd C, da Costs SS, Meurer L, Rosito LP, da Silva AR, Alves SL (2009) Comprasion of acquired cholesteatoma between pediatric and adult patients. Eur Arch Otorhinolaryngol 266(10):1553–1561. https://doi.org/10.1007/s00405-009-0957-0. (Epub 2009 Mar 26)
14. Chan K, Wang P, Chen Y, Wu C (2011) Facial nerve dehiscence at mastoidectomy for cholesteatoma. J Int Adv Otol 7:311–316
15. Kozerska M, Skrzat J, Spulber A, Walocha J, Wroński S, Tarasiuk J (2017) Micro-CT study of the dehiscences of the tympanic segment of the facial canal. Surg Radiol Anat 39(4):375–382. https://doi.org/10.1007/s00276-016-1744-4