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Otolaryngologists and iatrogenic facial nerve injury: a meta-analysis

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Abstract

Background Iatrogenic facial nerve injury is one of the otolaryngologists' major fears during surgeries. Despite technological advances, the risk of iatrogenic facial nerve palsy remains high. The aim of this study is to meta-analyse papers published about different iatrogenic causes of facial nerve injury. This is a meta-analysis study carried out at ENT departments of Cairo and MUST universities from April to October 2022. It was structured according to the recommendations of the reporting system for meta-analysis (PRISMA).

Results A total of 168 manuscripts were revised, and after the comprehensive search, 44 studies met our inclusion criteria; 736 cases out of 15,846 (4.6%) were included. The patients who underwent otolaryngologic surgeries are 716 (97.3%), and those who underwent other related procedures are 20 (2.7%).

Conclusion Multiple causes of iatrogenic facial nerve injury have been reported. The commonest cause is parotid surgeries (364 cases, 49.5%), and the least common cause is arterial embolization (3 cases, 0.4%). It is more common in females more than males and in adults more than young. The most common injured part is extra-temporal part (199 cases, 27%), and the marginal mandibular branch is the most common injured branch in (160 cases, 21.7%). Geographically, it is more distributed in Germany (175 cases, 23.8%).

Keywords Facial nerve palsy, Iatrogenic facial nerve paralysis, Iatrogenic facial nerve injury, Delayed facial nerve palsy

Background

Iatrogenic facial nerve injury (IFNI) is one of the most devastating complications of many surgical procedures. Sudden and unexpected facial nerve paralysis (FNP) not only affects the cosmetic issue but also affects patient's life socially, economically, and psychologically [1].

Iatrogenic facial nerve injury is one of the otolaryngologists' major fears during surgeries. Despite technological advances, the risk of iatrogenic facial nerve palsy remains high [2].

The aim of this study is to meta-analyse articles published about different iatrogenic causes of facial nerve injury in the field of otolaryngology during different surgical procedures and the incidence of each cause.

Methods

This is a meta-analysis study carried out at ENT departments of Cairo and MUST universities from April to October 2022. It was structured according to the recommendations of the reporting system for meta-analysis (PRISMA) as shown in Fig. 1.

This is done by the following steps:

1. Target questions
2. Population, intervention, control, and outcomes (PICO) and PRISMA recommendations
3. Searching strategy
4. Evaluation of articles with study selection
5. Data collection and analysis
6. Interpretation
7. Discussion and conclusion

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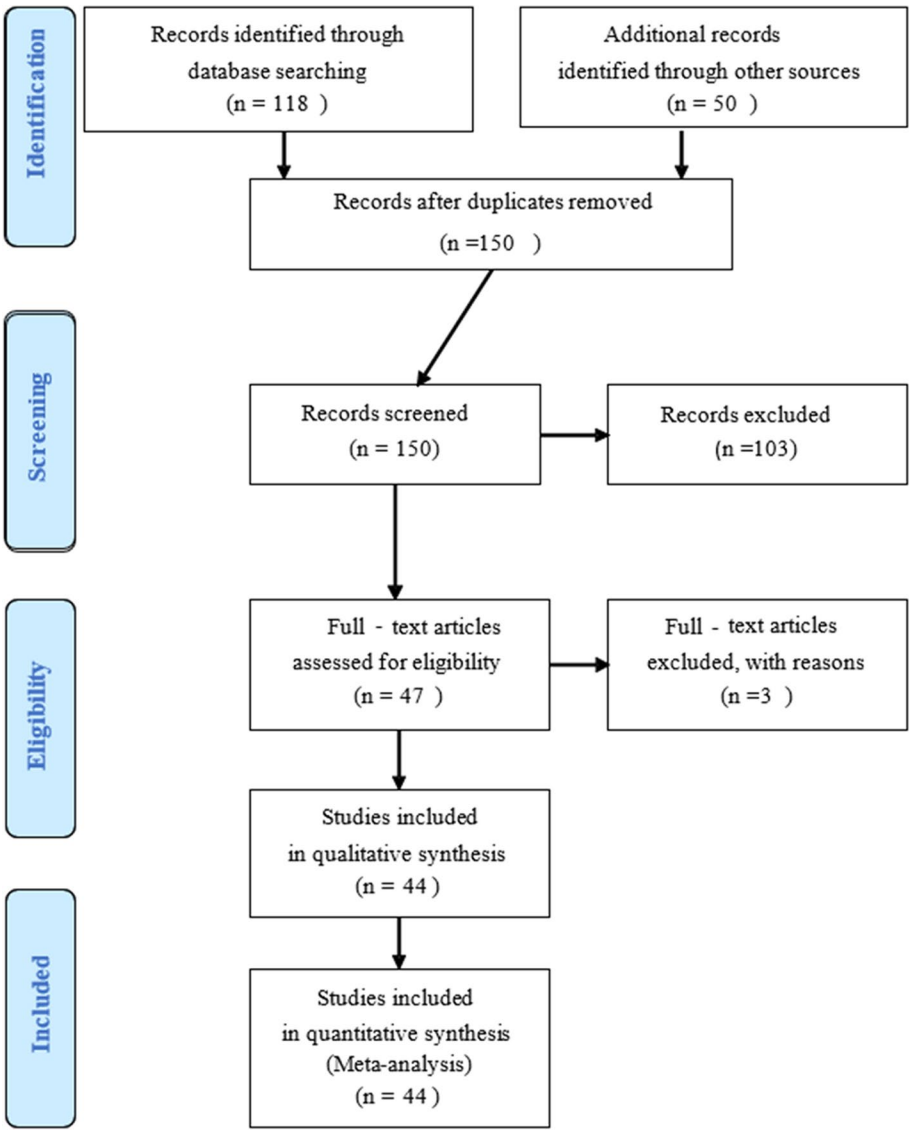

Fig. 1 PRISMA flow chart for the current study

Target questions

a. How can an iatrogenic facial nerve injury occur?
b. Which surgery or approach has the highest rate of FN injury?
c. Which FN segment is the most affected during IFNI?

Regarding the PICO

- The (P) participants: Patients who underwent different surgeries during which the facial nerve was injured
- The (I) intervention: Procedures causing iatrogenic facial nerve injury
- The (C) comparator: Observation
- The (O) outcome: Postoperative rates of IFNI and how to avoid FN injury

Search strategy (identification and location of articles)

We searched on web databases: PubMed, Embase, Medline, Cochrane library, Ovid interface, and the search engine Google Scholar from 2000 to 2021, and duplicates were removed.

Keywords used are as follows: facial nerve paralysis, iatrogenic facial nerve injury, iatrogenic facial nerve injury, and delayed facial nerve palsy.

Inclusion criteria are as follows:

- Participants of both sexes and all ages are included (human studies).
- Iatrogenic facial nerve injury due to different surgeries or procedures
- Different types of study design
- English articles

Exclusion criteria are as follows:

- Idiopathic facial nerve palsy
- Congenital facial nerve palsy
- Accidental facial nerve injury
- Articles in languages rather than English

Evaluation of articles

All articles were 168, and by removing repeated 18 articles (first filter), the total articles were 150. The excluded articles due to irrelevance (the second filter) were 106. So, the included relevant articles are 44 articles as shown in Fig. 1.

- PubMed: Results 118, duplicates 14, included 43, and excluded 61
- Ovid: Results 35, duplicates 4, included 1, excluded 30
- Cochrane Library: Results 15 — all are excluded.

Data collection and analysis

Reported in results

Interpretation

Reported in results

Discussion and conclusion

Reported in discussion and conclusion

Results

A total of 168 manuscripts were revised, and after the comprehensive search, 44 studies met our inclusion criteria; 736 cases out of 15,846 (4.6 %) were included for meta-analysis. The patients who underwent otolaryngological surgeries are 716 (97.3%), and those who underwent other related procedures are 20 (2.7%).

Demographic data

Facial nerve injury is more predominant in females; in this study, it occurred in 378 females (51.4%), while it occurred only in 321 males (43.6%). Two out of 44 studies did not mention the sex discrimination including 37 cases (5%). The mean age of the cases of each study was also included in table with a total mean age about 41.9 ± 2.5 standard deviation (SD). Three out of the 44 papers did not mention the age of the included cases as shown in Table 1.

Incidence and aetiology of iatrogenic facial nerve injury

The size of total sample included is 15,846 cases and underwent different surgical procedures. In comparison with other causes of facial nerve injury, IFNI has a low incidence rate (736 patients, 4.6%). *P*-value among studies is statistically significant ($P < 0.0001$), 95% $CI = 99.34$ to 99.55%) as in Fig. 2 and Table 2. The number of cases with FN injury differs in relation to the type of surgery; the highest number of cases is those who underwent parotid surgeries (364 cases, 49.5%), while arterial embolization as in glomus tumour and facial arteriovenous fistula by microparticles of polyvinyl alcohol (PVA) has the least number of cases (3 cases, 0.4%).

During parotidectomy, there were 364 cases (49.5%) with FN injury including 104 cases with primary surgeries and 10 cases with revision surgery. There were 120 patients with total parotidectomy including two patients who underwent radical parotidectomy in which the facial nerve was sacrificed. There were also 97 cases of superficial (lateral) parotidectomy.

Surgical resection of tumours comes in the second place by 173 cases (23.5%); 95 cases (12.9%) in vestibular schwannoma resection by the trans-labyrinthine approach and 78 cases (10.6%) during resection of skull base tumours and FN schwannoma caused FNP in 78 cases (10.6%).

Otologic surgeries account for 168 cases (22.8%). Most common is mastoidectomy in 49 cases (6.7%) and then tympanoplasty in 32 cases (4.3%) and myringoplasty in 13 cases (1.8%). The 49 mastoidectomy cases include 7

Table 1 Demographic data of the study's articles

Study	Sample size	Mean age	Males	Females
Linder et al. (2017) [3]	20	44.7	12	8
Safdar et al. (2006) [4]	2	35	2	0
Asma et al. (2009) [2]	11			
Long et al. (2004) [5]	4	35.6	1	3
Kumar et al. (2011) [6]	4	29.3	3	1
Xu et al. (2015) [7]	15	43.6	6	9
Caylan et al. (2006) [8]	1	20	0	1
Zhou et al. (2015) [9]	16	40.5	7	9
Michael and Raut (2007) [10]	21	37	11	10
Shea and Ge (2001) [11]	11	53	5	6
Rinaldo et al. (2002) [12]	1	20	1	0
Marioni et al. (2002) [13]	1	59	1	0
Salvinelli et al. (2004) [14]	7	42	1	6
Thom et al. (2013) [15]	11	53.5	7	4
Sheahan and Viani (2007) [16]	1	58	1	0
Mandour et al. (2017) [17]	4	4.25	3	1
Alzhrani et al. (2016) [18]	26			
Fayad et al. (2003) [19]	5	40	1	4
Joseph et al. (2009) [20]	1	19	1	0
Binnetoglu et al. (2020) [21]	6	6.48	3	3
Meier et al. (2006) [22]	24	60	9	15
O'Regan et al. (2007) [23]	90	48	33	57
Guntinas-Lichius et al. (2006) [24]	139	52	63	76
Gaillard et al. (2005) [25]	56	52.7	29	27
Upton et al. (2007) [26]	55	56	31	24
Shlizerman and Ashkenazi (2005) [27]	1	4	1	0
Windfuhr et al. (2009) [28]	10		3	7
Rinaldi et al. (2012) [29]	66	49.6	33	33
PU et al. (2020) [30]	29	52.6	13	16
Misirlioglu et al. (2016) [31]	1	15	0	1
Tzermpos et al. (2012) [32]	1	20	0	1
Hotta et al. (2002) [33]	2	31.5	0	2
Chevalier et al. (2010) [34]	1	34	0	1
Rai et al. (2008) [35]	1	21	0	1
Alberio et al. (2018) [36]	1	69	1	0
Ramdasi et al. (2015) [37]	1	40	0	1
Pang et al. (2005) [38]	1	10	1	0
Vrabec et al. (2003) [39]	8	49	4	4
Feng et al. (2021) [40]	1	61	0	1
Lee et al. (2015) [41]	1	39	0	1
Odat et al. (2018) [42]	1	33	0	1
Sanna et al. (2006) [43]	22	43.1	12	10
Limb et al. (2001) [44]	1	26	0	1
Hayler et al. (2020) [45]	55	44.6	22	33
Total	736		321	378
		Mean age = 41.9 ± 2.5 SD	43.6%	51.4%

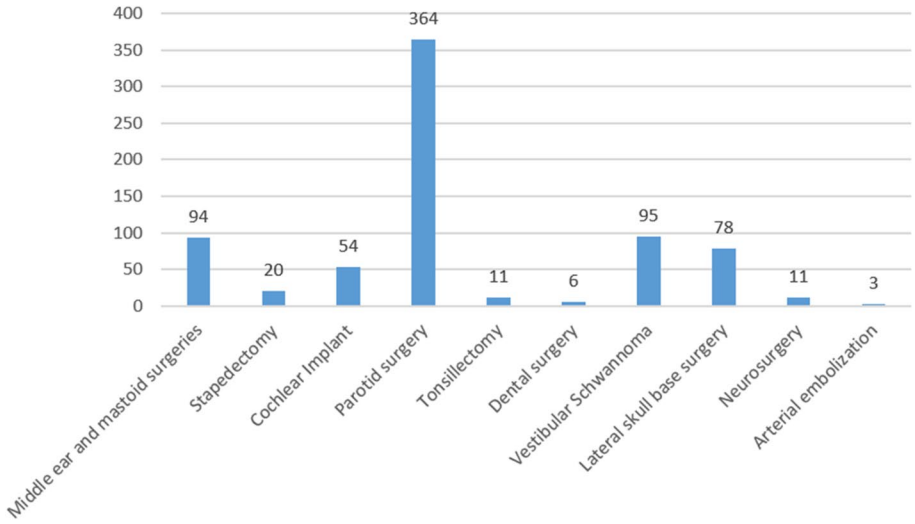

Fig. 2 Incidence of FNP in different surgeries

Table 2 Incidence and aetiology of facial nerve palsy

Procedure	Total cases	IFNI cases	Incidence	Studies
Middle ear and mastoid surgery	3402	94	2.8%	Asma et al. (2009) [2], Caylan et al. (2006) [8], Long et al. (2004) [5], Kumar et al. (2011) [6], Michael and Raut (2007) [10], Linder et al. (2017) [3], Safdar et al. (2006) [4], Xu et al. (2015)7, and Zhou et al. (2015) [9]
Stapedectomy	2860	20	0.7%	Shea and Ge (2001) [11], Rinaldo et al. (2002) [12], Marioni et al. (2002) [13], and Salvinelli et al. (2004) [14]
Cochlear implantation	7229	54	0.7%	Thom et al. (2013) [15], Sheahan and Viani (2007) [16], Mandour et al. (2017) [17], Alzhrani et al. (2016) [18], Fayad et al. (2003) [19], Joseph et al. (2009) [20], and Binnetoglu et al. (2020) [21]
Parotidectomy	1231	364	29.6%	O'Regan et al. (2007) [23], Meier et al. (2006) [22], Guntinas-Lichius et al. (2006) [24], Gaillard et al. (2005) [25], and Upton et al. (2007) [26]
Tonsillectomy	649	11	1.7%	Shlizerman and Ashkenazi (2005) [27] and Windfuhr et al. (2009) [28]
Vestibular schwannoma resection	220	95	43.2%	Rinaldi et al. (2012) [29] and PU et al. (2020) [30]
Dental procedures	6	6	100%	Misirlioglu et al. (2016) [31], Tzermpos et al. (2012) [32], Hotta et al. (2002) [33], Chevalier et al. (2010) [34], and Rai et al. (2008) [35]
Neurosurgical procedures	77	11	14.3%	Alberio et al. (2018) [36], Ramdasi et al. (2005) [37], Pang et al. (2005) [38], and Vrabec et al. (2003) [39]
Arterial embolization	3	3	100%	Feng et al. (2021) [40], Lee et al. (2015) [41], and Odat et al. (2018) [42]
Surgery of skull base tumours	169	78	46.2%	Sanna et al. (2006) [43], Limb et al. (2001) [44], and Hayler et al. (2020) [45]
Total	15,846	736	4.6%	44 articles

cases with revision surgery and 41 cases with primary surgeries. Primary surgeries include 12 cases with modified radical (MRM), 5 with radical mastoidectomy (RM), and 8 cases with cortical mastoidectomy (CM). Cochlear implantation (CI) accounts 54 cases (7.3 %) through posterior tympanotomy approach. Also, there were 20 cases of stapedectomies including 14 cases of primary stapedectomy and 6 cases of revision surgeries.

Anaesthesia procedures account for 16 cases (2.2%) of FNP including 5 cases during inferior alveolar nerve block for different dental procedures and 11 cases after anaesthesia for adenotonsillectomy surgery caused by infiltration with bupivacaine substance in the peritonsillar space.

Onset of facial nerve palsy

Eighteen out of the 44 studies reported the onset of facial paralysis. Immediate onset occurred in 282 cases (38.3%), while delayed onset FNP occurred in 454 cases (61.7%). *P*-value among studies is statistically significant ($P < 0.0001$), 95% $CI = 96.41$ to 98.12% as shown in Table 3.

Table 3 Onset of facial nerve paralysis

Study	Sample size	Immediate onset FNP	Delayed onset FNP
Middle ear surgery	94	22	72
Stapedectomy	20	1	19
Cochlear implant	54	15	39
Parotidectomy	364	109	255
Tonsillectomy	11	11	0
Vestibular Schwannoma	95	95	0
Dental procedure	6	2	4
Neurosurgery	11	2	9
Arterial embolization	3	2	1
Tumour surgery	78	23	55
Total	736	282	454
	$P < 0.0001$	38.3%	61.7

Clinical picture of facial palsy

In the present study, 379 cases (51.5%) have incomplete FNP, while complete FNP occurred in 350 cases (47.7%). Seven cases are missed in the studies. *P*-value among studies is statistically significant ($P < 0.0001$), 95% $CI =$ 94.19 to 97.23% as shown in Table 4.

Site of facial nerve injury

The extra-temporal part is the most common site injury; it was injured in 199 cases (27%), while the intratemporal part was injured in 114 cases (15.5%). The intracranial part is the least injured by 33 cases (4.5%). The marginal mandibular nerve is the most common injured branch in 160 cases (21.7%) and then the chorda tympani branch in 37 cases.

The facial nerve was intact in 58 cases (7.9%), while it was injured partially in 30 cases. It was dehiscent in 24 cases, swollen in 23 cases, and transected in 20 cases. The FN was sacrificed in 17 cases (2.3%) mostly during parotid surgeries.

Diagnosis of facial nerve injury

House-Brackmann grading system is the most common diagnostic tool used in these studies. It was used in almost all studies, but facial palsy grades are mentioned clearly in 248 cases (33.7%) as the following: 31 cases with grade 1, 88 cases with grade 2, 59 cases with grade 3, 48 cases with grade 4, 17 cases with grade 5, and only 5 cases with grade 6. Electrophysiological tests were used in all parotid surgery and cochlear implantation studies. Radiological investigations as HRCT and MRI were used pre- and postoperative in most of the studies. Also, panoramic radiography was used in dental procedures, while neck radiography is used post tonsillectomy.

Management of facial nerve injury

Facial nerve exploration and decompression were done in about 19 cases (2.6%), while cable nerve graft was used in 15 cases (2%) including greater auricular nerve graft in 14 cases and sural nerve in one case, while muscle transfer is used in 5 cases. Facial nerve anastomosis was used in 5 patients including end-to-end anastomosis and facio-facial anastomosis.

Prognosis and duration of facial nerve palsy

After many treatment approaches used in these studies, about 357 cases (48.5%) had complete recovery, 161 cases (21.9%) had incomplete or partial recovery, while 28 cases (3.8%) did not recover. About 190 patients had no records of recovery.

The period of paralysis of facial nerve was heterogeneous across reports ranging from 8 h in Shlizerman and Ashkenazi (2005) [27] to 36 months in Rinaldo et al.

Table 4 Clinical picture of facial nerve palsy

Study	Sample size	Complete FNP	Incomplete FNP
Middle ear and mastoid surgery	94	70	24
Stapedectomy	20	19	1
cochlear implant	54	48	6
Parotidectomy	364	117	247
Tonsillectomy	11	1	10
Vestibular Schwannoma	95	31	64
Dental procedure	6	2	4
Neurosurgery	11	3	8
Arterial embolization	3	3	0
Lateral skull base surgery	78	56	15
Total	736	350	379

(2002) [12]. The mean period of paralysis was 203 days. Only 3 studies did not mention the recovery duration.

Geographical distribution of the FNP cases in the world

In this meta-analysis study, 44 papers are included from 17 countries all over the world. The largest number of studies done in one country was 10 papers in the United States of America (USA). However, the largest number of cases was 175 in Germany (23.8%) as shown in Table 5.

Discussion

Injury to the facial nerve is an undesirable drawback in the field of otolaryngology; this could happen even with expert surgeons. For an inexperienced surgeon, the fear of injury in the nerve may lead to the avoidance of the FN instead of identifying it [46].

This may be the first meta-analysis that includes different types of surgeries resulting in IFNI that may face otolaryngologists. Other meta-analysis studies only discussed one or two types of surgeries, but we included 10 different types of surgeries from 17 different countries in the world. Also, we included a high number of studies (44 papers) about the double or triple of some other meta-analysis studies.

In this study, in a series of 736 patients of iatrogenic facial palsy out of total 15,846 cases, parotid surgeries were implicated to be the most common cause of facial nerve injury (49.5%), and then, surgical resection of tumours by 173 cases (23.5%) and otologic surgeries accounts for 168 cases (22.8%). Alberti and Biagioni (1972) have agreed that IFNI is the most common and severe complication of parotid gland surgery [47]. Hohman et al. (2014) agreed that resections of the head and neck are the second most common cause of IFNI followed by ear surgeries, but they stated that maxillofacial surgeries are the most common cause of IFNI [48]. This can be justified that they did not include any patients who underwent parotid surgeries and included large number of cases who underwent oral surgeries in the opposite.

Oliver et al. (1980) agreed that the extra-temporal part is the most common injured portion. In our study, it was injured in 199 cases (27%), followed by the intratemporal part in 114 cases (15.5%) [49]. Olsen et al. (1994) agreed that the marginal mandibular branch is the most common injured branch; in this study, it was involved in 160 cases (21.7%) and then chorda tympani branch in 37 cases (5%) [50]. Michael and Raut (2007) have agreed that chorda tympani nerve injury has a higher incidence rate in otologic surgeries [10].

The results presented in this study suggest a high incidence rate of FN injury after primary otologic surgeries (159 cases, 33%) more than that after revision surgeries (23 cases, 4.8%). On the other hand, Schuring (1988) and Wiet (1982) have a statistically significant difference in their results. They stated that the incidence of IFNI associated with primary surgeries has been estimated to be 0.6% while 3.7% in revision surgeries [51, 52]; this can be justified by high number of primary otologic surgeries done by junior staff and residents who did not identify well the FN landmarks during primary surgery. Also, in the studies we entailed, most of the revision surgeries were performed by expert senior staff, and the urgent referral to multidisciplinary management centres reduces the incidence of IFNI in revision surgeries. Also, the increased use of intraoperative facial nerve monitoring (IOFNM) during surgeries and the revolution in radiological field help to identify well the facial nerve course and to detect the lesions, thus helping in avoiding the facial nerve injuries nowadays.

In the present study, 379 cases (51.5%) have incomplete or transient facial nerve palsy more than complete palsy; Perekrest and ZhM (1983) and Gerlings (1932) agreed with that [53, 54]. Eisele et al. (2010), Prasad et al. (1993), and Hughes et al. (1995) agreed that complete FNP is mostly caused by sacrificing the FN during parotid carcinoma or surgical resection of vestibular Schwannoma and skull base tumours. In our study, FN was sacrificed in 17 cases of parotid surgeries [55–57].

This study reported that IOFNM was used in all cases of CI and helped in reducing the IFNI rate. But it was also used in most of parotidectomies, and it is the most

Table 5 Geographical distribution of the FNP cases in the world

Country	Number of papers	Number of cases	Most common surgery type
Australia	1	55	Tumour resection
China	3	60	Vestibular schwan. resection
Egypt	1	4	Cochlear implantation
France	3	77	Parotidectomy
Germany	3	175	Parotidectomy
Greece	1	1	Dental procedures
India	4	7	Mastoidectomy
Ireland	2	3	Mastoidectomy
Israel	1	1	Tonsillectomy anaesthesia
Italy	6	98	Vestibular schwan. resection
Japan	1	2	Dental procedures
Malaysia	2	15	Mastoidectomy
Saudi Arabia	1	1	Arterial embolization
South Korea	1	1	Arterial embolization
Turkey	2	2	Mastoidectomy & dental procedures
UK	2	111	Parotidectomy
USA	10	123	Parotidectomy
Total = 17	44	736	

common cause of IFNI. We suggest this is related to surgeons' surgical skills.

Kumar et al. (2000) agreed that the CT scan could identify the site of injury of the intratympanic part of the FN, and this will be helpful in managing the case. In all our patients, preoperative CT in primary otologic surgery for chronic ear is less beneficial in avoiding FN injury. However, for revision ear surgery, HRCT is more helpful to the surgeon in identifying the extent of the disease, the anatomy of the facial nerve [58]. Surgeons with complete immediate postoperative FN paralysis reported that the anatomical landmarks of facial nerve could not be identified intraoperatively [2].

In this study, we noticed that early revision surgery should be attempted within a few days. Facial nerve exploration and decompression were done in about 19 cases (2.6%), while cable nerve graft was used in 15 cases (2%) including greater auricular nerve graft in 14 cases and sural nerve in one case. About 359 cases (48.6%) had complete recovery. Gittins et al. (1999) agreed that immediate repair of the cut FN is carried out by cable grafting after identifying the proximal and distal ends of the cut nerve [59].

This study noticed some deficiencies that should be considered as follows:

(1) Other languages rather than English were excluded.
(2) Some individual patient data were missed.
(3) Most of the studies included were retrospective case series or case reports.
(4) Small sample size
(5) This meta-analysis includes studies over the years from 2000 to 2021.

Conclusion

The risk of iatrogenic facial nerve injury during neurotological surgeries is exceedingly low compared with other causes of facial nerve injury (735/15,846 cases, 4.6%). The commonest cause of IFNI is parotid surgeries (364 cases, 49.5%), and the least common cause is embolization (3 cases, 0.4%). It is more common in females more than males and in adults more than young. Facial nerve injury is of delayed onset in (454 cases, 61.7%) more than immediate onset. The most common injured part is extra-temporal part (199 cases, 27%), and the marginal mandibular nerve is the most common injured branch in (160 cases, 21.7%). Geographically, it is more distributed in Germany (175 cases, 23.8%), that is regarding articles were included in this study. The prognosis of facial nerve palsy seems to be excellent regardless the treatment strategy; 48.5% of cases have complete recovery. Using anatomical landmarks and intraoperative facial nerve monitoring, also surgeons' good surgical skills decrease the incidence of nerve injury. The facial nerve should remain the otolaryngologist's friend.

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Authors' contributions
SMZ contributes with the idea, data, general supervision, writing the paper, and submit the paper. MSH contributes with data collection and general revision. MKE contributes with methods, data collection and analysis, and writing. SHJ contributes with data collection and revision. The authors read and approved the final manuscript.

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Availability of data and materials
Data are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study has been approved by the Ethical Committee of ENT Department, Cairo, and MUST Universities. Reference number: not applicable/or not available. Consent to participate is not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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