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Original Article

Facial Nerve Dehiscence and Cholesteatoma: A Comparison between Decades

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OBJECTIVES: To evaluate the incidence of facial canal dehiscence (FCD) and other intraoperative findings over the last 20 years as well as correlation with the Japanese Otological Society/European Academy of Otology and Neurotology classification in patients with cholesteatoma.

MATERIALS and METHODS: A total of 469 patients operated from 1998 to 2018 were selected and divided into 2 groups of 10 years each.

RESULTS: Dehiscence was significantly higher in patients with a history of pathology longer than 5 years (22.7%). Higher values were observed in revision surgery, 44.4% in the first period and 41.7% in the second. The tympanic segment was the one most frequently involved, affecting 92% of patients in the first period and 97% of patients in the second. Dehiscence occurred significantly more often in patients with a semicircular canal fistula, 14.8% in the first decade and 8.8% in the second. The incidence of FCD was significantly higher in patients with primary cholesteatoma (especially in those with combined pars tensa-flaccida) than in those with a secondary acquired one, 31.5% vs 7.4% in the first period, 21.1% vs 7.4% in the second, and in those with a stage III disease, 42% in the first period, 33.3% in the second.

CONCLUSION: Patients with a shorter history of cholesteatoma as well as those not previously operated had a lower incidence of FCD. The tympanic tract of the facial nerve remains the most frequent site of dehiscence, while the association between dehiscence and fistula of the semicircular canal remains strong. Patients with combined pars tensa-pars flaccida and stage III cholesteatoma have a higher incidence of FCD.

KEYWORDS: Cholesteatoma, facial nerve, dehiscence

INTRODUCTION

One of the most feared postoperative complications of middle ear cholesteatoma surgery is the facial nerve paralysis. Dehiscence of the fallopian canal could be correlated to this sequela. Histological studies have found a significantly high incidence of facial canal dehiscence (FCD) in patients with normal temporal bones. Moreano et al., analyzing human temporal bones, described high incidences of micro and macro dehiscences, 56% and 69%, respectively [1]. Similar data have been reported by other authors [2, 3]. In patients suffering from chronic otitis media with or without cholesteatoma, the incidence of facial nerve dehiscence (FND) ranged from 8.9% to 45.5% intraoperatively [4]. In most cases, the tympanic segment was the most frequent facial nerve tract involved in bone dehiscence.

The focus of this research was to analyze factors that may justify the discrepancy between histological and intraoperative data, particularly when radiological findings cannot always be confirmed intraoperatively.

High-resolution computed tomography (HRCT) of the middle ear and petrous bone undoubtedly represents the most important imaging technique for investigating hypotympanum, facial recess, and the condition of the labyrinthine canal, which cannot be evaluated by otomicroscopy [5]. HRCT has proven to be effective in identifying FND [6].

This study was presented at the International Congress of ORL-HNS 2019 (ICORL 2019), April 25-28, 2019, Seoul, South Korea.

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In a previous study by Magliulo et al. [7], a correlation was observed between HRCT and surgical findings in a selected group of 67 patients with FND. The sensitivity and specificity were 69% and 87%, respectively. The kappa value (radiological-surgical correlation) was found to be fair (0.53).

Yu et al. [8] in their retrospective study comprising 76 patients, observed a correlation of 88.2% between radiological and surgical findings. Kanotra et al. [9] described a 33.33% sensitivity, 100% specificity, a positive predictive value, and a 91.11% negative predictive value with a p=0.267, not a statistically significant value, in predicting the difference between HRCT and intraoperative findings. Alzoubi et al. [10] and Rai [11] also observed similar results. These data prove the importance of analyzing other factors that may predict the presence of an FND.

The purpose of this study was to compare the data collected in our center over the last 20 years on patients with chronic cholesteatomatous otitis media, who underwent otological surgery, evaluating the presence of FND. We compared the incidence in adult patients, the differences between primary and revision surgeries, the most common anatomical sites, and the possible presence of semicircular canal (SCC) fistulas. We also explored the influence of disease duration before surgeries.

MATERIALS AND METHODS

In this study, a total of 469 patients were enrolled, 267 males and 202 females, with an age range between 18 and 86 years (average age: 46.8 years) affected by chronic suppurative otitis media with cholesteatoma. All surgical procedures were performed between 1998 and 2018 by one of the authors.

Patients were divided into 2 groups: those operated from 1998 to 2008 and those operated from 2008 to 2018.

All the patients were studied focusing on the preoperative presentation of clinical symptoms, especially facial palsy and duration of pathology, defined as the time between diagnosis and surgery. Otomicroscopy and HRCT scans were performed in the whole group and analyzed. They underwent intact canal wall technique (ICWT) or canal-down technique (CDT) using microscopic approach. Dehiscence of the facial nerve was identified intraoperatively with a microscope and confirmed by palpation while removing the cholesteatoma. The classification proposed by Moody and Lambert [12] was used to categorize the site of dehiscence. Their six-site system uses the oval window and cochleariform process as landmarks, grouping dehiscence of the tympanic segment of the facial nerve based on a functional association with these anatomical structures. According to this classification the facial tympanic segment of the facial nerve was divided into 6 sites: proximal, middle, distal, proximal-middle, middle-distal, and total.

Moreover, the Joint Consensus Statements on Definition, Classification, and Staging proposed by the Japanese Otological Society (JOS) and the European Academy of Otology and Neurotology (EAONO) were used to categorize the types of cholesteatoma [13].

Statistical Analysis

The chi-squared (χ^2) test and odds ratio (OR) were employed to evaluate the significance of the multiple factors analyzed. A p value of less than 0.05 was chosen as a threshold of statistical significance.

This research was performed in accordance with the principle of the Declaration of Helsinki and approved by the local ethics committee.

RESULTS

The overall incidence of FND in the entire group was 25.8% (121/469 cases). This number has followed a decreasing trend in recent years. In fact, we detected a total incidence of 29.5% (88/297 cases) in patients who underwent surgery from 1998 to 2008 and a lower incidence of 19.3% (33/171 cases) in those operated in the last 10 years, with a statistical significance (χ^2=6.04 OR= 1.76, and p=0.015)

Dehiscence was significantly higher in patients with a history of pathology longer than 5 years. This trend diminished over the years and was not statistically significant for those with less than 5 years pathology but statistically significant (p=0.02) for those with greater than 5 years pathology. In the period 1998–2008, a rate of dehiscence of 34.4% versus 14.1%, respectively was observed in patients with a history of more than 5 years and less than 5 years (χ^2=10.68, OR=3.19, p=0.002). In the last 10 years, these values went down to 22.7% and 7.7%, respectively (χ^2=4.37, OR=3.49, p=0.05). (Table 1).

Primary and revision surgery were also correlated with the incidence of FND. Higher values were observed in revision surgery in both periods, 44.4% vs. 24.8% in the first one (χ^2=10.15, OR=2.43, p=0.002), 41.7% vs. 15.6% in the second one (χ^2=8.96, OR=3.85, p=0.004). (Table 2). A statistically significant reduction of incidence over the years has been noted for primary surgery (p=0.04), but not for revision surgery (p=0.81).

All the procedures were performed with ICWT or CDT. The incidence of FND was significantly higher only in patients operated with CDT in the first period (36.3% vs. 23.9%) (χ^2= 1.02 OR=1.81, p=0.02), while in the second period (21.1% vs. 16.3%) (χ^2=0.47, OR=1.37, p=0.49)

MAIN POINTS

- A comparison of the data collected in our center over the last 20 years regarding patients with cholesteatoma has been conducted, focusing on incidence of FCD and correlated intraoperative findings.
- A progressive reduction of the total incidence was observed over the years.
- A higher incidence in those previously operated on or with a history of pathology longer than 5 years and a strong correlation between FCD and semicircular canal fistula has been confirmed.
- The tympanic tract, specifically its middle segment, remains the most vulnerable part of the facial nerve.
- A higher incidence has been observed in patients with a primary acquired cholesteatoma, specifically in those with a combined pars tensa-pars flaccida and in those with a stage III disease.

no statistically significant difference was noted (Table 3). A statistically significant reduction of incidence over the decades has been described only for those operated with CDT (p=0.01).

The near totality of patients had a dehiscence of the tympanic segment of the facial nerve, 92% in the 1998–2008 period and 97% in the 2008–2018 period. As already mentioned, the Moody and Lambert classification was used to categorize the sub-site of dehiscence of the facial nerve tympanic segment. In both periods, the middle tract was the one most frequently involved (38.3% and 72.7%, respectively) (Table 4).

Table 1. Incidence of dehiscence with respect to disease duration before surgery

	Dehiscence	
Disease Duration	**1998-2008**	**2008-2018**
Less than 5 years	10/71 (14.1%)	3/39 (7.7%)
More than 5 years	78/227 (34.4%)	30/132 (22.7%)

Table 2. Incidence of dehiscence – primary versus revision surgery

	Dehiscences	
Surgery	**1998-2008**	**2008-2018**
Primary	56/226 (24.8%)	23/147 (15.6%)
Revision	32/72 (44.4%)	10/24 (41.7)

Table 3. Incidence of dehiscence with respect to the procedure

	Dehiscences	
Technique	**1998-2008**	**2008-2018**
Intact canal wall mastoidectomy	39/163 (23.9%)	7/43 (16.3%)
Canal wall-down mastoidectomy	49/135 (36.3%)	27/128 (21.1%)

Table 4. Site of dehiscent tympanic segment

	Dehiscences	
Middle	**1998-2008**	**2008-2018**
Middle	31/81 (38.3%)	24/33 (72.7%)
Distal	6/81 (7.4%)	0/33 (0%)
Proximal	4/81 (4.9%)	1/33 (3%)
Proximal-middle	7/81 (8.6%)	4/33 (12.1%)
Middle-distal	27/81 (33.3%)	1/33 (3%)
Total	4/81 (4.9%)	1/33 (3%)
Not mentioned	2/81 (2.5%)	2/33 (6.1%)

The correlation between FND and semicircular canal fistulas has been studied. In particular, dehiscence occurred significantly more often in patients with lateral SCC fistula, affecting 14.8% of patients with a concomitant dehiscence in the period 1998–2008 (χ^2=9.97, OR= 3.87, p=0.003) and 8.8% of patients with a dehiscence in the period 2008–2018 (χ^2=7.81, OR=13.16, p=0.03). The total incidences of fistulas in these 2 groups of patients were 7.4% in the 1998–2008 period and 2.3% in the 2008–2018 period (Table 5). A statistical analysis of the association between the fistula site and dehiscence of the various portions of the tympanic segment was not possible because of the limited number of relevant cases.

None of the patients in our survey developed postoperative iatrogenic facial nerve palsy. Four of them presented a preoperative facial nerve palsy, grade III in 2 and grade VI in 2 according to the House-Brackmann classification. All 4 cases manifested within 7 days before surgery. After 1 year of follow-up, the recovery results were grade I in 2 patients, grade II in 1, and grade IV in 1, showing a significant success of the procedures.

The JOS/EAONO Joint Consensus were used to classify cholesteatomas. A majority of patients were affected by retraction pocket cholesteatoma, 271 (90.9%) in the first decade and 152 (88.8%) in the second one. The incidence of FCD in those patients was significantly higher than those with a secondary acquired cholesteatoma, 31.5% vs 7.4% in the first period (χ^2=6.98, OR=5.81, p=0.02), statistically significant and 21.1% vs. 7.4% in the second (χ^2=2.70, OR=4.8, p=0.13), not statistically significant. Lower incidences have been observed in both groups of patients in the last 10 years, statistically significant (p=0.02) for those with retraction pocket and not statistically significant for those with non-retraction pocket (p=0.77).

In the group of patients with retraction pocket cholesteatoma, the pars flaccida type was the most common in both decades, 197 patients (72.7%) and 112 patients (73.7%), respectively. The incidence of FCD was higher in those with a combined pars tensa and pars flaccida form, 46.7% in the first period and 37.5% in the second (Table 6).

Finally, all the patients were classified according to the disease stage. Incidence was found to be higher in those with a stage III, 42% in the first period (29/69 patients) and 33.3% in the second (13/39 patients). The difference between the two periods was not statistically significant (χ^2= 0.79, OR=1.45, p=0.37). A reduction of incidence over decades has been described in patients with stage I and stage II. A statistically significant reduction has been seen in stage II (χ^2=5.32, OR=2.07, p=0.01) but not in stage I (χ2=0.48, OR=1.8, p=0.50) (Table 7).

Table 5. Incidence of facial nerve dehiscence – correlation with semicircular canal fistula

	1998-2008		2008-2018	
Semicircular canal fistula	**With Dehiscence**	**Without Dehiscence**	**With Dehiscence**	**Without Dehiscence**
+	13/88 (14.8%)	9/210 (4.3%)	3/34 (8.8%)	1/137 (0.7%)
-	75/88 (85.2%)	201/210 (95.7%)	31/34 (91.2%)	136/137 (99.3%)

Table 6. Incidence of FCD (JOS/EAONO classification of cholesteatoma)

	Dehiscence	
Type	**1998-2008**	**2008-2018**
Pars flaccida cholesteatoma	62/197 (31.5%)	24/112 (21.4%)
Pars tensa cholesteatoma	17/59 (28.8%)	5/32 (15.6%)
Combined	7/15 (46.7%)	3/8 (37.5%)
Secondary acquired cholesteatoma	2/27 (7.4%)	1/19 (5.3%)

Table 7. Incidence of FCD and stage of cholesteatoma (JOS-EAONO classification)

	Dehiscence	
Stage	**1998-2008**	**2008-2018**
I	7/40 (17.5%)	2/19 (10.5%)
II	52/189 (27.5%)	18/113 (15.9%)
III	29/69 (42%)	13/39 (33.3%)

DISCUSSION

Dehiscence of the facial nerve canal is caused by the failure of ossification during embryological development or reabsorption of the canal bone due to secondary processes, such as cholesteatoma [14]. Dehiscence of the facial nerve canal makes the facial nerve more vulnerable to thermal and inflammatory injury or trauma during surgical manipulation.

In the literature, the incidence of FND found at the time of cholesteatoma surgery varies considerably and ranges from 8.9% to 45.5% [4]. This high difference can be explained in many ways. Primarily, it can be correlated to the extension of the disease. An incidence of 40% was reported by Vashishth et al. [15]: their relatively small patient sample and their inclusion criteria, including involvement of the labyrinth, facial nerve, posterior fossa, dura and intracranial complications can justify their higher incidence. Moreover, there is a lack of consistency in the method of assessing the dehiscence intraoperatively. Some authors [8, 9] relied only on microscopic vision. Some investigators considered intraoperative endoscopic evaluation to be essential and others also routinely palpated the nerve [16]. We suggest that both types of observation and palpation should be carried out in order to obtain a more secure evaluation.

The highest incidence was found by Jaswal et al. [17], attesting to 45.5% in their prospective review of 146 patients affected by chronic otitis media. However, only 11 of these patients had cholesteatoma and 5 of them had dehiscence. This is probably the reason their values were much higher compared with other studies, in which authors described values very similar to ours.

One important aspect that emerged from this study is a remarkable reduction of FND over the years, from 27.7% in the 1998–2008 period to 17.7% in the 2008–2018 period. The incidence of 17.7% in the last 10 years is in line with the data reported by Moody & Lambert (18.8%) [12], Ozbek et al. (21.1%) [16] and more recently by Trinidade (19%) [4], while in the period 1998–2008, the results matched those found by Shinnabe et al. [18], Wang et al. [19], and Lin et al. [20]. This is probably attributable to a more timely diagnosis and a wider use of radiological techniques, such as HRCT and magnetic resonance imaging (MRI), making it possible to identify the cholesteatoma in its early stages, with a consequent reduction of sequelae.

Looking into the primary versus revision surgery, Trinidade et al. [4] in their prospective case-control study, reported an incidence of 18.4% vs. 19.5%; (p=0.77) in primary versus revision surgery. Their data agree with those of other studies. In fact, Wang et al. [19] and Lin et al. [20] performed retrospective chart reviews of 155 and 117 patients, respectively and reported that the possibility of FND being higher in revision surgery was not significant (p=0.28 and p=0.535, respectively). Likewise, Selesnik et al. [21], in a review of 59 patients, showed that the incidence in primary and revision surgery was 30% and 35%, respectively. However, the data emerging from this work disagree with those of other authors [4, 15, 18, 19]. In fact, a substantial increase in the incidence of FND in previously operated patients has been observed. This reduction can be explained by early diagnosis. This could be correlated to many factors, such as the presence of further disease embracing the fallopian canal that might have already been thinned or an erroneous iatrogenic disclosure of the facial nerve during primary surgery. An incidence of 22% versus 42.3% in primary versus revision surgery in the 1998–2008 period was found, with a reduction trend over the years, compared with 15.1% and 35.5% in the second period.

A majority of patients had a dehiscence of the tympanic segment, 92.3% in the 1998–2008 period and 95.4% in the 2008–2018 period. These data coincide substantially with those collected by most other authors, namely that around 80% of patients have a dehiscence of the tympanic segment [4,12,14-20]. As already mentioned, the Moody and Lambert classification was used to assess the distribution of dehiscence in the tympanic segment [12]. These authors distinguished proximal, middle, and distal portions of this segment using the oval window and cochleariform process as landmarks. Our results confirmed that the majority of cases of FND of the tympanic segment were centered on the oval window, the middle tract: 40.5% in the 1998–2008 period and 71.4% in 2008–2018 period. Dehiscence in the area posterior to the geniculate ganglion, the so-called proximal location, was seen in 16.7% of the cases, a value similar to the 12% described by Moody and Lambert [12]. This result is particularly important because it shows the relevance of the floor of the anterior epitympanum. In cholesteatoma surgery, involvement of this area may unexpectedly increase the risk of facial nerve injury during dissection. Thus, the importance of this region must not be underestimated because it indicates the need to remove the head of the malleus for safer management. However, when the differences between the sites of dehiscence involved in primary and revision surgery were compared, no significant differences emerged.

Fistulas of the semicircular canals are likely to occur where there is an FND, probably due to erosion of the bone covering the canal caused by cholesteatoma. We observed the co-existence of this condition in 15.4% of cases in the first decade, going down to 9.1% in the second decade. Several authors have investigated this phenomenon, but our incidence of 15.4% was closest to that described by Trinidade et al. (14.5%) [4], while Moody and Lambert [12] found an incidence of 12.8%. The OR of this finding in the present work was 4.79, higher than that quoted by Moody and Lambert (OR = 3.63) [12] but lower than found

by Trinidade (OR=6.71) [12] and much lower than that quoted by Ozbek et al. (OR=22.5) [16].

Finally, FCD was correlated with the type and stage of cholesteatoma, following the Joint Consensus proposed by the Japanese Otological Society and European Academy of Otology and Neurotology [13]. The number of patients found to have a retraction pocket cholesteatoma was significantly higher than those with a non-retraction pocket. These data are in accordance with James et al. [22], Motegi et al. [23], and Kitahara et al. [24], but not with Ardıç et al. [25], who found 44% of the patients affected by a secondary acquired cholesteatoma. In regard to the subtype of retraction pocket cholesteatoma, the numbers found were very similar to Matsuda et al. [26], slightly different from Motegi et al. [23] and Yoshida et al. [27], but diverged significantly from Ardıç et al. [25] and James et al. [22]. None of the authors cited have investigated the correlation between the incidence of FCD and the type and stage of cholesteatoma as proposed by the JOS-EAONO classification. Incidence was higher in those with a primary acquired cholesteatoma, probably due to its greater extent and localization. Patients with a secondary acquired cholesteatoma had minor forms with less bone erosion. In the group with primary cholesteatoma, incidence was higher in both decades in those with a combined pars flaccida and pars tensa. This could be explained by a more extensive disease. The same can be assumed for the patients with a stage III, in whom a higher incidence was described for both periods.

CONCLUSION

Assessing the data collected in our center over 2 decades and comparing it with the most recent literature, the following conclusions have been drawn:

1. The total incidence of FND has progressively decreased over the years.
2. An increase in the incidence of patients with a longer disease history (>5 years) (χ^2=4.37, OR=3.49, p=0.05), in those previously operated (χ^2=8.96, OR=3.85, p=0.004) and with association of fistula are confirmed (χ^2=7.81, OR=13.16, p=0.03).
3. The tympanic tract of the facial nerve remains the most frequent site of dehiscence, confirming the importance of the anterior epitympanum as a high-risk localization.
4. The incidence of FCD is higher in patients affected by primary acquired cholesteatoma in both decades, specifically in those with a combined pars tensa-pars flaccida cholesteatoma. Those with a stage III disease have a higher incidence of dehiscence.

Ethics Committee Approval: Ethics committee approval was received for this study from the Ethics Committee of Sapienza University.

Informed Consent: Written informed consent was obtained from the patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - G.M., A.P.; Design - G.M., G.I.; Supervision - G.M., G.I.; Resource - G.G., I.C.V.; Materials - G.G., I.C.V., V.R.; Data Collection and/or Processing - G.G., I.C.V., V.R., A.P.; Analysis and/or Interpretation - G.M., Antonio Greco, Claudio Vicini, G.I.; Literature Search - G.G., I.C.V., V.R., A.P.; Writing - G.G., I.C.V., G.M.; Critical Reviews - G.M., A.G., C.V., G.I.

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