

## The evolution of tonsil surgery and rethinking the surgical approach to obstructive sleep-disordered breathing in children

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### Abstract

Within the last 10 to 15 years, a significant amount of research in tonsil surgery has focused on reduction of post-operative pain and recovery time. In order to minimize or avoid morbidity, a number of otolaryngologists in the United States and Europe have revived a historical procedure, previously known as ‘tonsillotomy’, specifically for those patients with obstructive sleep-disordered breathing (OSDB) due to adenotonsillar hypertrophy. More recently, surgeons have used terms such as partial tonsillectomy, partial intracapsular tonsillectomy or subtotal tonsillectomy to describe their procedure and have employed a variety of modern instrumentation. This return to a ‘partial’ procedure has generated a debate similar to that which occurred amongst tonsil surgeons about 100 years ago, when tonsillotomy was the most commonly performed procedure. Today, concerns about regrowth and problems with infection of the remaining tonsillar tissue have been raised. Such concerns, combined with an incomplete understanding of why the ‘partial’ procedure was abandoned in the early twentieth century, may explain why tonsil surgeons hesitate to change their approach to patients with OSDB due to adenotonsillar hypertrophy. These issues can be addressed in a meaningful way only through a detailed review of the evolution of tonsil surgery, which is presented here. This information, along with a summary of the last 10 years’ experience with these techniques, supports the use of a ‘partial’ procedure in children with OSDB due to adenotonsillar hypertrophy. Future areas of research are also discussed.

**Key words:** Tonsillectomy; Otorhinolaryngologic Surgical Procedures; Sleep Apnoea Syndromes; Tonsillotomy, partial tonsillectomy, partial intracapsular tonsillectomy

### Introduction

The primary cause of obstructive sleep-disordered breathing (OSDB) in most children is hypertrophic tonsils alone, hypertrophic adenoids alone or both.<sup>1</sup> In these cases, the surgical procedure most commonly recommended and performed today is tonsillectomy and/or adenoidectomy or removal of the entire palatine tonsillar tissue and any adenoid tissue which obstructs the nasopharyngeal airway.

Despite the many different types of instruments that are available and used today, tonsillectomy has two fundamental unsolved problems which have been the focus of a significant amount of research over the last 10 to 15 years, i.e. post-operative pain, resulting in a prolonged recovery, and post-operative bleeding. These problems may arise as a consequence of both the design of the tonsillectomy procedure itself and the instruments selected to perform the operation.

The majority of otolaryngologists in the United States currently use an electrosurgical device to remove the tonsils and/or control bleeding. The heat generated from this instrument may be as high as 400°C, which can create a significant sphere of injury to the surrounding musculature of the tonsillar fossa.<sup>2</sup> It is possible that this may intensify the inflammatory process, contribute significantly to the amount of post-operative pain and prolong the recovery period.<sup>3–5</sup> Irrespective of method used, the post-operative pain subsides once the surface of these muscles has remucosalized, which may also reduce the incidence of bleeding due to exposed vessels.

Based on this hypothesis for the development of post-operative pain, some otolaryngologists have sought to develop a minimally invasive alternative to tonsillectomy which avoids exposure and injury of the pharyngeal musculature.

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One solution is to develop a procedure that would leave a thin rim of tonsil tissue on an intact tonsillar capsule as a 'biological dressing' in order to reduce the degree of the inflammatory response within the pharyngeal musculature and to speed the healing process. Interestingly, such an operation (i.e. the removal of only a portion of the palatine tonsil, or 'tonsillotomy') was common practice amongst the majority of tonsil surgeons in the United States until approximately the 1930s.<sup>6</sup> A great debate, at times very passionate, occurred amongst tonsil surgeons, beginning around 1906 with the first clear description of complete excision, or tonsillectomy. Tonsil surgeons argued over which technique was the best, tonsillotomy or tonsillectomy, for any indication. However, the 'partial' procedure was eventually abandoned in favour of tonsillectomy as a result of changes in the understanding of both tonsillar physiology and the pathophysiology of other systemic diseases (such as rheumatism, scarlet fever and chronic heart disease, which were thought to originate from the 'diseased' remnants of tonsil tissue).<sup>7-9</sup>

Although tonsil and adenoid hypertrophy, with associated upper airway obstruction, has been recognized since the earliest description of tonsil surgery in the first century AD, both local and systemic infections and 'infectious processes' were the most common indications for tonsil surgery in the past. At the present time, the opposite is true, and the most common indication for tonsil surgery now is OSDB due to hypertrophic lymphoid tissue. Given this shift in the more common indication for tonsil surgery, and our better understanding of infection, inflammation and immunity, it makes sense to now revisit the concept of the partial removal of tonsil tissue for the surgical management of tonsillar hypertrophy causing OSDB in children.

However, a complete grasp of these issues and an insight into why the tonsillectomy operation exists in its current form (and why the 'partial' procedure fell into disrepute) can be understood only through a detailed review of the evolution of tonsil surgery. This we present below. However, in an attempt to avoid any misrepresentation of the past, this review of the development of tonsil surgery differs significantly from previously published material in that all the sources cited are the original publications wherever possible.

Based on the proposed hypothesis of the aetiology of post-operative pain and bleeding presented here, a procedure to remove only a portion of the tonsil tissue offers surgeons the opportunity to resolve the remaining fundamental problems inherent in the tonsillectomy operation.

However, as a general principle, no surgical procedure is without disadvantages or complications, and the 'partial' procedure is no exception. Two major concerns exist. One is that the remaining tonsillar tissue might regrow and eventually produce obstructive symptoms. A second concern is that the physiology of the remaining tonsil might be altered, with disruption of some of the remaining tonsillar crypts, leading to problems with infection.

While more information is needed to provide a completely satisfactory answer to these questions and to confirm previously published complication rates, we here summarize the state of current knowledge, which we believe supports the use of a 'partial' procedure in patients with OSDB due to adenotonsillar hypertrophy. Future areas of research, such as the documentation of these procedures' efficacy and their relation to the rising costs of health care, are also discussed.

### Evolution of tonsil surgery

The history of tonsil surgery may be divided into four periods. The earliest period begins with the first clear description of a procedure to remove a portion of the tonsils, in the first century AD, and extends to 1828, with the publication of the first popular tonsillotome, or tonsil guillotine. The second period may be considered the 'era of automatic instruments' (1828 to approximately the 1930s), during which strings, wires and knives were abandoned in favour of various tonsillotomes to remove a portion of the tonsil. Although the procedure that we know today as tonsillectomy (i.e. removal of the entire tonsil with the capsule intact) was conceived, described and published by American otolaryngologists as early as 1906,<sup>10</sup> tonsillectomy did not become common practice until approximately the 1930s.<sup>6</sup> The third period (from approximately the 1930s to the late 1990s) may be considered the 'era of tonsillectomy', during which tonsillotomy was abandoned and the goal of all tonsil surgeons became the removal of the tonsil, the whole tonsil and nothing but the tonsil. While the majority of surgeons are currently still performing tonsillectomy regardless of the indication for surgery, the current time (i.e. the late 1990s to the present) may be distinguished from the 'era of tonsillectomy' and considered as a fourth period, as some surgeons are performing a partial procedure for those patients with OSDB, using various instruments such as the CO<sub>2</sub> laser, coblation or plasma excision devices, and them microdebrider.<sup>11</sup>

The first clear reference to tonsil surgery dates back almost 2000 years to the first century AD, when Aulus Cornelius Celsus, a Roman writer and physician, described the use of a finger to remove the tonsil and recommended a hook and scalpel when that method was ineffective.<sup>12</sup> He also emphasized the importance of removing only a portion of the tonsil, recognizing that any attempt to remove the entire tonsil might result in uncontrollable haemorrhage. This fear of haemorrhage was stressed for centuries and may largely explain why tonsillectomy was not described until the early 1900s.

Over the following 1700 years, numerous other approaches to the removal of tonsil tissue were described. Thin wires, similar to those used in pianos, were forcibly pulled through the tonsil, while others used strings which were tied around the visible portion of the tonsil and left in place for one or several days as the tissues underwent necrosis. While these methods may have been more painful or taken a longer period of time, wires and strings were

favoured by surgeons over the use of knives due to concerns about haemorrhage. As one might imagine, it must have required an excess of heroism and extreme fortitude to undergo such an ordeal. Hence, while tonsil surgery was performed, it was done so very infrequently.

The period from 1827 to 1832 has been characterized as one with a 'spirit of instrumental unrest'.<sup>13</sup> More than eight different kinds of guillotine-type instrument, or tonsillotomes, were described in these five years. The instruments designed by Philip Syng Physick and William B Fahnestock gained considerable popularity and were modified many times over the next 100 years.<sup>14,15</sup> Physick, a Philadelphia surgeon educated in England, detailed the advantages of his device thus.

'It [is] easy to cut off ... any portion ... of the enlarged tonsil in this manner. The operation can be finished in a moment's time. The pain is very little, and the haemorrhage so moderate that it has not required any attention in four cases.'

Although the indications for surgery were not well defined at this time, this period marks a major advance in tonsil surgery, as the speed with which the operation could be performed was of the utmost importance given the absence of any type of anaesthetic. These instruments brought some consistent feasibility to the operation, since it could now be performed within seconds and without the need for great force. As a result, tonsillotomy, i.e. removal of only a portion of the tonsil, was performed with increasing frequency.

The operation that we know today as tonsillectomy, i.e. removal of the entire palatine tonsil by dissection, was conceived and described by American otolaryngologists in the early 1900s.<sup>10</sup> A few decades earlier, physicians had been beginning to recognize that, although the tonsillotomy operation could be performed quickly, the results were often less than adequate. Anecdotal evidence, case reports and even large patient series numbering in the thousands were presented, showing that patients were being seen after tonsillotomy with persistent symptoms and diseases such as 'rheumatism', scarlet fever and chronic heart disease, which were attributed to the retained tonsil tissue.<sup>7-9,16</sup> In fact, it was not at all uncommon for patients during this period to have had as many as two or three tonsil operations in their lifetime in an effort to become completely free of these various heart, lung and arthritic diseases. In this period, numerous examples exist in both the medical and surgical literature of miraculous cures following complete excision of tonsils. King's article,<sup>7</sup> for instance, contains photographs of the hand of a patient with 'severe arthritis' who was completely cured several weeks following an injection of an autogenous vaccine derived from the patient's own tonsil tissue. King cites another case of a boy with such 'advanced torticollis' that he was unable to turn his head until after a tonsillectomy was performed. Such reports were highly influential in persuading 'tonsillotomists' to convert to tonsillectomy.

In 1910, Greenfield Sluder of St Louis and Whillis and Pybus of England independently demonstrated that it was possible to perform a tonsillectomy, or removal of the palatine tonsil in its entirety, with the capsule intact, using a guillotine-type instrument or tonsillotome rather than a knife or scissors.<sup>17,18</sup> As a result of their work, and that of numerous others who described a careful dissection method to avoid the problems ascribed to retained tonsil tissue, very few physicians in the United States, if any, were performing tonsillotomies or partial tonsillectomies by the 1930s. Surgeons also had more time to operate, since the use of anaesthetics had improved by this time, with the result that anyone performing a tonsil operation, by whatever means or instrumentation, now performed a tonsillectomy.<sup>19,20</sup> Furthermore, tonsillotomy was abandoned in favour of tonsillectomy regardless of the indication for surgery and is absent from any discussion of tonsil surgery in the American otolaryngology literature and textbooks after 1940.

As tonsil surgeons worked to perfect their tonsillectomy techniques, the time required to complete the procedure could be measured in minutes. The operation was fast and thorough. However, the control of both intra- and post-operative haemorrhage was noted to be a significant issue.<sup>21</sup>

The use of electrosurgical instruments to control bleeding was an important development for all surgical disciplines, and such devices were employed in tonsil operations as far back as 1887.<sup>22,23</sup> Perhaps the most well known electrosurgical device, the 'bovie', was first used to control bleeding in neurosurgical procedures in 1926.<sup>24</sup> Although these types of instruments were employed in tonsil surgery, their use was limited only to those procedures performed under a local anaesthetic, until the mid to late 1950s, which saw the introduction of halothane, a non-flammable inhalational anaesthetic agent, and the more routine practice of endotracheal intubation.<sup>25</sup> The 'hot' or 'electrocautery' tonsillectomy, i.e. complete removal of the tonsil tissue and simultaneous control of haemorrhage with the same instrument (an electrosurgical device) under general anaesthesia, did not gain popularity until the mid to late 1980s. Since then, it has become the most common method due to its ability to minimize bleeding and shorten operative time.

However, as was noted earlier, 'electrocautery' tonsillectomy is associated with a significant period of post-operative pain.<sup>3-5</sup> Tonsil surgeons have been challenged to devise a better procedure and/or new instrumentation – something that would result in less post-operative pain and a more rapid recovery but without sacrificing our ability to relieve symptoms and control haemorrhage.

A more modern technique, removing only a portion of the tonsil, was described in an animal model as early as 1965 using cryosurgery.<sup>26</sup> Hill reported his experience with 46 adults who had undergone this procedure and found that the amount of discomfort was about 50 per cent that of surgical removal and that the amount of tissue destruction was about 40 per cent. However, by

the 1980s, this procedure was abandoned due to the cost, the inconveniences of handling liquid nitrogen, reports of post-operative bleeding and accounts of life-threatening post-operative oedema.<sup>27</sup>

In the last 10 years, partial tonsillectomy, or tonsillotomy, has reappeared in the medical literature. In 1993, two Russian physicians described the use of a Bochon loop for the partial removal of hypertrophic tonsils in children; they proposed that this procedure preserved the relevant physiological function of the tonsil while reducing the duration of treatment and preventing chronic inflammation.<sup>28</sup> Two groups in Sweden have since reported their experience with tonsillotomy for the relief of obstructive symptoms in children, using a CO<sub>2</sub> laser. These studies have shown that tonsillotomy is effective in relieving obstructive symptoms, while reducing post-operative pain, parental distress, surgical time and overall cost.<sup>29–31</sup> More recently, Lee *et al.* have also revisited the tonsillotomy operation, referring to their procedure as a subtotal tonsillectomy. They have described the removal of 90 to 95 per cent of the tonsil using ionized field ablation (also known as plasma excision or coblation) for children and adults with obstructive tonsillar hypertrophy.<sup>32</sup> A larger series, of 528 patients, was published by the same group, with a minimum post-operative follow-up period of four weeks.<sup>33</sup> A multi-centre study, which included 43 patients from four different institutions who were followed over 12 months, is also available.<sup>34</sup> Finally, Chang has reported a series of 101 patients, with a follow-up period of one week.<sup>35</sup>

In 1997, Koltai *et al.* described the use of a microdebrider for adenoid surgery, calling the procedure a 'power-assisted' adenoidectomy.<sup>36</sup> Subsequently, this same device was utilized to remove a portion of the tonsil, leaving a thin rim of lymphoid tissue, thus performing a so-called 'intracapsular tonsillar reduction' or 'intracapsular partial tonsillectomy'.<sup>6,37</sup> The word 'intracapsular' highlights the preservation of a thin layer of tonsil tissue which can act as a barrier to trauma and infection of the tonsillar fossa's pharyngeal musculature. These tonsil remnants are then cauterized to achieve haemostasis without violating the underlying capsule. The preferred term for this procedure is now 'powered intracapsular tonsillectomy' (PIT). This nomenclature emphasizes the use of the microdebrider and the importance of the capsule. When combined with an adenoidectomy, the procedure is termed a 'powered intracapsular tonsillectomy and adenoidectomy' (PITA).<sup>38</sup>

While some surgeons can remove an adequate quantity of tonsil tissue with a tonsillotome or guillotine device, historical experience suggests a lack of consistent precision with these older instruments; this may be avoided with the use of a microdebrider. Two initial reports demonstrated that PIT significantly reduces post-operative pain, allowing for a faster and easier recovery, and is as effective in eliminating the source of upper airway obstruction as conventional tonsillectomy.<sup>6,37</sup> A trend towards reduced post-operative haemorrhage and reduced readmission for dehydration was also noted, but

statistical significance was not observed due to the modest number of patients. A subsequent study of PIT in almost 900 children from four different US institutions confirmed previous findings that PIT is as effective as tonsillectomy in relieving obstructive symptoms, based on parental surveys, with a significant decrease in delayed return to normal diet and activity and with less pain. The rates of delayed post-operative haemorrhage and readmission for dehydration were also statistically significantly lower in the PIT group.<sup>38</sup>

Two recent studies provide additional data confirming an improved outcome of PIT over electrocautery tonsillectomy. Sobol *et al.* reported their experience with a total of 74 patients.<sup>39</sup> While they found no significant difference in the number of days taken for resolution of pain or resumption of normal activity between patients undergoing PIT versus electrocautery tonsillectomy, they did find that those patients who underwent PIT returned to a normal diet 1.7 days earlier. Alternatively, Derkay *et al.* described their experience with 300 patients and found no difference between these two groups in terms of days to return of normal diet.<sup>40</sup> However, they did note a faster return to normal activity and a shorter duration of post-operative pain medication requirement in the PIT patients.

### Tonsillar regrowth

A major concern about the partial tonsillectomy procedure is the possibility that the remaining tonsil tissue might regrow and create problems with subsequent infection or obstruction. Given that removal of only a portion of the tonsil was the most commonly performed procedure prior to the 1930s, a review of the medical literature before this time would serve as a valuable source of information on the incidence of tonsillar regrowth. Although regrowth is an intuitive concept, a review of the literature and our knowledge to date suggest that this is a credible but uncommon problem.

In 1899, F E Hopkins was one of the first to address the issue of recurrence of the tonsil after surgery.<sup>41</sup> He described one of his patients, a 13-year-old boy, who had two tonsil operations six months apart as a result of tonsillar regrowth. Hopkins noted that the excision was 'thorough' at the first operation, based on an examination of the patient three weeks after surgery, and that the diagnosis of 'simple hypertrophy' was confirmed after the second operation by a pathologist. He further commented that the child suffered from 'repeated attacks of amygdalitis' in between the two operations. Hopkins also performed a thorough review of the medical literature and found seven other papers documenting tonsillar regrowth following tonsillotomy. The majority of these were single case reports with an interval between surgeries as long as five years. Three of these references provide some sense of the incidence of regrowth. One physician repeated the operation 'four or five times in about 500 cases' and another physician 'had to do a second operation but twice in over 150 cases'. The internationally renowned otolaryngologist

Morell Mackenzie reported, 'among the many hundreds of cases in which I have operated, I recall but two in which there was any sign of subsequent enlargement'.

Anecdotal reports of regrowth following tonsillectomy have also been published. Edward Roberts proposed that, occasionally, lingual tonsil tissue would fill the empty pharyngeal tonsillar fossa in as little as 48 hours.<sup>42</sup> He further commented that an ideal tonsillectomy leaves the fossa lined with fascia. However, photomicrographs demonstrating the existence of lymph nodes within this fascia have been published. These nodes may also hypertrophy and fill the tonsillar fossa in a similar fashion. Despite these occurrences, Roberts reinforced the concept of tonsillectomy over tonsillotomy when he wrote, 'evidence that a tonsil thoroughly removed ever grows is lacking'. Comments on the compensatory hypertrophy of remaining lymphoid tissue like this, without specific data, may be found as recently as 1977.<sup>43</sup> Due to the concerns of extra lymphoid tissue in the oropharynx, one physician went so far as to advocate an 'expanded tonsillectomy' in which the infratonsillar nodules extending along the tongue base and into the hypopharynx were removed along with the palatine tonsils.<sup>44</sup>

When the more recent published experience with partial tonsillectomy is reviewed, one finds again that regrowth does occur but at a very low incidence. The two Swedish groups that used CO<sub>2</sub> laser to perform tonsillotomy presented three series of patients followed for a period of two to two and a half years: one with 33 children, a second with 43 and a third with 21.<sup>29-31</sup> While none of these reports specifically commented on regrowth of tonsil tissue, there were no cases of return of obstructive symptoms in the first or second series, and only one child in the third series went on to have a 'completion' tonsillectomy for persistent symptoms, two years after the first surgery. As for the experience with ionized field ablation, plasma excision or coblation, no mention has been made of tonsil regrowth. However, each of the two series of patients undergoing ionized field ablation (coblation) were followed up post-operatively for a period of only four weeks or less.<sup>32,33</sup> The largest series following patients undergoing PIT or PITA included 900 children and reported a regrowth rate of 0.46 per cent over a mean follow-up period of 14 months.<sup>38</sup> Another group noted tonsillar regrowth in nine out of 278 patients (3.2 per cent) following a PITA procedure, over a follow-up period ranging from four weeks to one year.<sup>45</sup> Two of these nine children went on to have a tonsillectomy for recurrence of OSDB.

### Infection following a 'partial' procedure

Few, if any, would argue that our current understanding of infection in general and, more specifically, infection of the tonsils is very different from that prior to the 1930s. Consequently, unlike the information gained about tonsil regrowth, a literature review of problems with infections following tonsillotomy from that period would be of no value to

surgeons today. The only data that are useful and available now come from the experience of surgeons who have performed 'partial' procedures within the last 10 years.

So far, problems with recurrent or chronic infection of the remaining tonsillar tissue in children who have undergone a 'partial' procedure with any kind of instrumentation have been documented but are infrequent. Of the 528 patients who underwent a subtotal tonsillectomy with coblation in the study by Lee *et al.*, 256 patients had a history of chronic tonsillitis, 70 had recurrent tonsillitis and two had peritonsillar abscess.<sup>33</sup> No problems with infection were identified post-operatively. Follow up was for a minimum of four weeks. Patients with a history of recurrent infections were excluded from all of the studies that used CO<sub>2</sub> laser to perform a tonsillotomy.<sup>29-31</sup> No mention was made of any problems with tonsil infection following the procedure. The earliest large series of patients who underwent a PIT or PITA procedure, 243 and 870 patients with follow-up periods of one to 12 months and two months to 2.6 years, respectively, also failed to identify any post-operative problems with recurrent or chronic tonsil infection.<sup>6,38</sup> A recent report by Sorin *et al.*, which included 278 patients followed over a period of four weeks to one year, found one patient with an episode of streptococcal-positive tonsillitis. This person did eventually undergo tonsillectomy but as a consequence of OSDB recurrence and not because of tonsillitis. Peritonsillar abscess following PITA has also been described<sup>46</sup> (personal communication).

### Discussion

The surgical treatment for upper airway obstruction and OSDB in children caused by hypertrophic tonsils and/or adenoids has come a long way since the first clear description of tonsil surgery in the first century AD. The evolution of tonsil surgery has led surgeons to the very elegant operation we now know as tonsillectomy, which has served patients with obstructive symptoms well over the last seven decades.

However, the use of an electrosurgical device to perform the procedure and to manage the problem of haemorrhage, inherent in tonsillectomy, has created another challenge for tonsil surgeons – how to minimize or eliminate a prolonged post-operative recovery period. This has been the focus of a significant amount of research in tonsil surgery over the last 10 to 15 years and is certainly a goal worthy of pursuit.

Both tonsil surgeons and device manufacturers have offered some creative solutions to this problem. Some surgeons have called for minimal use of the cautery device.<sup>47,48</sup> However, perhaps due to concerns about intra-operative blood loss, incidence of post-operative haemorrhage and ease of dissection, this method has not gained widespread popularity.

Another proposal has been the use of a harmonic scalpel for tonsillectomy. This instrument has been proposed to have an advantage over electrosurgical

devices due to the reduced temperature it generates – as low as one-fourth that of the electrocautery device.<sup>49</sup> This would produce a smaller sphere of injury to the pharyngeal musculature. However, the harmonic scalpel has a number of disadvantages: a steep learning curve to achieve adept use; difficulty in controlling bleeding from large vessels; and the fact that the instrument can only be used to perform tonsillectomy and not adenoidectomy.<sup>50</sup>

A return to the ‘forgotten’ historical concept of removal of only a portion of the tonsil offers another alternative solution to surgeons who are interested in reducing the length and severity of the post-operative recovery period following tonsillectomy via electrosurgical dissection, without having to compromise on blood loss, operative time or the incidence of post-operative haemorrhage. Partial tonsil removal is an intuitively obvious solution: it reduces the hypertrophic tissue giving rise to OSDB, while preserving a thin rim of tonsil tissue and thereby limiting the sphere of injury to and inflammatory response of the pharyngeal musculature, which is thought to cause the prolonged recovery period.

When considering a return to such a previously abandoned procedure, it is important to understand why the old procedure was discarded and to learn from those experiences, rather than expend energy and valuable resources re-learning such knowledge.<sup>51</sup> Therein lies the importance of a thorough understanding of the development of tonsil surgery. In fact, the choice of the phrase ‘evolution of tonsil surgery’ is not intended to suggest that a modern return to a ‘partial’ procedure would be part of a natural ‘evolutionary’ process or that the very existence of tonsillectomy for any indication is threatened in any way. Similarly, a debate now over tonsillectomy or a ‘partial’ procedure, unlike that which occurred about 100 years ago, need not focus on finding a single best procedure and completely abandoning one of the two types of surgeries for any or all indications for tonsil surgery. Rather, the phrase ‘evolution of tonsil surgery’ emphasizes the importance of understanding where we have been as tonsil surgeons, thereby guiding us towards potential future directions.

For example, Gyrus-ENT (Bartlett TN, USA) has developed a new instrument called the diego™ Powered Dissector, a microdebrider combined with a radiofrequency device. This coblation device, originally designed for rhinologic and sinus procedures, would allow for a very elegant ‘partial’ procedure in which tonsil tissue could be removed while simultaneously being able to achieve haemostasis. Similarly, Isaacson has described removal of 90 per cent of the tonsil tissue while simultaneously achieving haemostasis, using bipolar electrosurgical scissors.<sup>52</sup>

There are a number of advantages of a ‘partial’ procedure using modern instrumentation such as the microdebrider or the coblation device. Many, if not all, tonsil surgeons find such devices easy to use, and both may also be used to perform adenoidectomy. The coblation device offers yet another advantage over the microdebrider in that it could be used to perform either a ‘partial’ procedure or a tonsillectomy.

However, no surgical procedure is without complications, and the partial tonsillectomy is no exception. Even full tonsillectomy has a number of complications, but the operation is frequently performed due to its overwhelming benefits, given the appropriate indication.<sup>53</sup> While both historical data and more recent experience with the ‘partial’ procedure clearly indicate that regrowth of remaining tissue does occur, the incidence is low. However, it is possible that, with more procedures and a longer follow-up period, we might see an increase in the incidence of regrowth. It is clear that longer follow-up periods and more patients are needed to completely address this issue. Similar to regrowth, the available evidence today indicates that infection following a ‘partial’ procedure does occur but at a very low incidence. Some surgeons might be concerned, for example, that peritonsillar abscess has been described following a ‘partial’ procedure. Those who are concerned and therefore advocate complete removal must recognize that this same complication has also been described following full tonsillectomy.<sup>54,55</sup> However, at the present time, due to concern over infection and the small amount of data available, both chronic and recurrent tonsillitis are best viewed as relative contraindications for ‘partial’ procedures. Experience with more patients and longer follow-up periods is needed to enable better definition of the indications for this procedure and to address the issue of what specific infection incidence would constitute an absolute contraindication.

As tonsil surgeons work to improve upon the tonsillectomy operation we know today, two important issues for future research remain to be adequately addressed. The first is demonstration of efficacy and the second is the rising costs of health care. All of the information on the efficacy of ‘partial’ procedures that is now available is based on parental surveys of obstructive symptoms. To date, no study on any ‘partial’ procedure has included polysomnographic data. This is important, both pre-operatively, to confirm a diagnosis of obstructive sleep apnoea, and post-operatively, to confirm resolution or reduction in obstructive sleep apnoea severity (given the lack of correlation between the history and physical examination and sleep study results).<sup>56</sup>

Finally, health care costs continue to rise in the United States. Of the many reasons that are responsible for this, the one considered the most significant by the majority of health care economists is the development and adoption of new technology, meaning new medications, medical therapies, diagnostic equipment, and surgical procedures and devices.<sup>57–59</sup> Given the additional cost of the devices now being used for ‘partial’ procedures, such as the microdebrider and the coblator, data should be presented to demonstrate cost-effectiveness prior to widespread adoption of the new technique and/or instrumentation.

## Summary

Within the last 10 to 15 years, a significant amount of research in tonsil surgery has focused on various

efforts to reduce both the post-operative pain and the recovery time. In order to minimize or avoid these morbidities, some tonsil surgeons have revisited a historical procedure, partial tonsillectomy, for OSDB due to tonsillar hypertrophy in children. With a clear understanding of the evolution of tonsil surgery and the advances in our medical knowledge over the last century, this development makes intuitive sense. The evidence to date indicates that this procedure offers a number of advantages over tonsillectomy for this particular indication and supports the use of a 'partial' procedure in children with OSDB due to adenotonsillar hypertrophy. Although regrowth of the remaining tonsillar tissue and problems with infection do occur, the incidence appears to be small. More studies are necessary to verify these complication rates and to determine if the additional cost of the instrumentation involved offers value for the healthcare dollar.

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