Wound healing after tonsillectomy – A Review of the Literature

Nishant Hemanth Davidoss MBBS[1,2,*], Robert Eikelboom[2,3,4] BEng MApplSc PhD, Peter Leon Friedland[1,2,3,5] MBChB MMed FCS, Peter Luke Santa Maria[1,2,3,6] MBBS PhD

[1]Department of Otolaryngology, Head and Neck, Skull Base Surgery, Sir Charles Gairdner Hospital, Australia

[2]Ear Sciences Centre, School of Medicine, The University of Western Australia, Australia

[3]Ear Science Institute of Australia, Australia

[4]University of Pretoria, Pretoria, South Africa

[5]School of Medicine, The University of Notre Dame, Australia

[6]Department of Otolaryngology, Head and Neck Surgery, Stanford University, USA

***Corresponding Author**

Nishant Hemanth Davidoss (M.B.B.S Hons)

Address:	Sir Charles Gairdner Hospital, Hospital Avenue, Nedlands, WA, 6009.
Email:	NishantDavidoss@gmail.com
Phone:	+61 421 000 748
Fax:	+61 8 9346 4899

Financial Supporter

The Garnett Passe and Rodney Williams Memorial Foundation

Abstract

Objective: To summarize the available literature related to wound healing post tonsillectomy including the stages of healing, experimental models for assessing healing (in animals and humans), and the various factors which affect wound healing.

Data Sources: Ovid MEDLINE literature search of the English literature.

Review Methods: Literature search using the search terms “tonsillectomy”, or “tonsil” and “wound healing". 31 articles that objectively assessed tonsillectomy wound healing and were included for analysis in this review.

Results: The majority of current wound healing assessments in humans investigating tonsillectomy wound healing involve serial direct clinical examinations of the oral cavity. Many patient and surgical factors have been shown to affect wound healing after tonsillectomy. There is some research to suggest the administration of adjunctive treatment options in the post-operative period may be beneficial to tonsillectomy wound healing.

Conclusions: Wound healing post tonsillectomy is an area which has been poorly researched. Having a better understanding of the process of wound healing would allow surgeons to potentially prevent, anticipate, and manage complications from the surgery which arise as part of the healing process.

Keywords: tonsillectomy, tonsil, wound healing.

1. Introduction

Tonsillectomy is a commonly performed surgical procedure with an estimated 577,000 pediatric and 225,000 adult cases performed per year in the United States.[1] While the actual procedure itself is one that an Otolaryngologist can perform relatively safely and quickly, the healing process results in a few uncomfortable weeks for most patients. The procedure is associated with the risk of complications such as pain, dehydration, wound infection and secondary hemorrhage. Postoperative presentations for post-tonsillectomy hemorrhage occurs at an estimated rate of 3% in paediatrics and 6% in adults, presentations for dehydration occurs in approximately 4% of paediatrics and 2% of adults, presentations for pain in 2% paediatrics and 11% of adults and presentations for infection or fever in 1% of paediatrics and 6% of adults.[2]

Despite this, very little has been published on wound healing after tonsillectomy. Thus, clinicians have limited evidence on how to direct therapies to improve tonsillectomy wound healing. Better knowledge in this area may lead to improved evaluation of potential adjunctive therapies to improve the postoperative experience, and reduce the wound healing complications secondary to tonsillectomy including the large associated health care costs. This article summarizes the available literature surrounding wound healing post tonsillectomy including the stages of healing, experimental models for assessing healing (in animals and humans), and the various factors which affect wound healing.

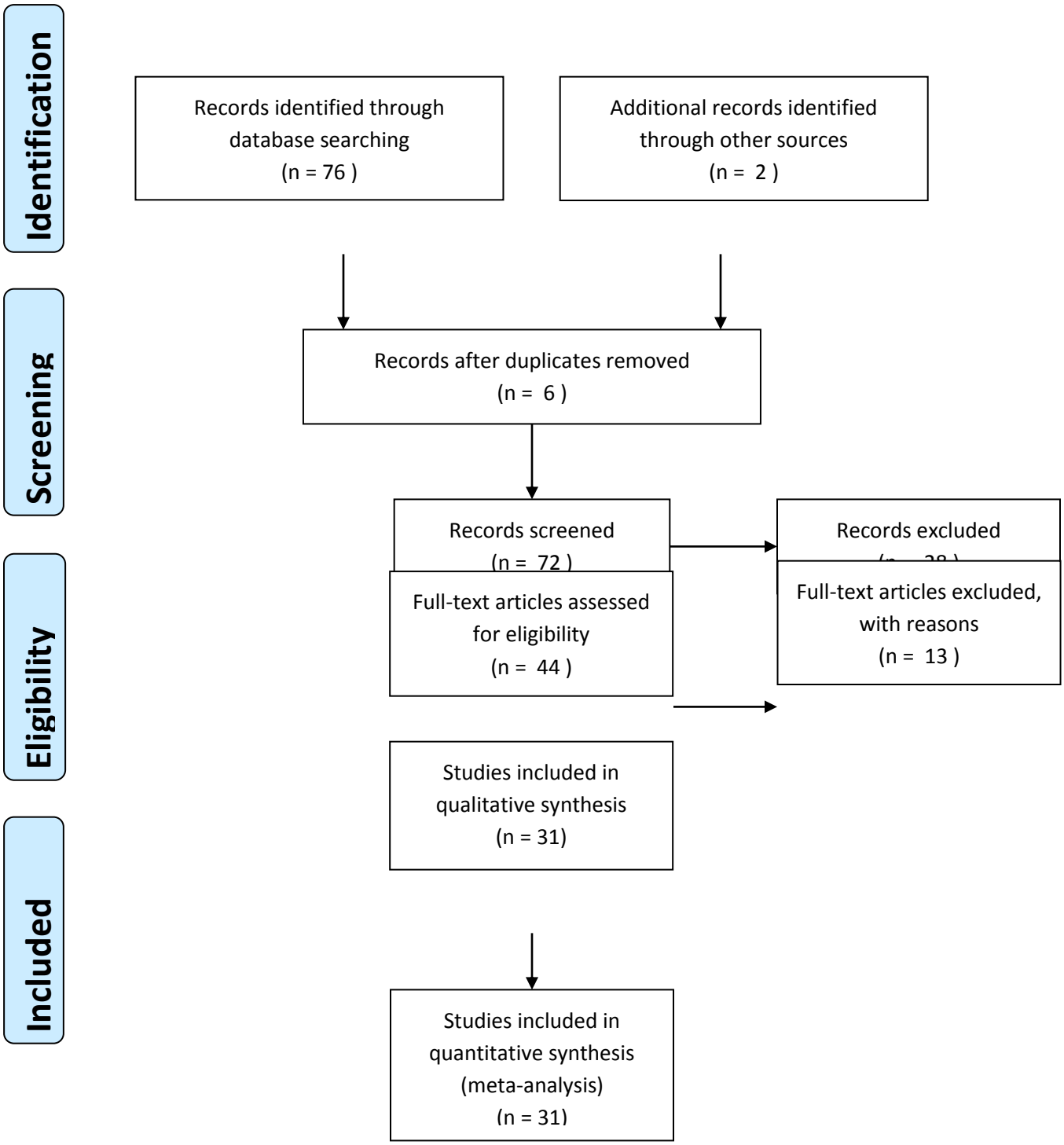

Figure 1: The review strategy of the review summarised according to PRISMA guidelines.[3]

2. Material and Methods

The review strategy is summarized according to PRISMA guidelines (Figure 1).[3] An Ovid MEDLINE literature search was conducted to identify relevant publications published between January 1966 to September 2017 using the search terms “tonsillectomy”, or “tonsil” and “wound healing" (search performed on 25th September 2017). 76 abstracts were found. The title and abstract of articles were assessed for their potential relevance i.e. an objective assessment of tonsillectomy wound healing; the full text of these were retrieved. The references of all publications identified as relevant were manually searched for further potentially relevant titles, resulting in two additional articles. Only articles in English were included (26 studies excluded)**.** Six abstracts were duplicate and excluded. The full texts of two articles were not available. The full text of the remaining 44 articles were retrieved and assessed. A further 13 studies were excluded because they were not relevant to the topic. Finally, 31 articles that objectively assessed tonsillectomy wound healing and were included for analysis in this review.

3. Results and analysis

The various animal and human models assessing wound healing post tonsillectomy are summarized in Table 1. Prior animal studies have primarily evaluated the effects of various surgical instruments such as lasers and electrosurgical devices on oral wound healing.[4] The assessment of tonsillar fossae healing has been described at macroscopic (direct examination)[5] or microscopic levels (punch biopsies).[5, 6] Experimental models in humans have primarily evaluated healing through either

Table 1: Summary of methods used to evaluate tonsillar fossa healing in different experimental models.

Author	Year	Experimental model	Number of subjects	Method of assessment
Kara et al[8]	2016	Human	50	Direct clinical examination (estimating area of epithelialization)
Sadikoglu et al[9]	2009	Human	110	
Stavroulaki et al[10]	2007	Human	32	
Noordzij et al[11]	2006	Human	48	
Temple et al[12]	2001	Human	38	
Sharp et al[13]	1991	Human	99	
Anderson et al[14]	1975	Human	165	
Freeman et al[15]	1992	Human	34	
Ozcan et al[16]	1998	Human	89	
Celebi et al[18]	2013	Human	122	Direct clinical examination (estimating area of slough as a surrogate marker for healing)
Tepe Karaca et al[19]	2013	Human	30	
Ragab et al[20]	2012	Human	300	
Mozet et al[21]	2012	Human	176	
Hahn et al[22]	2009	Human	105	
Akbas et al[23]	2004	Human	60	
Cook et al[24]	1992	Human	137	
Isaacson et al[34]	2012	Human	14	Clinical photographs (estimating area of epithelialization)
Park et al[7]	2015	Human	198	Endoscopic photographs (estimating area of epithelialization)
Mat Lazim et al[33]	2013	Human	63	
Vaiman et al[17]	2003	Human	179	Fibreoptic nasopharyngoscopic evaluation of tonsillar fossae (estimating area of epithelialization)
Kataura et al[5]	1975	Canine	28	Direct clinical examination AND

				histological examination (punch biopsies taken from tonsillar fossae)
Johnson et al[6]	2008	Canine	12	Histological examination (punch biopsies taken from tonsillar fossae)
Orlowski et al[28]	2016	Human	50	Visual analog scale (utilizing various features from clinical examination in a points system to provide a score for healing)
Hanci et al[26]	2015	Human	50	
Aydin et al[25]	2014	Human	40	
Aksoy et al[27]	2010	Human	50	
Magdy et al[31]	2008	Human	60	
Elwany et al[32]	2008	Human	60	
Windfuhr et al[29]	2010	Human	100	
Auf et al[30]	1997	Human	38	
Heywood et al[35]	2010	Human	5	Magnetic resonance imaging

subjective direct clinical examination of the tonsillar fossae,[7-32] serial photography of the area,[33, 34] or the use of magnetic resonance imaging (MRI).[35]

4. Discussion

4.1 Stages of healing

Healing of oral mucosal wounds post tonsillectomy is an area that has been poorly studied. At a macroscopic level, healing within the tonsillar fossae occurs via secondary intention. It involves keratinized squamous epithelium healing over a wound bed composed of muscle and also any remnant tonsillar lymphoid tissue in the case of partial tonsillectomy. This pattern of healing is thought to be similar to that in human skin, but occurs more rapidly and is less likely to scar.[4, 34] It is also similar to canine or porcine oral wound models.[34] The timeframe and processes that occur at these various stages can be sub-divided into the early, intermediate, and late phases of healing.

Most of the macroscopic evalaution of the post tonsil wound has been in humans while histological studies have relied on canine tonsil wounds or surrogate models in other species.[5, 6]

4.1.1 Early – Inflammatory stage (within 24-48hours)

Macroscopic

Soft tissue edema, Inflammatory exudate, uvula edema.

Microscopic

Soft tissue oedema involving the uvula, tonsillar pillars, and tongue occur within the first 24 hours.[34] This occurs as part of the inflammatory cascades triggered by the surgical removal of the tonsil (regardless of technique used), venous engorgement from compression of the tongue by the tonsillectomy gag, and mucosal damage from retractor edges.[36] Exposed nerve fibres and muscle fibre injury within the open pharyngeal wound may result in pain.[37] The inflammatory response which is compounded by the presence of commensal bacteria within the oral cavity causing a fibrinous clot containing inflammatory cells and bacteria to form in the tonsillar fossae.[6, 34, 36] Granulation tissue forms underlying this. The mucosa lining the tonsillar pillars begins to contract.[34]

4.1.2 Intermediate – Proliferative phase (Day 5-approximately Day 14)

Occurs until epithelialization has occurred across the whole wound

Macroscopic

By Day 5 white material fills the tonsil fossa that can be removed easily. It has previously been termed a “fibrinous clot” but it has not been proven to contain fibrin or contain hemostatic clot products.

By Day 7 the peripheral epithelial edges seem to be ingrowing with pink mucosa

By Day 9 the pink epithelial edges are covering larger areas. There is very little remnant of the white debris in the centre of the wound. As the pink, normal mucosa of the oral

cavity epithelializes over the wound area, it gradually replaces the areas containing white material.

By day 12 the pink mucosa almost completely covers the entire tonsil wound bed.

Microscopic

Angiogenesis within the tonsillar fossae commences from pre-existing vessels in the extracellular matrix, facilitating the formation of granulation tissue.[38] The granulation tissue further proliferates within the tonsillar fossae, often protruding beyond the pillars by day 5.[34, 36] Continued oropharyngeal epithelial ingrowth from the periphery and epithelial contracture results in separation of the fibrinous clot by day 7, exposing the underlying granulation tissue,[34, 36] often coinciding with a period of increased risk of secondary hemorrhage.[36]

4.1.3 Late – Remodelling phase (After approximately Day 14)

Occurs once epithelialization is complete.

Macroscopic

By Day 17 full epithelialization has occurred.

Continued ingrowth of advancing epithelium leads to coverage of most of the tonsillar fossa by day 12, commencing the simultaneous involution of the vascular stroma.[34] The tonsillar fossae appear to have a normal epithelial lining by approximately day 17 as a result of coverage by a thickened layer of epithelium.[34]

4.2 Models of assessment

Few animal and human experimental models for assessing oral wound healing exist. The vast majority of post-tonsillectomy complications such as pain, reduced oral intake, and secondary hemorrhage occur during the various phases of healing. Measures to minimize the occurrence and severity of these complications may rely in part on a clinician's ability to adequately assess wound healing. We discuss a summary of findings within the literature surrounding the various methods employed in assessing wound healing post tonsillectomy.

4.2.1 Human models

Experimental models in humans that have investigated wound healing in tonsillectomy almost exclusively evaluate the macroscopic appearance of the tonsillar fossae. This review did not identify any studies which have examined actual wound site at a histological level. Because of the lack of histological evidence, most of the understanding of human tonsillar wound healing is based on the macroscopic appearance.

Estimation of healed area

The vast majority of studies aim to gauge the area of epithelialisation within the healing tonsillar fossae as a marker for wound healing. The most common approach described in the literature is to estimate epithelialisation by direct clinical examination of the oral cavity,[8-16] or fibreoptic nasopharyngoscopic evaluation of the tonsillar fossae by a clinician.[17] Other studies have utilized clinical photography to estimate the area of healing by obtaining either macroscopic,[34] or endoscopic photographs.[7, 33]

Size/thickness of "slough"

The thickness of the presumed fibrinous clot or amount of wound exudate present within the healing tonsillar fossae has also often been cited as a surrogate marker for tonsillectomy wound healing. Most of these studies utilize either a 4-point,[21] or 5-point grading system (i.e. full slough = 0% healing ranging to no slough = 100% healing).[18, 20] Other studies utilized the interpretation made by a single clinician's examination finding on designated post-operative days of follow-up (e.g. appointment at day 7 post tonsillectomy).[22, 24] One study used the absolute size of the slough present as an arbitrary indicator of the rate of healing.[19] Another study simply used the absolute presence or absence of slough as a marker of healing.[23]

Visual analog scales

Visual analog scales (VAS) were frequently utilized by authors to assess wound healing. The most commonly used method was described by Magdy et al.[26, 27, 31, 32] The degree of mucosal erythema, edema, fossa whitening and wound healing (utilizing size of slough as a surrogate marker for this), was graded as being either absent, present or severe (scores of 0, 1 or 2, respectively).[31] The wound healing scores were then recorded at each post-operative follow-up appointment. Other studies have used similar scales by employing various permutations of clinical examination findings, such as the amount of tonsillar slough, degree mucosal edema, and the amount of epithelial regrowth, in their VAS.[28, 30] The authors of one study assessed wound healing through the use of VAS by having a single examining clinician compare the degree of granulation and epithelialisation within the tonsillar fossae at various days of post-

operative follow-up.[25] Yet another study simply compared the percentage of “redness” and “whiteness” within the tonsillar fossa as a marker of wound healing.[29]

Magnetic resonance imaging

MRI has also been used to perform peri-operative assessments in an attempt to characterize the appearance of inflammatory lesions produced by bipolar radiofrequency volumetric tissue reduction within the tongue base, soft palate and via tonsillectomy.[35] The authors were able to demonstrate sequential changes in the appearance (size and signal intensity) of the inflammatory lesions on follow-up MRI.[35]

4.2.2 Animal models

Experimental models in animals have mainly explored the impact of different surgical instruments on wound healing in the oral cavity.[4] Similarly to human models, assessment of wound healing after a tonsillectomy has previously occurred through direct examination of the tonsillar fossa. Experimental animal models have, however, also been able to evaluate wound healing tonsillar fossae at a microscopic level through the performance of punch biopsies at various post-operative days.[5, 6] In an attempt to provide an objective means to evaluate epithelial wound healing, the authors of one study proposed a novel 5-point histological mucosal wound healing grading scale by passing scores of 0 (healed), 1, or 2 (inflamed) for histological features such as inflammatory surface crust, vessel wall necrosis, intact surface epithelium, neutrophilic infiltrate, and myofibroblast proliferation observed from the biopsy specimens.[6]

4.3 Factors affecting wound healing

Wound healing after tonsillectomy is an area that has been poorly reported. When evaluated in studies, it is often an outcome that is secondarily assessed to other outcomes such as pain and secondary hemorrhage following tonsillectomy. Furthermore, the absence of a standard method of evaluating wound healing after tonsillectomy leads to variable reporting the outcome within the literature.

4.3.1 Technical factors

Operative technique

A summary of the statistically significant findings from studies evaluating for differences in wound healing with varying tonsillectomy techniques is described in Table 2. Several studies have suggested that patients who underwent cold dissection tonsillectomy experience reduced tonsillar fossa healing time. They have proposed that electrocautery methods produce high temperatures which cause more damage to adjacent soft tissue, prolonging healing time. An experimental canine model has suggested that microdebrider intracapsular tonsillectomy produced quicker healing than electrocautery.[6] At a microscopic level, they found that this technique resulted in higher rates of surface crust absence (post-operative day 3 and 9), higher rates of intact surface epithelium (post-operative day 3, 9 and 20), absence of vessel wall necrosis, along wih slightly lower levels of neutrophilic infiltrate and myofibroblast proliferation (post-operative 3 and 9).[6] They proposed that the spared tonsillar capsule acts as a “biologic dressing” which allows for improved healing.[6] Other experimental animal models which evaluated the impact of various surgical techniques on oral wound

Table 2: Findings from studies investigating the impact of surgical technique on wound healing in tonsillectomy.

Author	Design	Patients	Techniques compared	Outcome
Ragab et al[20]	Prospective randomized controlled trial (double-blind)	300	Ultrasonic scalpel Bipolar electrocautery Bipolar radiofrequency Cold dissection	Bipolar electrocautery group showed significantly reduced tonsillar fossa healing during the first and second post-operative weeks than all other techniques ($p < 0.01$).
Sadikoglu et al[9]	Prospective randomized controlled trial (single-blind)	110	Plasma knife Bipolar electrocautery Cold dissection	Shorter post-operative healing time in Cold dissection technique group than Plasmaknife technique and Bipolar electrocautery ($p < 0.05$).
Magdy et al[31]	Prospective randomized controlled trial (double-blind)	60	Coblation Cold dissection Monopolar electrocautery CO_2 laser	Significantly slower healing in Monopolar electrocautery produced than Coblation after 7 postoperative days ($p = 0.004$), with no significant difference after 15 postoperative days.
Stavroulaki et al[10]	Prospective randomized controlled trial (single-blind)	32	Thermal welding Cold dissection	No statistically significant difference in healing between groups ($p = 0.226$).
Noordzij et	Prospective	48	Coblation	No statistically significant

al[11]	randomized controlled trial (single-blind)		Monopolar electrocautery	difference in healing between groups (*p* = “not significant”).
Temple et al[12]	Prospective randomized controlled trial (double-blind)	38	Coblation Bipolar electrocautery	More rapid healing of the tonsillar fossae was found in the Coblation group (*p* value not specified).
Auf et al[30]	Prospective randomized controlled trial (double-blind)	38	KTP-laser Cold dissection	Slower wound healing and increased slough and in KTP-laser group at day 14 (*p* < 0.01).

healing have suggested that cold steel dissection minimises tissue damage to surrounding structures, allowing for quicker healing.[39] Conversely, experimental animal models have shown that the use of electrocautery and laser techniques within the oral cavity causes more damage to collateral structures, and hence delay tissue healing.[40]

Haemostasis

One study which compared three methods (gauze packing, bipolar electrocautery, or local anesthetic infiltration) of intraoperative hemostasis during cold dissection tonsillectomy found that tonsillar bed healing was delayed in the diathermy group (p = 0.04).[22] Another study comparing two different types of tonsillar fossa packing (gauze swab or alginate swab) to achieve intraoperative hemostasis found no difference in the rate of post-operative healing.[13] FloSeal® (Baxter, Deerfield, IL, USA) is a hemostatic agent containing human-derived thrombin. When in contact with a bleeding site, it forms a stable clot by converting fibrinogen into a fibrin plug. In a study comparing the effect of two means of intraoperative hemostasis (bipolar electrocautery or topical administration of FloSeal), patients in the FloSeal group showed significantly quicker wound healing throughout the post-operative observation period (p < 0.013 on days 1-5, 10 and 20).[21] Another study comparing the effect of topically applied (spray method) fibrin glue (hemostatic and bacteriostatic agent) to electrocautery (bipolar or monopolar) on tonsillectomy wound healing.[17] While the authors of the study reported that patients in the fibrin glue group experienced quicker healing, no statistical evidence was provided to corroborate this finding.[17]

4.3.2 Co-morbidities

Untreated laryngopharyngeal reflux has been previously shown to significantly slow wound healing after tonsillectomy (p = 0.016 at day 7, and p = 0.029 at day 14).[32] The authors suggested that the proteolytic effect of contents within gastric reflux which has previously been shown to cause significant damage to mucosal epithelium in other sites such as the esophagus could similarly slow healing by damaging the vulnerable healing tissue within the tonsillar fossa.[32, 41]

4.3.3 Adjunctive treatment

Autologous serum

Patients who had autologous serum (intra-operatively, and then at 8 and 24 hours) topically administered to a single tonsillar fossa experienced accelerated epithelialisation within the same tonsillar fossa compared to the contralateral side (p = 0.008 on day 5, and p = 0.002 on day 10).[8] The authors proposed that the presence of epitheliotropic factors within the autologous serum facilitated more rapid healing on the ipsilateral side.[8] They also suggested the topical administration of autologous serum conferred a local bacteriostatic response due to the presence of antimicrobial substances such as immunoglobulin G and lysozyme.[8]

Antibiotics

Only two studies have objectively assessed the impact of antibiotic administration on tonsillectomy wound healing.[23, 28] Patients who were administered prophylactic oral

cefuroxime experienced slower healing by having thicker slough (p = 0.037 on day 3) and more mucosal swelling (p = 0.030 on day 3, and p = 0.036 on day 7).[28] The authors of that study suggested that this may have been a reflection of the patients not receiving antibiotics also experiencing less post-operative pain and swallow dysfunction, and thus quicker healing.[28] In another study where authors investigated the effect of fusafungine (an antibiotic with an anti-inflammatory agent) in a spray formulation on tonsillectomy wound healing, patients who were administered the spray experienced a quicker healing process when assessed postoperatively (p = 0.031 on day 10, and p = 0.001 on day 14).[23]

Sucralfate

Sucralfate is a cytoprotective agent which works by forming a “barrier” over wounds.[42] It is effective in treating skin ulcers, burns, and disease processes resulting in mucosal damage (such as gastritis and peptic ulcer disease).[42] Two prior studies assessed the impact of topical sucralfate on tonsillectomy wound healing.[15, 16] Patients were administered the medication in the form of a gargle and were instructed to swallow it. When compared to placebo, neither study found it to be beneficial in tonsillectomy wound healing.[15, 16]

Hyaluronic acid

Hyaluronic acid is a glycosaminoglycan which is found in the various parts of the human body (e.g. extracellular matrix of skin).[26] It is a growth factor which is naturally secreted during the process of wound healing.[26] Patients in one study who had 1mL of PureRegen Gel Sinus® (hyaluronic acid gel by BioRegen Biomedical Co. Ltd, Hamburg,

Germany) topically applied intra-operatively to a single tonsillar fossa experienced quicker healing compared to the contralateral side ($p < 0.001$ at day 14).[26]

Dexpanthenol

Dexpanthenol is an alcoholic analog which has moisturizing properties.[18] Patients in one study who received dexpanthenol pastilles post-operatively experienced less pain and quicker wound healing on every single day they were assessed ($p < 0.05$ on days 1, 3, 7 and 14).[18]

Tualang Honey

It has been shown that honey stimulates monocytes to release mediators which are involved in the regulation of the inflammatory cascade and healing.[43] These mediators may promote the formation of granulation tissue in wounds.[33] Patients in one study who received Tualung honey (Federal Agriculture Marketing Authority, Malaysia) intra-operatively (2-3mL administered topically to tonsillar fossae) and post-operatively (4mL consumed orally thrice-daily for seven days) experienced significantly quicker wound healing on every single day they were assessed ($p < 0.001$ on days 1, 3, 7 and 14).[33]

Prednisolone

Two previous studies have objectively evaluated the impact of prednisolone on tonsillectomy wound healing. The intra-operative injection of prednisolone (20mg) into the base of both tonsillar fossae did not produce any substantial difference in the wound healing of patients in that study.[14] In a different study, both adult and pediatric patients

who were administered a seven-day course of oral prednisolone (0.25mg/kg once daily) experienced quicker re-epithelialisation of their tonsillar fossae ($p < 0.001$ on day 7 and 14).[7]

4.3.4 Dietary modification

A single study which objectively evaluated the impact of three different post-tonsillectomy diets ("rough foods", "soft foods", and "no specific advice") on wound healing found no statistically significant effect of diet on wound healing.

4.4 Limitations

As this is a review of the literature, we are limited by the past research in this area. Due to the lack of human research in this area, assumptions are made that mammalian wound healing is similar in animal models.

5. Conclusion

Wound healing post tonsillectomy is an area which has been poorly researched and reported. Having a better understanding of the process of wound healing potentially prevent, anticipate, and manage complications from the surgery which arise as part of the healing process. Most of the current experimental models in humans investigating tonsillectomy wound healing involve serial direct clinical examinations to estimate the epithelialising area. There is a lack of validated assessment methods of tonsillar wound healing as well as human histological research. Different patient and surgical factors have been shown to affect wound healing. The pre-operative management of pre-

existing laryngopharyngeal reflux and the intra-operative use gauze packing to achieve haemostasis (instead of bipolar electrocautery) both offer cost-effect means of improving wound healing post-operatively. While there is some research to suggest there is a role for use various adjunctive treatment options such as FloSeal, Fibrin glue, and autologous serum intraoperatively, along with the administration of oral prednisolone in the post-operative period, they are more expensive and come with potential side-effects. Further research needs to be conducted to ascertain if they are truly efficacious in improving wound healing post tonsillectomy.

Conflicts of interest and source of funding

Peter Luke Santa Maria is a listed inventor on a patent, currently owned by Stanford University for a treatment for post-tonsillectomy wound healing (US 2015/056651).

The Garnett Passe and Rodney Williams Memorial Foundation.

Acknowledgements

Nil.

References

1 Cullen KA, Hall MJ, Golosinskiy A. Ambulatory surgery in the United States, 2006. *Natl Health Stat Report* 20091-25
2 Curtis JL, Harvey DB, Willie S, Narasimhan E, Andrews S, Henrichsen J, et al. Causes and costs for ED visits after pediatric adenotonsillectomy. *Otolaryngol Head Neck Surg* 2015;**152:**691-6
3 Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *J Clin Epidemiol* 2009;**62:**1006-12
4 Isaacson G. Pediatric tonsillectomy: an evidence-based approach. *Otolaryngol Clin North Am* 2014;**47:**673-90
5 Kataura A, Doi Y, Narimatsu E. Histological research concerning cryotonsillectomy in dogs. *Arch Otorhinolaryngol* 1975;**209:**33-45
6 Johnson K, Vaughan A, Derkay C, Welch JC, Werner A, Kuhn MA, et al. Microdebrider vs electrocautery: a comparison of tonsillar wound healing histopathology in a canine model. *Otolaryngol Head Neck Surg* 2008;**138:**486-91
7 Park SK, Kim J, Kim JM, Yeon JY, Shim WS, Lee DW. Effects of oral prednisolone on recovery after tonsillectomy. *Laryngoscope* 2015;**125:**111-7
8 Kara M, Erdogan H, Altinisik HB, Aylanc H, Guclu O, Derekoy FS. Does topical use of autologous serum help to reduce post-tonsillectomy morbidity? A prospective, controlled preliminary study. *J Laryngol Otol* 2016;**130:**662-8
9 Sadikoglu F, Kurtaran H, Ark N, Ugur KS, Yilmaz T, Gozdemir M, et al. Comparing the effectiveness of "plasma knife" tonsillectomy with two well-established tonsillectomy techniques: cold dissection and bipolar electrocautery. A prospective randomized study. *Int J Pediatr Otorhinolaryngol* 2009;**73:**1195-8
10 Stavroulaki P, Skoulakis C, Theos E, Kokalis N, Valagianis D. Thermal welding versus cold dissection tonsillectomy: a prospective, randomized, single-blind study in adult patients. *Ann Otol Rhinol Laryngol* 2007;**116:**565-70
11 Noordzij JP, Affleck BD. Coblation versus unipolar electrocautery tonsillectomy: a prospective, randomized, single-blind study in adult patients. *Laryngoscope* 2006;**116:**1303-9
12 Temple RH, Timms MS. Paediatric coblation tonsillectomy. *Int J Pediatr Otorhinolaryngol* 2001;**61:**195-8
13 Sharp JF, Rogers MJ, Riad M, Kerr AI. Combined study to assess the role of calcium alginate swabs and ligation of the inferior tonsillar pole in the control of intra-operative blood loss during tonsillectomy. *J Laryngol Otol* 1991;**105:**191-4
14 Anderson HA, Rice BJ, Cantrell RW. Effects of injected deposteroid on posttonsillectomy morbidity: a double-blind study. *Arch Otolaryngol* 1975;**101:**86-8
15 Freeman SB, Markwell JK. Sucralfate in alleviating post-tonsillectomy pain. *Laryngoscope* 1992;**102:**1242-6
16 Ozcan M, Altuntas A, Unal A, Nalca Y, Aslan A. Sucralfate for posttonsillectomy analgesia. *Otolaryngol Head Neck Surg* 1998;**119:**700-4
17 Vaiman M, Eviatar E, Shlamkovich N, Segal S. Effect of modern fibrin glue on bleeding after tonsillectomy and adenoidectomy. *Ann Otol Rhinol Laryngol* 2003;**112:**410-4
18 Celebi S, Tepe C, Yelken K, Celik O. Efficacy of dexpanthenol for pediatric post-tonsillectomy pain and wound healing. *Ann Otol Rhinol Laryngol* 2013;**122:**464-7
19 Tepe Karaca C, Celebi S, Oysu C, Celik O. Does cooling the tonsillar fossae during thermal welding tonsillectomy have an effect on postoperative pain and healing? *Eur Arch Otorhinolaryngol* 2013;**270:**363-6

20 Ragab SM. Six years of evidence-based adult dissection tonsillectomy with ultrasonic scalpel, bipolar electrocautery, bipolar radiofrequency or 'cold steel' dissection. *J Laryngol Otol* 2012;**126:**1056-62
21 Mozet C, Prettin C, Dietze M, Fickweiler U, Dietz A. Use of Floseal and effects on wound healing and pain in adults undergoing tonsillectomy: randomised comparison versus electrocautery. *Eur Arch Otorhinolaryngol* 2012;**269:**2247-54
22 Hahn CH, Rungby JA, Overgaard T, Moller H, Schultz P, Tos M. Effect of diathermy on pain and healing in tonsillectomy, compared with other methods of haemostasis: a randomised study. *J Laryngol Otol* 2009;**123:**648-55
23 Akbas Y, Pata YS, Unal M, Gorur K, Micozkadioglu D. The effect of fusafungine on post-operative pain and wound healing after pediatric tonsillectomy. *Int J Pediatr Otorhinolaryngol* 2004;**68:**1023-6
24 Cook JA, Murrant NJ, Evans KL, Lavelle RJ. A randomized comparison of three post-tonsillectomy diets. *Clin Otolaryngol Allied Sci* 1992;**17:**28-31
25 Aydin S, Taskin U, Altas B, Erdil M, Senturk T, Celebi S, et al. Post-tonsillectomy morbidities: randomised, prospective controlled clinical trial of cold dissection versus thermal welding tonsillectomy. *J Laryngol Otol* 2014;**128:**163-5
26 Hanci D, Altun H. Effectiveness of hyaluronic acid in post-tonsillectomy pain relief and wound healing: a prospective, double-blind, controlled clinical study. *Int J Pediatr Otorhinolaryngol* 2015;**79:**1388-92
27 Aksoy F, Ozturan O, Veyseller B, Yildirim YS, Demirhan H. Comparison of radiofrequency and monopolar electrocautery tonsillectomy. *J Laryngol Otol* 2010;**124:**180-4
28 Orlowski K, Lisowska G, Misiolek H, Paluch Z, Misiolek M. The Efficacy of Perioperative Antibiotic Therapy in Tonsillectomy Patients. *Advances in clinical and experimental medicine : official organ Wroclaw Medical University* 2016;**25:**493-503
29 Windfuhr JP, Sack F, Sesterhenn AM, Landis BN, Chen YS. Post-tonsillectomy taste disorders. *Eur Arch Otorhinolaryngol* 2010;**267:**289-93
30 Auf I, Osborne JE, Sparkes C, Khalil H. Is the KTP laser effective in tonsillectomy? *Clin Otolaryngol Allied Sci* 1997;**22:**145-6
31 Magdy EA, Elwany S, el-Daly AS, Abdel-Hadi M, Morshedy MA. Coblation tonsillectomy: a prospective, double-blind, randomised, clinical and histopathological comparison with dissection-ligation, monopolar electrocautery and laser tonsillectomies. *J Laryngol Otol* 2008;**122:**282-90
32 Elwany S, Nour YA, Magdy EA. Does laryngopharyngeal reflux affect healing and recovery after tonsillectomy? *J Laryngol Otol* 2008;**122:**603-8
33 Mat Lazim N, Abdullah B, Salim R. The effect of Tualang honey in enhancing post tonsillectomy healing process. An open labelled prospective clinical trial. *Int J Pediatr Otorhinolaryngol* 2013;**77:**457-61
34 Isaacson G. Tonsillectomy healing. *Ann Otol Rhinol Laryngol* 2012;**121:**645-9
35 Heywood RL, Khalil HM, Kothari S, Chawda S, Kotecha BT. Radiological airway changes following bipolar radiofrequency volumetric tissue reduction. *J Laryngol Otol* 2010;**124:**1078-84
36 Isaacson G. Tonsillectomy care for the pediatrician. *Pediatrics* 2012;**130:**324-34
37 Cohen N, Sommer DD. Post-tonsillectomy pain control: consensus or controversy? *Pain Manag* 2016;**6:**31-7
38 Couto EV, Ballin CR, Sampaio CP, Maeda CA, Ballin CH, Dassi CS, et al. Experimental study on the effects of bismuth subgallate on the inflammatory process and angiogenesis of the oral mucosa. *Braz J Otorhinolaryngol* 2016;**82:**17-25
39 Sinha UK, Gallagher LA. Effects of steel scalpel, ultrasonic scalpel, CO2 laser, and monopolar and bipolar electrosurgery on wound healing in guinea pig oral mucosa. *Laryngoscope* 2003;**113:**228-36
40 Liboon J, Funkhouser W, Terris DJ. A comparison of mucosal incisions made by scalpel, CO2 laser, electrocautery, and constant-voltage electrocautery. *Otolaryngol Head Neck Surg* 1997;**116:**379-85
41 Tobey NA, Hosseini SS, Caymaz-Bor C, Wyatt HR, Orlando GS, Orlando RC. The role of pepsin in acid injury to esophageal epithelium. *The American journal of gastroenterology* 2001;**96:**3062-70

42 Siupsinskiene N, Zekoniene J, Padervinskis E, Zekonis G, Vaitkus S. Efficacy of sucralfate for the treatment of post-tonsillectomy symptoms. *Eur Arch Otorhinolaryngol* 2015;**272:**271-8
43 Tonks A, Cooper RA, Price AJ, Molan PC, Jones KP. Stimulation of TNF-alpha release in monocytes by honey. *Cytokine* 2001;**14:**240-2

Summary

- Wound healing post tonsillectomy is an area which has been poorly researched
- Current experimental models in humans investigating tonsillectomy wound healing involve serial direct clinical examinations of the tonsillar fossae
- Various patient and surgical factors have been shown to affect wound healing
- There may be a role for the use of adjunctive treatment options in the post-operative period to improve wound healing