Original Article

Post-tonsillectomy haemorrhage in Australia—a multivariable analysis of risk factors

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Background: Tonsillectomy is a common procedure in otolaryngology and currently, there are limited multivariable analyses regarding factors associated with secondary post-tonsillectomy haemorrhage (PTH) in an Australian metropolitan setting. This study aims to provide further analysis of various factors associated with secondary PTH in an Australian metropolitan health service.

Methods: A retrospective review was conducted for all elective tonsillectomies performed at Western Health, Australia between December 2011 and December 2015. Multivariable logistic regression analyses were performed.

Results: A total of 1,257 tonsillectomies were included. Secondary PTH was observed in 87 (6.9%) patients with 35 (2.8%) returning to theatre. No differences in PTH were found between surgical techniques, month of tonsillectomy, same day discharge and surgeon experience. Multivariable analysis showed that patients receiving ibuprofen (OR =2.07; 95% CI =1.08, 3.99), as well as a 1-year increase in age (OR =1.03; 95% CI =1.01, 1.05) were associated with significantly increased odds of PTH.

Conclusions: Tonsillectomy is a common procedure in otolaryngology and this study provides updated local data for a more accurate comparison of surgical outcome.

Keywords: Tonsillectomy; hemorrhage; otolaryngology; Australia; emergencies; risk factors; analgesia; seasons; hospital; retrospective study

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Introduction

Tonsillectomy is one of the most common surgical procedures in adult and paediatric otolaryngology head and neck surgery and is performed for indications including recurrent tonsillitis, obstructive sleep apnoea and recurrent peritonsillar abscess (1-3).

A significant complication following tonsillectomy is post-tonsillectomy haemorrhage (PTH), which may be associated with significant morbidity, including transfusions or emergency surgical management (4,5). Secondary PTH is defined as any bleeding more than 24 hours post-operatively (6). Several factors such as surgical technique, patient age, gender, post-operative analgesic use and surgical indication have been implicated as risk factors associated with a higher rate of secondary PTH (7-11). There is no standardised technique or post-operative analgesic regime for the operative and perioperative management of patients

undergoing tonsillectomy. Moreover, there are significant variations in practice and reported rates of secondary PTH in the literature (5,12,13).

Local practice and factors such as temperature and season may contribute to this variation in haemorrhage rates. A study by MacFarlane *et al.* showed that monopolar diathermy was the most popular surgical technique used for tonsillectomies in Australia while studies in the United Kingdom found cold steel dissection as the preferred technique (3,14). Whilst studies in the past decade have identified a significantly higher rate of PTH in winter months (15-17), Cadd *et al.* conducted the only Australian retrospective review of 941 tonsillectomies in Australia showing no significant seasonal variation in haemorrhage rates (18). However, local environmental factors such as temperature and season have been found to be associated with other conditions such as angina pectoris (19) and intracranial haemorrhage (20).

Currently, there are no multivariable analyses assessing potential risk factors associated with secondary PTH in an Australian setting, with previous studies investigating single factors such as post-operative analgesic use, patient age and surgical indications (3,18,21,22). Therefore, surgeons often rely on overseas data for comparison, which may not accurately reflect local practice.

This study aims to further investigate various factors which might be associated with secondary PTH haemorrhage in an Australian metropolitan setting. This may provide current data for a more accurate comparison of surgical outcome.

Methods

A retrospective review was conducted of all adult and paediatric elective tonsillectomies performed at Western Health, Australia between 1st December 2011 and 31st December 2015. Tonsillectomies for the diagnosis and staging of suspected or proven malignancy, as well as emergency tonsillectomies, were excluded from this study. Quality assurance was approved by the Western Health Human Research Ethics Committee.

De-identified data for patient demographics, indication for surgery, concurrent procedures (such as adenoidectomy), surgical technique, operator experience and post-operative analgesia were recorded. All readmissions were recorded, with secondary PTH defined as any bleeding from the tonsillar fossa more than 24 hours after tonsillectomy as observed by a medical practitioner. We categorized the timing of the procedure into seasonal periods: spring (September to November), summer (December to February), autumn (March to May) and winter (June to August).

Frequency and proportions were used to describe the patients that underwent tonsillectomy between December 2011 and December 2015. We fitted logistic regression models to estimate the univariable associations between the following risk factors: age (years), season (autumn, spring, summer or winter), indication for tonsillectomy (recurrent tonsillitis, peritonsillar abscess or obstructive sleep apnoea), technique (bipolar diathermy, monopolar diathermy, coblation or cold steel) and analgesia used (celecoxib, ibuprofen, paracetamol or did not receive analgesia) and the following two outcomes: PTH (yes/no) and return to theatre (yes/no). Multivariable logistic regression analyses assessed the association between the above-mentioned risk factors and the two outcomes. All analyses were performed using Stata version 13.1 (StataCorp LP, College Station, TX, USA).

Results

Over a period of 4 years, 1,257 tonsillectomies were included in the review. *Table 1* shows the overall characteristics of the cohort by risk factors. The median age was 12 years (inter-quartile range: 5, 22; range 1 to 72 years). OSA was the most common indication for surgery (705, 56.1%), followed by recurrent tonsillitis (517, 41.1%). The surgical techniques utilised were monopolar (312, 24.9%) and bipolar diathermy (735, 58.5%), coblation (13, 1.0%) and cold steel dissection (196, 15.6%). Tonsillectomies were performed by surgeons with varying levels of experience (house medical officers to consultants), most commonly by consultants (664, 52.8%) and registrars (426, 33.9%). Day case tonsillectomies (patients discharged on the same day of surgery) accounted for 26.8% of all cases. Various analgesic regimes were used with celecoxib and ibuprofen being the most frequently used non-steroidal anti-inflammatory drugs (532, 42.3%).

Secondary PTH was observed in 87 (6.9%) patients. On average, secondary PTH occurred at a median of 7 days (SD). No differences in secondary PTH were found between genders, surgeon's level of experience and day case tonsillectomies.

Table 2 shows the results from the univariable and multivariable logistic regression models for the outcome of PTH. After adjusting for the risk factors, season and

Table 1 Descriptive statistics for 1,257 patients who underwent tonsillectomy between December 2011 and December 2015

Risk factors	Median [IQR] or n (%)
Age (years)	12 [5, 22]
Season	
Autumn	350 (27.8)
Spring	329 (26.2)
Summer	327 (26.0)
Winter	251 (20.0)
Indication	
Recurrent tonsillitis	517 (41.1)
Peritonsillar abscess	35 (2.8)
OSA	705 (56.1)
Technique	
Bipolar diathermy	735 (58.5)
Coblation	13 (1.0)
Cold steel dissection	196 (15.6)
Monopolar diathermy	313 (24.9)
Analgesia	
Celecoxib	395 (31.4)
Ibuprofen	137 (10.9)

IQR, interquartile range (i.e., 25th and 75th percentiles); OSA, obstructive sleep apnoea.

surgical technique were not associated with whether or not a patient had a PTH. Patients receiving ibuprofen had a 2-fold increased odds of PTH compared to those receiving celecoxib (OR =2.07, 95% CI =1.08, 3.99). As well, the odds of PTH increased slightly for a 1-year increase in age from 1 to 72 years of age (OR =1.03; 95% CI =1.01, 1.05). Patients undergoing tonsillectomy for recurrent tonsillitis had significantly higher odds of PTH on univariable analysis compared to other indications (OR =0.57; 95% CI =0.37, 0.89, P=0.013), but this became non-significant on multivariable analysis (OR =0.79; 95% CI =0.49, 1.29, P=0.350).

Table 3 shows the results from the univariable and multivariable logistic regression models for the outcome of return to theatre. After adjusting for the risk factors, season, surgical technique and surgical indication were not associated with whether or not the patient returned to theatre. The odds of returning to theatre increased slightly for a 1-year increase in age (OR =1.04; 95% CI =1.02, 1.07).

Discussion

Over 30,000 tonsillectomies were performed in Australia between July 2015 and June 2016, making it one of the most commonly performed procedures in both adult and paediatric otolaryngology, head and neck surgery (23). Indications for tonsillectomy include conditions such as recurrent tonsillitis, obstructive sleep apnoea, or recurrent peritonsillar abscess (1-3,24). Throughout the history of tonsillectomy, postoperative haemorrhage from the tonsillar bed remains the most important complication requiring emergency management (6). Given the significance of bleeding in the upper airway, consequences of secondary PTH may include blood transfusions, return to theatre or even death (4,25). Studies investigating causes for secondary PTH remain inconclusive, with current theories suggesting postoperative clot sloughing or infection in the tonsillar bed as potential causes for secondary PTH (6,26,27).

Whilst numerous studies have been conducted on PTH, there is still significant variation in the reported rates of secondary PTH (5,8,10,14,28,29). The secondary PTH rate in this study is 6.9%, which is consistent with reported rates in literature, with Australian studies reporting PTH rates ranging from 2.0% to 7.7% (18,21,22). A review of 63 studies by Blakley *et al.* concluded that the maximum acceptable PTH rate is 13.9% (29). However, Evans *et al.* commented that reported rates may often be underestimated due to failure of patients to present to the hospital where their procedure was performed or failure to attend follow up appointments. They conducted a telephone survey showing that actual haemorrhage rates may be up to 40% (12).

Patients undergoing tonsillectomy due to recurrent tonsillitis have been shown to have a higher likelihood of PTH compared to other indications such as obstructive sleep apnoea (7,11,30). Perkins *et al.* suggested that this is possibly associated with greater intra-operative trauma due to scarring from recurrent tonsillitis which may result in subsequent clot sloughing post-operatively (11). Moreover, OSA patients are believed to have a reduced fibrinolytic rate which may also reduce their likelihood of PTH (11). Our study shows that patients undergoing tonsillectomy due to OSA have a significantly lower risk of PTH compared to those with an indication of recurrent tonsillitis (OR =0.57; 95% CI =0.37, 0.89; P=0.013). However, consistent with other studies (7,11), this risk becomes non-significant on

Table 2 Logistic regression analysis of the association between various risk factors and post tonsillectomy haemorrhage

Risk factor	No. of PTH (N=87)	No. of non-PTH (N=1,170)	Univariable model		Multivariable model*	
			OR (95% CI)	P value	OR (95% CI)	P value
Age (years)	–	–	1.03 (1.01, 1.05)	<0.001	1.03 (1.01, 1.05)	0.001
Season						
Autumn	21	329	Ref	–	Ref	–
Spring	32	297	1.69 (0.95, 2.99)	0.073	1.69 (0.92, 3.09)	0.092
Summer	18	309	0.91 (0.48, 1.75)	0.782	0.89 (0.46, 1.74)	0.741
Winter	16	235	1.07 (0.54, 2.09)	0.851	1.27 (0.64, 2.53)	0.489
Indication						
Recurrent tonsillitis	48	469	Ref	–	Ref	–
Peritonsillar abscess	0	35	N/E	–	N/E	–
OSA	39	666	0.57 (0.37, 0.89)	0.013	0.79 (0.49, 1.29)	0.350
Technique						
Bipolar diathermy	50	685	Ref	–	Ref	–
Coblation	0	13	N/E	–	N/E	–
Cold steel dissection	13	183	0.97 (0.52, 1.83)	0.933	0.81 (0.41, 1.58)	0.528
Monopolar diathermy	24	289	1.14 (0.69, 1.89)	0.617	1.09 (0.62, 1.90)	0.766
Analgesia						
Celecoxib	27	368	Ref	–	Ref	–
Ibuprofen	19	118	2.19 (1.18, 4.09)	0.013	2.07 (1.08, 3.99)	0.029

*, multivariable model includes all of the risk factors presented in the table. OR, odds ratio; 95% CI, 95% confidence interval; OSA, obstructive sleep apnoea; PTH, post-tonsillectomy haemorrhage; Ref, reference category; N/E, not estimated because number of cases is 0.

multivariable analysis, suggesting that other factors are likely contributing to PTH (OR =0.79; 95% CI =0.49, 1.29; P=0.350).

Age had repeatedly been implicated as a risk factor for significantly higher rates of secondary PTH, in both Australian and international studies (7,8,10). Our study also shows that after adjusting for several key risk factors, older patients are at a slightly higher risk of PTH (OR =1.03; 95% CI =1.01, 1.05; P=0.001) and return to theatre for arrest of PTH (OR =1.04; 95% CI =1.02, 1.07; P=0.001). This may be explained by the larger proportion of adults undergoing tonsillectomy due to recurrent tonsillitis, which is associated with a greater degree of tonsillar scarring and neovascularization from repeated infections compared to children undergoing the procedure, whose indications are mostly due to obstructive sleep apnoea (31).

Previous studies have reported conflicting results with regards to the role of gender as a risk factor for PTH, with some studies showing males being associated with significantly greater risk of PTH (5,8,10,28,32), Coordes *et al.* found a significantly greater rate of PTH in males and postulated the possibility of sex hormone differences as well as lower rates of medication compliance as possible causes (28). However, other factors are likely contributing to these gender differences in PTH as Coordes *et al.* also reported a greater proportion of male patients with surgical indications of peritonsillar abscess. Our analysis, along with findings from other studies, did not show any significant difference in PTH rates between genders (11,14,33).

Several studies have found an association between surgical experience and PTH rates, thought to be due to the use of excessive diathermy for haemostasis in the tonsillar fossa, resulting in a higher likelihood of clot sloughing (8,10,14). However, this study as well as multiple previous studies did not demonstrate any significant association between PTH rates and the surgeon's experience, from

Table 3 Logistic regression analysis of the association between various risk factors and return to theatre

Risk factor	No. of PTH (N=39)	No. of non-PTH (N=1,218)	Univariable model		Multivariable model*	
			OR (95% CI)	P value	OR (95% CI)	P value
Age	–	–	1.03 (1.01, 1.06)	0.004	1.04 (1.02, 1.07)	0.001
Season						
Autumn	10	340	Ref	–	Ref	–
Spring	11	318	1.18 (0.49, 2.81)	0.715	1.26 (0.50, 3.13)	0.623
Summer	10	317	1.07 (0.44, 2.61)	0.877	1.08 (0.44, 2.69)	0.865
Winter	8	243	1.12 (0.44, 2.88)	0.815	1.28 (0.49, 3.36)	0.611
Indication						
Recurrent tonsillitis	18	499	Ref	–	Ref	–
Peritonsillar abscess	0	35	N/E	–	N/E	–
OSA	21	684	0.85 (0.45, 1.61)	0.622	1.19 (0.59, 2.40)	0.628
Technique						
Bipolar diathermy	23	712	Ref	–	Ref	–
Coblation	0	13	N/E	–	N/E	–
Cold steel dissection	5	191	0.81 (0.30, 2.16)	0.674	0.66 (0.23, 1.85)	0.424
Monopolar diathermy	11	302	1.13 (0.54, 2.34)	0.748	0.99 (0.44, 2.20)	0.978
Analgesia						
Celecoxib	13	382	Ref	–	Ref	–
Ibuprofen	6	131	1.35 (0.50, 3.61)	0.555	1.47 (0.53, 4.10)	0.462

*, multivariable model includes all of the risk factors presented in the table. OR, odds ratio; 95% CI, 95% confidence interval; OSA, obstructive sleep apnoea; Ref, reference category; N/E, not estimated because number of cases is 0.

house medical officers to consultant surgeons (17,28,33). It is of note that all tonsillectomies performed at our centre were performed or supervised by consultant otolaryngologists which may limit the significance of this finding.

The role of surgical technique has long been debated as a risk factor for secondary PTH. Both a Cochrane systematic review and a systematic review conducted by Leinbach *et al.* failed to demonstrate any difference between 'cold' tonsillectomy techniques such as cold steel dissection versus 'hot' tonsillectomy techniques such as diathermy and coblation (34,35). However, the National Prospective Tonsillectomy Audit's (NPTA) analysis of 33,921 tonsillectomies in the United Kingdom demonstrated a significantly higher PTH rate for 'hot' tonsillectomy techniques compared to 'cold' techniques, with monopolar or bipolar diathermy techniques having an odds ratio of 2.5 to 3.2 compared to cold steel dissection with haemostasis using ties (15). Lee *et al.* reported a smaller difference in secondary PTH between these techniques (17). A postulated theory for this difference is due to the significantly greater surgical thermal injury sustained in the tonsillar fossa following excessive or high wattage diathermy (up to 60–70 ℃ for coblation and 400–600 ℃ for diathermy) (36,37). This study did not find any difference between PTH rates in tonsillectomies performed using cold steel dissection, monopolar diathermy, bipolar diathermy or coblation techniques. This may reflect the difference in practice in Australia, as monopolar diathermy had been shown to be the most commonly utilized tonsillectomy technique in contrast with cold steel dissection in the United Kingdom (3). Although Australian studies comparing tonsillectomy techniques are limited, O'Leary and Vorrath as well as Walker *et al.* did not demonstrate any significant difference in PTH rates between 'cold' and 'hot' techniques (21,22). Moreover, Walker *et al.* found a greater

contribution of age as a risk factor for PTH compared to surgical technique.

The use of NSAIDs in the management of post-tonsillectomy pain have often been implicated as a risk factor for secondary PTH due to the inhibition of the COX pathway (38,39). Systematic reviews have suggested that NSAID use following tonsillectomy is associated with a significant increase in the risk of PTH (38,40,41), with an updated Cochrane review finding insufficient evidence to exclude a higher risk of PTH in patients who are given NSAIDs post-tonsillectomy (42). However, a recent systematic review and meta-analysis did not find a significant association between NSAID use and secondary PTH, nor a significant difference in PTH rates between varying types of NSAIDs (43). The authors explained that their results, which conflict with previous studies, might be due to different inclusion criteria and outcome measures, as well as a lack of quality measures in previous studies. Our data has shown that ibuprofen use is associated with a higher risk of PTH compared to celecoxib use (OR =2.07; 95% CI =1.08, 3.99, P=0.029). This may be due to celecoxib's selective inhibition of the COX-2 pathway, which has also been shown to have a lower risk of gastrointestinal bleeding and ulcers both in short and long term use (44).

Given the variation in reported secondary PTH rates, local factors such as seasonal and meteorological variations may have a significant influence on PTH. Seasonal variation has been shown to occur in other conditions such as epistaxis (45), intracranial haemorrhage (45), and myocardial infarction (46). This is supported by various studies from the United Kingdom showing significantly higher PTH rates in winter, including data from the NPTA (15,17,47). The most common explanation for this is the higher likelihood of upper respiratory tract infections and coryza in winter (17). However, evidence for the role of post-operative infection as a cause for secondary PTH remains inconclusive (26,27,48,49). Other studies, including the only Australian study analyzing seasonal variation in PTH rates, did not show any difference between seasonal PTH rates (18,50,51). Although most of these studies utilise univariate analyses, our multivariable analysis validates these results and does not show any significant seasonal variation in PTH rates in Australia. However, variations exist between the climate of different Australian cities and therefore other meteorological factors such as temperature and humidity may contribute to seasonal variation in PTH rates which may need to be further investigated.

This study has provided updated evidence of various risk factors for secondary PTH in an Australian metropolitan setting, with older age and post-operative ibuprofen use being associated with a significantly higher PTH rate. The authors would therefore recommend that other analgesic agents should be considered for the management of post-operative pain, especially in older patients, to reduce their morbidity in the post-operative period. Being a retrospective study, there are certain limitations to our findings. Firstly, PTH rates may be underestimated as patients may present to other health services or fail to attend follow up appointments. A previous study had shown that PTH rates in the literature is often underestimated and may be up to as high as 40% (12). Moreover, patients' compliance with post-operative analgesia may affect the association between NSAIDs and PTH. Future prospective studies may address these issues, include blood transfusion as an outcome measure, as well as investigating the effect of various meteorological conditions on PTH.

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Footnote

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/ajo.2018.01.06). JR serves as an unpaid editorial board member of *Australian Journal of Otolaryngology*. The other authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Quality assurance was approved by the Western Health Human Research Ethics Committee. Informed consent was waived due to the retrospective nature of the study.

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