Wound healing after tonsillectomy – A Review of the Literature

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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.
Records identified through database searching (n = 76)

Additional records identified through other sources (n = 2)

Records after duplicates removed (n = 6)

Records screened (n = 72)

Studies included in qualitative synthesis (n = 31)

Studies included in quantitative synthesis (meta-analysis) (n = 31)

Full-text articles assessed for eligibility (n = 44)

Records excluded (n = 28)

Full-text articles excluded, with reasons (n = 13)

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). 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. The assessment of tonsillar fossae healing has been described at macroscopic (direct examination) or microscopic levels (punch biopsies). 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.

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Experimental model</th>
<th>Number of subjects</th>
<th>Method of assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kara et al[8]</td>
<td>2016</td>
<td>Human</td>
<td>50</td>
<td>Direct clinical examination (estimating area of epithelialization)</td>
</tr>
<tr>
<td>Sadikoglu et al[9]</td>
<td>2009</td>
<td>Human</td>
<td>110</td>
<td>Direct clinical examination (estimating area of epithelialization)</td>
</tr>
<tr>
<td>Stavroulaki et al[10]</td>
<td>2007</td>
<td>Human</td>
<td>32</td>
<td>Direct clinical examination (estimating area of epithelialization)</td>
</tr>
<tr>
<td>Temple et al[12]</td>
<td>2001</td>
<td>Human</td>
<td>38</td>
<td>Direct clinical examination (estimating area of epithelialization)</td>
</tr>
<tr>
<td>Anderson et al[14]</td>
<td>1975</td>
<td>Human</td>
<td>165</td>
<td>Direct clinical examination (estimating area of epithelialization)</td>
</tr>
<tr>
<td>Ozcan et al[16]</td>
<td>1998</td>
<td>Human</td>
<td>89</td>
<td>Direct clinical examination (estimating area of epithelialization)</td>
</tr>
<tr>
<td>Celebi et al[18]</td>
<td>2013</td>
<td>Human</td>
<td>122</td>
<td>Direct clinical examination (estimating area of epithelialization)</td>
</tr>
<tr>
<td>Tepe Karaca et al[19]</td>
<td>2013</td>
<td>Human</td>
<td>30</td>
<td>Direct clinical examination (estimating area of epithelialization)</td>
</tr>
<tr>
<td>Ragab et al[20]</td>
<td>2012</td>
<td>Human</td>
<td>300</td>
<td>Direct clinical examination (estimating area of epithelialization)</td>
</tr>
<tr>
<td>Mozet et al[21]</td>
<td>2012</td>
<td>Human</td>
<td>176</td>
<td>Direct clinical examination (estimating area of epithelialization)</td>
</tr>
<tr>
<td>Hahn et al[22]</td>
<td>2009</td>
<td>Human</td>
<td>105</td>
<td>Direct clinical examination (estimating area of epithelialization)</td>
</tr>
<tr>
<td>Akbas et al[23]</td>
<td>2004</td>
<td>Human</td>
<td>60</td>
<td>Direct clinical examination (estimating area of epithelialization)</td>
</tr>
<tr>
<td>Cook et al[24]</td>
<td>1992</td>
<td>Human</td>
<td>137</td>
<td>Direct clinical examination (estimating area of epithelialization)</td>
</tr>
<tr>
<td>Isaacson et al[34]</td>
<td>2012</td>
<td>Human</td>
<td>14</td>
<td>Direct clinical examination (estimating area of epithelialization)</td>
</tr>
<tr>
<td>Park et al[7]</td>
<td>2015</td>
<td>Human</td>
<td>198</td>
<td>Direct clinical examination (estimating area of epithelialization)</td>
</tr>
<tr>
<td>Mat Lazim et al[33]</td>
<td>2013</td>
<td>Human</td>
<td>63</td>
<td>Direct clinical examination (estimating area of epithelialization)</td>
</tr>
<tr>
<td>Vaiman et al[17]</td>
<td>2003</td>
<td>Human</td>
<td>179</td>
<td>Direct clinical examination (estimating area of epithelialization)</td>
</tr>
<tr>
<td>Kataura et al[18]</td>
<td>1975</td>
<td>Canine</td>
<td>28</td>
<td>Direct clinical examination AND Fibreoptic nasopharyngoscopic evaluation of tonsillar fossae (estimating area of epithelialization)</td>
</tr>
</tbody>
</table>

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6
<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>Species</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johnson et al</td>
<td>2008</td>
<td>Canine</td>
<td>Histological examination (punch biopsies taken from tonsillar fossae)</td>
</tr>
<tr>
<td>Orlowski et al</td>
<td>2016</td>
<td>Human</td>
<td>Histological examination (punch biopsies taken from tonsillar fossae)</td>
</tr>
<tr>
<td>Hanci et al</td>
<td>2015</td>
<td>Human</td>
<td>Visual analog scale (utilizing various features from clinical examination in a points system to provide a score for healing)</td>
</tr>
<tr>
<td>Aydin et al</td>
<td>2014</td>
<td>Human</td>
<td>Visual analog scale (utilizing various features from clinical examination in a points system to provide a score for healing)</td>
</tr>
<tr>
<td>Aksoy et al</td>
<td>2010</td>
<td>Human</td>
<td>Visual analog scale (utilizing various features from clinical examination in a points system to provide a score for healing)</td>
</tr>
<tr>
<td>Magdy et al</td>
<td>2008</td>
<td>Human</td>
<td>Visual analog scale (utilizing various features from clinical examination in a points system to provide a score for healing)</td>
</tr>
<tr>
<td>Elwany et al</td>
<td>2008</td>
<td>Human</td>
<td>Visual analog scale (utilizing various features from clinical examination in a points system to provide a score for healing)</td>
</tr>
<tr>
<td>Windfuhr et al</td>
<td>2010</td>
<td>Human</td>
<td>Magnetic resonance imaging</td>
</tr>
<tr>
<td>Auf et al</td>
<td>1997</td>
<td>Human</td>
<td>Magnetic resonance imaging</td>
</tr>
<tr>
<td>Heywood et al</td>
<td>2010</td>
<td>Human</td>
<td>Magnetic resonance imaging</td>
</tr>
</tbody>
</table>
subjective direct clinical examination of the tonsillar fossae, serial photography of the area, or the use of magnetic resonance imaging (MRI).

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. It is also similar to canine or porcine oral wound models. 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 evaluation of the post tonsil wound has been in humans while histological studies have relied on canine tonsil wounds or surrogate models in other species.

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

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.\textsuperscript{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.\textsuperscript{36} Exposed nerve fibres and muscle fibre injury within the open pharyngeal wound may result in pain.\textsuperscript{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.\textsuperscript{6, 34, 36} Granulation tissue forms underlying this. The mucosa lining the tonsillar pillars begins to contract.\textsuperscript{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. The granulation tissue further proliferates within the tonsillar fossae, often protruding beyond the pillars by day 5. 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, often coinciding with a period of increased risk of secondary hemorrhage.

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. 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.
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,\textsuperscript{21} or 5-point grading system (i.e. full slough = 0% healing ranging to no slough = 100% healing).\textsuperscript{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).\textsuperscript{22,24} One study used the absolute size of the slough present as an arbitrary indicator of the rate of healing.\textsuperscript{19} Another study simply used the absolute presence or absence of slough as a marker of healing.\textsuperscript{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.\textsuperscript{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).\textsuperscript{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.\textsuperscript{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. 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 with slightly lower levels of neutrophilic infiltrate and myofibroblast proliferation (post-operative 3 and 9). They proposed that the spared tonsillar capsule acts as a “biologic dressing” which allows for improved healing. 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.

<table>
<thead>
<tr>
<th>Author</th>
<th>Design</th>
<th>Patients</th>
<th>Techniques compared</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ragab et al[20]</td>
<td>Prospective randomized controlled trial (double-blind)</td>
<td>300</td>
<td>Ultrasonic scalpel, Bipolar electrocautery, Bipolar radiofrequency, Cold dissection</td>
<td>Bipolar electrocautery group showed significantly reduced tonsillar fossa healing during the first and second post-operative weeks than all other techniques ($p &lt; 0.01$).</td>
</tr>
<tr>
<td>Sadikoglu et al[9]</td>
<td>Prospective randomized controlled trial (single-blind)</td>
<td>110</td>
<td>Plasma knife, Bipolar electrocautery, Cold dissection</td>
<td>Shorter post-operative healing time in Cold dissection technique group than Plasmaknife technique and Bipolar electrocautery ($p &lt; 0.05$).</td>
</tr>
<tr>
<td>Magdy et al[31]</td>
<td>Prospective randomized controlled trial (double-blind)</td>
<td>60</td>
<td>Coblation, Cold dissection, Monopolar electrocautery, CO2 laser</td>
<td>Significantly slower healing in Monopolar electrocautery produced than Coblation after 7 postoperative days ($p = 0.004$), with no significant difference after 15 postoperative days.</td>
</tr>
<tr>
<td>Stavroulaki et al[10]</td>
<td>Prospective randomized controlled trial (single-blind)</td>
<td>32</td>
<td>Thermal welding, Cold dissection</td>
<td>No statistically significant difference in healing between groups ($p = 0.226$).</td>
</tr>
<tr>
<td>Noordzij et</td>
<td>Prospective</td>
<td>48</td>
<td>Coblation</td>
<td>No statistically significant</td>
</tr>
<tr>
<td>Author(s)</td>
<td>Study Design</td>
<td>Study Group 1</td>
<td>Study Group 2</td>
<td>Conclusion</td>
</tr>
<tr>
<td>-----------</td>
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<td>---------------</td>
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<td>------------</td>
</tr>
<tr>
<td>Temple et al&lt;sup&gt;12&lt;/sup&gt;</td>
<td>Prospective randomized controlled trial (double-blind)</td>
<td>38</td>
<td>Coblation</td>
<td>More rapid healing of the tonsillar fossae was found in the Coblation group (p value not specified).</td>
</tr>
<tr>
<td>Auf et al&lt;sup&gt;30&lt;/sup&gt;</td>
<td>Prospective randomized controlled trial (double-blind)</td>
<td>38</td>
<td>KTP-laser</td>
<td>Slower wound healing and increased slough and in KTP-laser group at day 14 (p &lt; 0.01).</td>
</tr>
</tbody>
</table>
healing have suggested that cold steel dissection minimises tissue damage to surrounding structures, allowing for quicker healing.\textsuperscript{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.\textsuperscript{40}

\textit{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 ($p = 0.04$).\textsuperscript{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.\textsuperscript{13} FloSeal\textregistered{} (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).\textsuperscript{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.\textsuperscript{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.\textsuperscript{17}
4.3.2 Co-morbidities

Untreated laryngopharyngeal reflux has been previously shown to significantly slow wound healing after tonsillectomy \((p = 0.016\text{ at day 7, and } p = 0.029\text{ at day 14})\). 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 \((p = 0.008\text{ on day 5, and } p = 0.002\text{ on day 10})\).\(^8\) 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). 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. 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).

**Sucralfate**

Sucralfate is a cytoprotective agent which works by forming a “barrier” over wounds. It is effective in treating skin ulcers, burns, and disease processes resulting in mucosal damage (such as gastritis and peptic ulcer disease). Two prior studies assessed the impact of topical sucralfate on tonsillectomy wound healing. 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.

**Hyaluronic acid**

Hyaluronic acid is a glycosaminoglycan which is found in the various parts of the human body (e.g. extracellular matrix of skin). It is a growth factor which is naturally secreted during the process of wound healing. 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).\textsuperscript{26}

*Dexpanthenol*

Dexpanthenol is an alcoholic analog which has moisturizing properties.\textsuperscript{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).\textsuperscript{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.\textsuperscript{43} These mediators may promote the formation of granulation tissue in wounds.\textsuperscript{33} Patients in one study who received Tualang 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).\textsuperscript{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.\textsuperscript{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).\textsuperscript{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).

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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