

Post-tonsillectomy pseudoaneurysm: an underestimated entity?

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Abstract

Objective: To identify patients undergoing arteriography to verify vascular complications of tonsillectomy, with an emphasis on pseudoaneurysm.

Patients and methods: We undertook a retrospective analysis of the case records of 8837 patients who had undergone tonsillectomy between 1988 and 2004 at our institution, together with a review of expert reports written for professional boards and civil courts as well as personal experiences or communication. We also conducted a literature review using the PubMed database.

Results: We identified seven cases with vascular abnormalities. In addition, we identified three cases of pseudoaneurysm formation, involving two children and one adult patient, with bleeding 21, 36 and 58 days after tonsillectomy. Successful management included embolisation (two patients) and revision surgery (one patient).

Conclusion: Post-tonsillectomy pseudoaneurysm formation is extremely rare and unrestricted by age. Correct diagnosis depends largely on a high index of clinical suspicion. Delayed and repeated episodes of gushing haemorrhage with spontaneous cessation appear to be a significant clinical marker. Immediate arteriography, with simultaneous embolisation, is highly recommended. The lingual artery is the most commonly involved vessel.

Key words: Tonsillectomy; Post-tonsillectomy Hemorrhage; Pseudoaneurysm; Complication; Episodic Bleeding

Introduction

Tonsillectomy carries the risk of arterial injury due to: the variable course of the great arteries and their close proximity to the tonsil; the abundant blood supply of the tonsillar region;¹ and the possibility of an aberrant course of the internal carotid artery.^{2–4} Blunt or penetrating trauma due to tonsil dissection and/or suturing to achieve haemostasis may result in a periarterial haematoma which expands with time. Ingrowing fibrotic tissue and endothelial cells subsequently encapsulate the haematoma. Liquefaction of the central part of the haematoma results in a potential space, with communication to the injured artery, resulting in a circumscribed dilatation of the blood vessel. Such a lesion is termed a ‘false aneurysm’ or ‘pseudoaneurysm’, since only part of the vessel wall is involved, in contrast with ‘true aneurysms’, which involve the whole vessel wall.

Pseudoaneurysms in the neck have been described in relation to peritonsillar abscess,^{5,6} radiation therapy⁷ and local infection.^{8,9} Considering the

frequency of tonsillectomy, a thorough knowledge of this potential post-operative complication is desirable.

This study identified patients with a proven post-tonsillectomy pseudoaneurysm from amongst those with post-tonsillectomy bleeding who had undergone arteriography after surgical attempts to achieve haemostasis had failed.

Patients and methods

The study included a retrospective chart review of all patients scheduled for tonsillectomy between 1 January 1988 and 31 October 2004 at our institution (Malteser Krankenhaus St Anna, Duisburg, Germany). This chart review was restricted to the search criteria ‘arteriography’ and ‘pseudoaneurysm’.

A similar review concerning neurological lesions was previously undertaken by the authors. From the expert’s office: localized neural lesions following tonsillectomy.¹⁰

A comprehensive literature review was also performed using the Medline computerised database

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(search items: “tonsillectomy” “aneurysm”). Articles, cited in these publications but not identified by the Medline literature review were included in the analysis of this study.

Results

Hospital data

We analysed data of 8837 patients (4515 males (51.1 per cent) and 4322 females (48.9 per cent)) who had undergone tonsillectomy with or without adenoidectomy.

Post-tonsillectomy haemorrhage requiring revision surgery was recorded for 286 patients (3.2 per cent). Primary haemorrhage (i.e. occurring less than 24 hours after surgery) had occurred in 196 patients (68.5 per cent), while the remainder had experienced secondary haemorrhage (i.e. occurring more than 24 hours after surgery).

We could identify only two cases in which arteriography was performed.

The first was a five-year-old girl with a proven post-tonsillectomy pseudoaneurysm (case 19 in Table I; see also Figure 1).

The second was a 51-year-old man who had undergone unsuccessful incision and drainage of a peritonsillar abscess, with tonsillectomy the following day under general anaesthesia. Abrupt, brisk bleeding had begun during tonsil dissection, requiring several suture ligations and also swab fixation to the tonsillar fossae. Direct vascular injury (either by tonsil dissection or previous drainage procedures) was excluded by immediate arteriography, with normal findings. However, the following day, recurrent bleeding after swab removal under general anaesthesia prompted a neck exploration, including exploration of the external carotid artery and its individual branches. No injured neck arteries were identified, and the subsequent course was uneventful (this patient is not included in Table II).

Data from the experts collection

We identified 128 cases related to post-tonsillectomy haemorrhage. Only 12 reports matched the search criteria ‘arteriography’, including two cases which also matched the search criteria ‘pseudoaneurysm’ (cases 20 and 21; Table I). Both patients had experienced a gushing haemorrhage with spontaneous cessation and an uneventful recovery after treatment.

Of the 12 patients undergoing arteriography, the results were: normal findings (cases one to four, Table II); injuries of the facial, ascending pharyngeal or lingual artery (cases five to eight, Table II); and vascular abnormalities (cases nine and 10, Table II).

Discussion

Early diagnosis and adequate management of post-tonsillectomy pseudoaneurysm is mandatory to prevent rupture with haemorrhagic shock and exsanguination. Post-tonsillectomy pseudoaneurysms may not rupture in every patient, as has been reported by DeFatta *et al.*,¹¹ Veyssier *et al.*¹² and Heyn *et al.*¹³ In contrast, our study shows that post-tonsillectomy

pseudoaneurysms are typically associated with bleeding complications (Table I). Van Cruijssen *et al.*¹⁴ have stated that post-tonsillectomy pseudoaneurysm only involves children under the age of 10 years, presumably due to the smaller anatomy and thinner pharyngeal muscles. However, the current and previous studies^{8,12,13,15–17} indicate that the occurrence of post-tonsillectomy pseudoaneurysm is not restricted by age (Table I). The clinical signs of this lesion may be confusing; a high index of clinical suspicion is thus mandatory in order to include post-tonsillectomy pseudoaneurysm in the differential diagnosis of head and neck masses.^{18–26}

Onset

False aneurysms in the head and neck have been reported to occur as early as four hours²⁷ and as late as eight months²⁸ after trauma or maxillofacial surgery.²⁹ In one case, a post-tonsillectomy pseudoaneurysm, resulting from a postsurgical parapharyngeal abscess, was attributed to bacterial spread caused by infiltration of local anaesthetic agent.¹⁵ One of our patients presented a comparable history of repeated peritonsillar abscesses despite repeated incision and drainage. In contrast to the case of delayed post-tonsillectomy haemorrhage reported by Laage and Beuthner,¹⁵ our patient suffered an immediate, gushing haemorrhage on tonsil dissection. We suspected that this patient’s unusual intensity of intra-operative bleeding resulted from a pseudoaneurysm, since a comparable case was reported in the literature.¹⁶ However, subsequent arteriography and neck exploration was capable to rule out this possible differential diagnosis.

Our patients with proven post-tonsillectomy pseudoaneurysm experienced bleeding 21, 36 and 58 days following tonsillectomy, variously, at a stage when their wounds should have been (almost) healed. This finding is supported by most other relevant reported cases, which describe post-tonsillectomy pseudoaneurysm associated with bleeding as occurring only exceptionally within the first few hours,³² being much more likely to occur 8,^{33,34} 10,^{17,34,35} 14,^{16,30,36} 15,³³ 16^{14,33} or 30³⁷ days, or even 36 years,¹² after tonsillectomy. Regrettably, the phenomenon of delayed post-tonsillectomy bleeding is not restricted to just those haemorrhages of pseudoaneurysm origin, as our results attest (see Table II).

Site

An analysis of magnetic resonance images in 100 children revealed that the distance from the internal carotid artery to the tonsillar fossa varied from 6.0 to 28.6 mm, depending on age and weight.³⁸ The external carotid artery courses more laterally and anterior to the internal carotid artery, suggesting that the latter should be involved in most cases of post-tonsillectomy pseudoaneurysm,^{16,35,36} due to its closer relationship to the tonsil.³⁸ However, the internal carotid artery was not involved in any of our patients (cases 19–21 of table I) and only two authors have reported such involvement.^{11,16} We consider the inferior tonsillar pole to carry a much greater

TABLE I
POST-TONSILLECTOMY PSEUDOANEURYSMS: PUBLISHED CASES

Case no	Study	Sex	Age (y)	Artery	Side	Symptoms (post-op day)	Treatment (day)
1	DeFatta <i>et al.</i> ^{11*}	F	8	ICA	L	Painful neck mass, miosis, ptosis (6)	MRI, MRA (vascular abnormality); CT + contrast (suspicious for abscess surrounding ICA pseudoaneurysm); arteriography (PTP of ICA); embolisation (6); subsequent neck revision with blunt dissection of carotid sheath (no frank pus, 6)
2	Heyn <i>et al.</i> ¹³	M	9	NS	NS	Dysphagia (2 y)	Vascular surgery
3	Heyn <i>et al.</i> ¹³	M	42	NS	NS	Dysphagia (4 wk)	Vascular surgery
4	Hoff <i>et al.</i> ³⁷	M	7	Lingual-facial trunk	R	PTH (minor, SC, 14) PTH (gushing, SC, 14) PTH (gushing, 30)	Embolisation (platinum coil) (14); BT + IV fluids + transcervical ligature of lingual (LM3) & facial a (30)
5	Karas <i>et al.</i> ³⁶	M	2	ECA	R	Haematemesis (SC, 14) Pulsatile neck mass (21–90)	Observation (wk 2); CT + contrast (enhancing + angiogram: ECA aneurysm); LECA via open transcervical approach (mth 3)
6	Laage & Beuthner ^{15†}	M	34	Carotid bifurcation	L	PTH (gushing, SC, 9) PTH (gushing, 23)	Drainage of parapharyngeal abscess (5); BT + IV fluids + neck revision (9); BT + surgical revision of neck + Teflon patch fixation to stent carotid a (18)
7	Maurer <i>et al.</i> ³⁴	M	18	Lingual	R	PTH (major, 6) PTH (minor × 2, SC, 8) PTH (major, 8) PTH (gushing, 8)	Swab fixation on left (6) and right (8) side; packing of entire pharynx; arteriography (PTP); embolisation (8)
8	Maurer <i>et al.</i> ³⁴	F	7	Lingual	L	PTH (minor × 3, SC, 10) PTH (gushing, 10) PTH (× 2, 18)	Observation (10); packing of entire pharynx, arteriography (normal findings) (10); packing removed (11); extubation (12); arteriography (PTP); transcervical ligation (18)
9	Menauer <i>et al.</i> ³⁵	F	7	Lingual	L	PTH (gushing, SC, 9) PTH (gushing, SC, 10) Pharyngeal mass (25)	Observation (9); BT (19); CT + arteriography + surgical revision via transcervical open approach + removal of aneurysm (25)
10	Mitchell <i>et al.</i> ³¹	F	3	Lingual	R	Haemorrhage (intra-op, profuse)	BT (2 units) immediately after dissection of R tonsil + transoral double ligation of identified bleeding vessel + arteriography (PTP) + embolisation with 4 multiple-fibre platinum coils
11	Pourhassan <i>et al.</i> ⁸	M	17	ECA	NS	Neck mass, dysphagia, dyspnoea (10)	Aneurysm resection + LECA (10)
12	Simoni <i>et al.</i> ³²	F	8	Lingual	R	Haemorrhage (intra-op, gushing) PTH (gushing, 1 h)	Constant intubation due to serious blood loss during tonsil dissection (1 & 3 h after tonsillectomy); repeated examination & SL under GA + BT (4 units) + FFP + albumin (250 ml) + crystalloid fluid resuscitation (3 l); arteriogram (PTP); embolisation with 4 complex platinum coils
13	Tovi <i>et al.</i> ¹⁶	F	14	ICA	R	PTH (intra-op, gushing) PTH (14) Severe pharyngeal & nasal bleeding, SC Dysphagia, facial pain, pharyngeal mass, mucosal deficiency	BT + local measures intra-op; CT + contrast (4 × 3 cm parapharyngeal mass); arteriography (PTP); transcervical clamping (after proximal occlusion of ICA did not provoke EEG changes); occlusion of ICA distal stump by 2 steel coils via catheter (introduced via arteriotomy) + suture ligation proximal & distal to PTP (14)

Continued

TABLE I Continued

Case no	Study	Sex	Age (y)	Artery	Side	Symptoms (post-op day)	Treatment (day)
14	van Cruijssen <i>et al.</i> ¹⁴	M	3.5	Lingual	R	PTH (SC, 5) PTH (SC, 9) PTH (SC, 16) PTH (during extubation)	Overnight admission (5); in-patient observation + BT (2 units) (9); examination under GA (pulsating pharyngeal wall) + SFP (16); re-intubation + digital oral pressure for 15 min + arteriography (PTP) + embolisation + BT (16)
15	Veyssier <i>et al.</i> ¹²	F	74	Unclear; anecdotal	R	PTH (intra-op, gushing) Haemoptysis (SC, 13 y) Haemoptysis (SC, 36 y) Neck mass, pharyngeal mass (36 y)	No specific treatment described
16	Walshe <i>et al.</i> ^{17‡}	M	30	Lingual	L	PTH (minor, SC) PTH (SC, 6) PTH (SC, 8) PTH (SC, 10)	Observation + hydrogen peroxide gargles (6); observation (8); examination under GA (pulsatile mass); CT angiogram (PTP); embolisation + BT (4 units) due to constant bleeding during embolisation (10)
17	Weber <i>et al.</i> ³³	F	10	Facial	NS	PTH (gushing, SC, 5) PTH (gushing, 10) PTH (gushing, 16)	Observation (5); examination under GA (NBV) + SL + E (10); arteriography (PTP) + embolisation with platinum coils (16)
18	Weber <i>et al.</i> ³³	F	5	Lingual	L	PTH (gushing, SC, 8) PTH (gushing, SC, 15)	Observation (8); examination under GA (NBV); gastroscopy (NBV); arteriography (PTP); embolisation with platinum coils (15)
19	Windfuhr <i>et al.</i> **	F	5	Lingual	L	PTH (gushing, SC, 8) PTH (gushing, SC, 36)	SL (8); BT + arteriography (PTP) + successful embolisation with platinum coils (36)
20	Windfuhr <i>et al.</i> **	M	5	Lingual	R	PTH (minor, SC, 11) PTH (major, SC, 22) PTH (major, SC, 57) PTH (gushing, 58)	Observation (11); BT (22); examination under GA (NBV) (57); arteriography (PTP); transcervical ligation of lingual a (58)
21	Windfuhr <i>et al.</i> **	M	18	Facial	L	PTH (minor, SC, 5) PTH (major, SC, 5) PTH (major, diffuse, 5) PTH (major, SC, 6) PTH (minor, diffuse, SC, 6) PTH (gushing, 21)	SL (5); Cafedrin-Theodrenalin (NBV) (6); SL (6); SL + arteriography (PTP) + embolisation with platinum coils (21)

*Ipsilateral peritonsillar abscess, abscess tonsillectomy; †post-tonsillectomy abscess formation; ‡tonsillectomy + uvulopalatoplasty. **Current study. No = number; post-op = post-operative; intra-op = intra-operative; F = female; M = male; ICA = internal carotid artery; ECA = external carotid artery; NS = not specified; L = left; R = right; y = years; mth = months; wk = weeks; h = hours; PTH = post-tonsillectomy haemorrhage; SC = spontaneous cessation; MRI = magnetic resonance imaging; MRA = magnetic resonance angiography; CT = computed tomography; PTP = post-tonsillectomy pseudoaneurysm; BT = blood transfusion; IV = intravenous; a = artery; LECA = ligation of ECA & individual branches; GA = general anaesthetic; SL = transoral suture ligation; FFP = fresh frozen plasma; EEG = electroencephalogram; SFP = suture of faucal pillars; NBV = no bleeding vessel identified; E = transoral electrocautery



FIG. 1

Post-tonsillectomy pseudoaneurysm of the left lingual artery. Of 8837 tonsillectomy procedures and 286 cases of post-operative haemorrhage requiring revision surgery under general anaesthesia, this was the first case of proven post-tonsillectomy pseudoaneurysm at our institution. (a) Transfemoral digital subtraction angiography in a 5-year-old girl, 36 days following tonsillectomy, establishing the diagnosis of post-tonsillectomy pseudoaneurysm (on that day, bleeding with spontaneous cessation had followed a brief bleeding episode 8 days after surgery). (b) The same imaging modality showing occlusion of the post-tonsillectomy pseudoaneurysm with six platinum coils, producing complete resolution.

risk of arterial injury during tonsillectomy, due to the variable course of the facial artery looping over the submandibular gland in this area. The lingual artery may also run close to the inferior tonsillar pole. Both arteries were involved in all of our patients (table I, case 19–21) and also in most other reported cases (Table I).

Simoni *et al.*³² have stated that pseudoaneurysms of the lingual artery are rare. This directly contrasts with our own findings: we found the lingual artery to be the most commonly involved artery in cases of post-tonsillectomy pseudoaneurysm and other tonsillectomy-related arterial injury (Table I). The facial artery is rarely involved in post-tonsillectomy pseudoaneurysm; there was only one such case in our patient population, and two cases reported in the literature.^{33,37}

Diagnosis and treatment

Rapid diagnosis of a post-tonsillectomy pseudoaneurysm is based on arteriography; ultrasound and computed tomography with contrast are also options. Arteriography with simultaneous embolisation has been reported as management for a ruptured lingual artery,³⁹ true and false aneurysms involving the lingual,¹⁷ external carotid³⁷ and internal carotid artery.^{16,30} Steel coils have been used to occlude a pseudoaneurysm of the internal carotid artery;¹⁶ however, platinum coils^{32,33} are advantageous due to their compatibility with microcatheter systems used in superselective catheterisation. Tovi *et al.*¹⁶ and Hertzanu *et al.*³⁰ (reporting on the same patient) have suggested a combined surgical-radiological approach for selected cases.

Embolisation was successful in three patients of our study (case 19 and 21 of table I; case 6 of table II), pseudoaneurysm and one with a damaged facial artery. Opatowsky *et al.*⁴⁰ reported the use of embolisation in two children with repeated post-tonsillectomy bleeding despite previous surgical revision. No definitive source of bleeding was identified by arteriography in either child. Prompted by a suspicious appearance, embolisation of the ascending palatine artery in one child and of the lingual plus ascending pharyngeal artery in the other child prevented further bleeding. Levy *et al.*³⁹ also reported the use of embolisation, in a 10-year-old girl with repeated bleeding episodes with spontaneous cessation. Post-tonsillectomy haemorrhage recurred in the recovery room, after haemostasis had previously been achieved under general anaesthesia. Arteriography was undertaken, including successful embolisation of a damaged left lingual artery.

Embolisation, even if superselective, was not successful in three patients, in our study, case 2, 4 and 5 of table II. Hoff *et al.*³⁷ reported post-tonsillectomy haemorrhage recurrence 16 days after previous embolisation (performed 14 days after tonsillectomy) comparable to the case of Hoff in case 20 of table I. As in one of our patients, immediate ligation of the injured vessel via an open transcervical approach proved successful.

Arteriography revealed normal findings in four of our patients (cases 1–4 of table II). It remains speculative whether repeated arteriography would have subsequently revealed a post-tonsillectomy pseudoaneurysm. Maurer and colleagues³⁴ reported a normal finding 10 days after surgery, yet a confirmed post-tonsillectomy pseudoaneurysm 8 days later, when bleeding recurred. Our study results

TABLE II
ARTERIOGRAPHY FINDINGS: EXPERTS COLLECTION

Case no	Sex	Age group	PTH (post-op day)	Treatment	Arteriography findings
1	M	Adult	Minor, SC (1)	Observation	Normal
			Minor, SC (5)	Observation	
			Minor, SC (5)	E	
			Major (7)	E + SL	
			Major, SC (13)	NBV + arteriography	
			Gushing (15)	SL + E	
2	F	Child 4 y	Gushing (18)	E + SL + LECA + resuscitation (died)	Normal; lingual + asc pharyngeal a embolised
			Major, SC (7)	NBV	
			Major, SC (7)	NBV + BT + E	
			Major (7)	NBV + arteriography + BT	
			Major (7)	SL	
			Major (7)	SL	
3	M	Adult 36 y	Minor, SC (5)	Ice pack	Normal
			Minor, SC (21)		
			Minor, SC (23)	SL	
			Major (29)	E + arteriography	
			Minor, diffuse (35)	SL + E	
			Major (39)	LACE (normal findings)	
4	F	Child 5 y	Minor, SC (6)		Normal; asc pharyngeal a embolised
			Minor, SC (6)		
			Minor, SC (8)	NBV	
			Minor, SC (8)	NBV	
			Minor, SC (8)	NBV	
			Minor, SC (8)	NBV	
			Major (9)	SL + E	
			Major (14)	Suture-fixed swabs + BT + arteriography	
			Major (17)	E	
			Major (17)	E	
5	M	Child 5 y	Gushing (8)	SFP	Injured lingual a embolised
			Gushing (9)	SFP + E	
			Major (9)	SFP + BT	
			Minor, SC (13)	Arteriography	
6	F	Adult 21 y	Major (13)	Pharyngeal packing	Injured facial a embolised
			Minor, SC (2)	SL + E	
			Minor, SC (16)	SL + E	
7	F	Adult 21 y	Gushing, aspiration, shock (17)	SL + packing + BT + arteriography	Injured lingual a
			Gushing (8)	SL	
			Gushing (9)	SL	
8	F	Adult 24 y	Gushing (10)	SL + LECA + arteriography + pharyngeal packing for 4 days + ligature of lingual a (day 14)	Disrupted facial a
			Minor, SC (6)	E	
			Minor, SC (11)	Observation	
			Gushing, cardiac arrest (15)	Resuscitation + BT + E + SL + fibrin glue	
9	F	Adult 29 y	Major (15)	Arteriography + LECA	Asc pharyngeal a originating from carotid bulb
			Major (5)	SFP	
			Gushing (6)	LECA + BT	
10	F	Adult 32 y	Major, SC (7)	Arteriography + artery ligation	Few ECA branches intact; arterial blood supply from ICA
			Minor, SC (7)	Observation	
			Major (12)	Coagula removed	
			Gushing (15)	SL	
			Gushing (16)	LECA	
Major (18)	Arteriography + ECA transection + ICA branches ligated + contralateral thyroid a ligated				

No = number; PTH = post-tonsillectomy haemorrhage; post-op = post-operative; M = male; F = female; SC = spontaneous cessation; E = transoral electrocautery; SL = transoral suture ligation; NBV = no bleeding vessel identified; LECA = ligature of external carotid artery & individual branches; BT = blood transfusion; asc = ascending; SFP = suturing of faecal pillars; a = artery

suggest that normal arteriography does not exclude the risk of later bleeding (Table II).

- **A ruptured pseudoaneurysm is an extremely rare cause of post-tonsillectomy haemorrhage**
- **Whenever episodes of gushing and secondary post-tonsillectomy bleeding with spontaneous cessation occur, arteriography should be considered to rule out vascular injuries, including pseudoaneurysm formation**
- **Simultaneous, superselective embolisation has been proven to be safe and effective. However, this is impractical in the acute emergency presented by life-threatening bleeding, aspiration or expanding cervical haematoma**

In cases of aspiration or life-threatening bleeding, arteriography is not practical. Instead, immediate surgery and intensive care are mandatory for a successful outcome. Whenever ligation of the external carotid artery is considered, the surgeons should exclude an aberrant arterial blood supply by branches of the internal carotid artery, as was shown for two patients in our study (Table II). Moreover, ligation of the external carotid artery may result in post-operative blindness due to atypical collaterals between the internal and external carotid artery.⁴¹

Conclusion

A ruptured pseudoaneurysm is an extremely rare cause of post-tonsillectomy haemorrhage; other causes of episodic post-tonsillectomy bleeding are much commoner. However, whenever episodes of gushing and secondary post-tonsillectomy bleeding with spontaneous cessation occur, arteriography should be considered to rule out vascular injury, including post-tonsillectomy pseudoaneurysm. Embolisation of the injured artery should be performed proximal and distal to the lesion, due to the extensive retrograde blood flow.

Simultaneous, superselective embolisation has been proven to be safe and effective. However, it is impractical in the acute emergency presented by life-threatening bleeding, aspiration or expanding cervical haematoma.

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Erratum

Post-tonsillectomy pseudoaneurysm: an underestimated entity? – Erratum

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This article¹ was published with three errors, as follows.

(1) On the first page, the second author's affiliation should have read 'Philipps University of Marburg, Marburg, Germany'.

(2) Also on the first page, the second paragraph of the Patients and Methods section should have read 'A similar review concerning neurological lesions was previously undertaken by the authors.'¹⁰ A new reference 10 should have appeared in the Reference list, reading '10 Windfuhr JP, Schloendorff G, Sesterhenn AM, Kremer B. From the expert's office: localized neural lesions following tonsillectomy. *Eur*

Arch Otorhinolaryngol 2009 Oct;**266**(10):1621–40. Epub 2009 Jan 31. All subsequent references should have been renumbered one greater, in both the text and the reference list.

(3) On the second page, the first sentence of the Results section should have begun 'We analysed the data of...'

Reference

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