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Radiofrequency Tonsil Reduction: Safety, Morbidity, and Efficacy

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Objectives: **To evaluate the safety, morbidity, and efficacy of radiofrequency tissue volume reduction of tonsils using two different surgical techniques and to compare these two techniques with each other and with classic tonsillectomy.** ***Study Design:*** **A nonrandomized retrospective review of tonsil reductions was made between 2000 and 2002 using in vivo studies associated with tonsil reduction and tonsillectomy performed either in the hospital operating room or in the outpatient treatment area.** ***Methods:*** **We studied 150 patients and divided them into three main groups based on surgical technique. Group A consisted of 50 consecutive patients who underwent tonsil "ablation," Group B contained another 50 consecutive individuals who received tonsil "coblation," and Group C consisted of 50 patients who underwent classic tonsillectomy (cold dissection). Each group consisted of two subcategories of children (age range, 1–12 y) and adults (age range, 12–60 y) with chronic tonsillar hypertrophy. Most of the pediatric patients underwent adenoidectomy during the same surgical procedure. Indications for tonsillectomy were those listed by the American Academy of Otolaryngology—Head and Neck Surgery. A retrospective chart review was used to assess procedures, safety, morbidity, and efficacy of tonsil reduction and tonsillectomy. Four specific end points of morbidity were investigated: pain, return to normal diet, return to normal activity, and use of pain medication. Efficacy of tonsillectomy was determined by the clinical observation of the remaining tonsillar tissue and compared with pretreatment photographs of the tonsils.** ***Results:*** **There were no complications in any of the groups. Efficacy was assessed based on the mean tonsil reduction and was found to be 100% for tonsillectomy, 86% for the tonsil coblation technique, but only 53.6% for the ablation technique. Morbidity was minimal in groups A and B and significantly greater in Group C. The number of pain days, narcotic-use days, and days before return to normal diet and activity were greatly reduced in groups A and B when compared with classic tonsillectomy (group C). Pain levels on day 1 were less than 3 (on a scale of 1–10) in groups A and B. The number of pain days and narcotic-use days was less than 4 days in groups A and B. Similarly, most patients returned to solid diet and normal activity by day 4. Pain levels, number of narcotic-use days, and number of days to return to normal diet and activity were significantly higher for classic tonsillectomy.** ***Conclusions:*** **Tonsil coblation has distinct advantages when compared with tonsil ablation and standard tonsillectomy. Tonsil coblation resulted in greater than 86% elimination of tonsillar tissue in both children and adults. In most patients, pain levels were minimal and limited to the first 48 hours after surgery. Return to normal diet and activity was much earlier in the coblation group versus classic tonsillectomy.** ***Key Words:*** **Radiofrequency tonsil reduction, tonsil coblation, snoring, OSA, tonsillectomy, painless tonsillectomy.**

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INTRODUCTION

Tonsillectomy remains as one of the most popular surgical procedures worldwide. In fact, its history dates back more than 2000 years and can be traced to the early writings of Celsius in the first century A.D.[1] Although being greatly reduced over the years, the potential for complications for morbidity during and after this surgery remains significant.[2] Despite the longevity of experience otolaryngologists have had with the surgery, no definitive consensus has been reached regarding an optimal technique. Besides blunt cold knife dissection, a variety of other techniques has arisen including monopolar and bipolar diathermy, cryosurgery, suction diathermy, bipolar scissor, KTP-532 laser, CO_2 laser, ultrasonic removal,[3] microscopic bipolar diathermy (MBPD), and, most recently, radiofrequency tonsil ablation and "coblation." All were developed with the hope of decreasing the major morbidities of the procedure; the most important of these include pain, reduced activity level, hemorrhage, and postoperative dehydration.

Specifically in regard to pain, no procedure has yet clearly been shown to stand above the rest, although a number of studies do report an increase in postoperative pain following cautery dissection compared with cold knife dissection.[2,4,5] The reason for pain after tonsillectomy is

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the disruption that occurs with exposure of underlying muscle fibers and nerve endings of the glossopharyngeal and vagus nerve that supply the region. Postoperatively, exposed to the outside elements, these tissues become inflamed, which can lead to spasm. Inflamed constrictor muscles are an intense source of pain because every swallow causes movement of these muscles. It would seem logical that any advancement in surgical technique would need to address the issue of damage and exposure of these structures.

The present study investigates two new systems of tonsil reduction that have gained attention recently.[6–8] The key innovation is not the technical aspect of the device but the concept of subtotal intracapsular tonsil reduction that avoids injury to the constrictor muscles as opposed to more classic methods of tonsillectomy. Temperature-controlled radiofrequency tonsil reduction is a technique by which a probe is introduced to the tissue in question and heated to temperatures ranging from 40°C to 70°C. A plasma field consisting of highly ionized particles is formed at the probe's surface that breaks down the molecular bonds of local tissue with a reduction in heat dissipation to surrounding structures as compared with coagulation by diathermic methods, which creates temperatures greater than 500°C. The technique can be used to remove tissue in three different ways. First, one may simply use the device to dissect along the capsular plane of the tonsil, much like a traditional tonsillectomy, and morbidity end points are likely to be comparable.[6] Second, one could use the probe to create small channels in the tonsil with dissipation of ionizing energy to surrounding tissue, with subsequent tissue death days or weeks later that leads to shrinkage and volume reduction (radiofrequency ablation). A third approach would be to perform a subtotal tonsil reduction by using the instrument to remove en bloc tonsillar tissue while avoiding the underlying capsule (radiofrequency coblation). It is the latter two approaches that we investigated in the present study and report on specifically in regard to postoperative morbidity and efficacy in tonsil volume reduction.

MATERIALS AND METHODS

The present nonrandomized retrospective study investigated patients who underwent tonsil reduction surgery and tonsillectomy by surgeons in our department. Patients were divided into three main study groups, A, B, and C (Table I). Group A (n = 50) consisted of patients who underwent elective tonsil reduction using radiofrequency tonsil ablation; patients in group B (n = 50) received treatment with tonsil coblation; and patients in group C (n = 50) underwent classic tonsillectomy (cold dissection). Please refer to the "Surgical Technique" section for a detailed description of the differences between the procedures of ablation and coblation. The groups were further subdivided into children (age range, 1–12 y) and adults (age range, 12–60 y). Data were obtained using a retrospective chart review of the first 50 consecutive patients who had undergone tonsil ablation starting in the period from October 2000 to March 2001, the first 50 consecutive patients who underwent tonsil coblation from March 2001 to November 2001, and 50 patients who underwent tonsillectomy between October 2000 and July 2002. Decisions to operate were made in accordance with the indications set out by the American Academy of Otolaryngology—Head and Neck Surgery.[9] Candidates in groups A and B included patients with symptomatic chronic tonsillar hypertrophy and upper airway obstruction secondary to tonsillar enlargement. Exclusion criteria for these reduction techniques were asymmetrical tonsillar hypertrophy with suspected lymphoma, a history of peritonsillar abscess, patients with a clear history of repeated streptococcal infections, and the patient's decision to undergo a traditional method of tonsillectomy. Patients in group C were all those excluded from groups A and B. Complications were studied by a review of all outpatient, inpatient, and clinical charts. The main outcome measures of morbidity that were studied are summarized in Table II and include pain, diet, medication, and activity. All patients or their parents complete a diary recording these variables on a daily basis, which is standard practice for all patients undergoing tonsillectomy in our department. Interviews with patients took place at approximately 1 week, 4 weeks, and 12 weeks during routine postoperative visits. Efficacy was assessed by determination of percentage of tissue volume reduction, which was determined at approximately 12 weeks. Specific attention was paid to recording morbidity end points. A complete literature search was conducted on the OVIDWEB-MEDLINE database searching for relevant studies that commented on the efficacy and morbidity of tonsillectomy in children and adults.

TABLE I.
Study Design.

	No.	Mean ± SD	Range
Group A—RF tonsil ablation			
Adults	22	32.7 ± 11.8	14–47
Children	28	5.9 ± 2.6	1–12
Group B—RF tonsil coblation			
Adults	15	31.1 ± 13.1	13–53
Children	35	6.3 ± 2.8	2–12
Group C—cold dissection			
Adults	10	27.2 ± 9.2	18–36
Children	40	4.2 ± 1.4	2–7

SD = standard deviation.

Statistical Analyses

All statistical analyses were performed using SPSS for Windows, version 10.0.7 (SPSS, Inc., Chicago, IL). Continuous data are displayed as mean ± SD. Statistical significance was accepted when P value was less than .05. The one-way ANOVA and the Student Newman-Keuls tests were used to compare continuous variable mean values between the three groups. Multiple Student t tests with Bonferroni correction were used to compare continuous variable means within each group. The Levine Test for Equality of Variances was used to determine statistically significant variances.

TABLE II.
Measured Outcomes.

1. Pain—Recorded on scale of 1–10 using VAS—Visual Analog Scale.
2. Diet—Days that patient ate liquid, soft, and normal diet were recorded.
3. Meds—Total quantity of medication consumed over 7 days was recorded.
4. Activity—Patient reported whether he or she had reduced or normal activity.

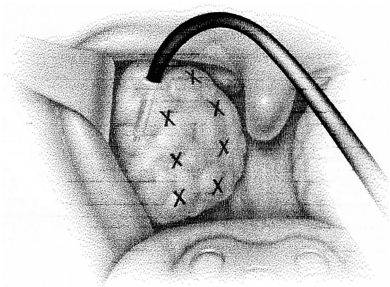

Fig. 1. Points of entry for probe for tonsil ablation. The active portion of the probe is completely submerged into the tonsil tissue.

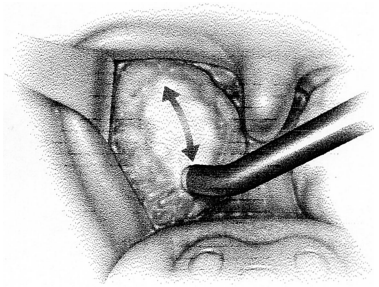

Fig. 3. Technique for tonsil "coblation." The wand skims the tonsil surface with continuous saline irrigation. The anterior pillar must be retracted to allow good visualization for near-complete ablation.

Surgical Technique

The technique of tonsil ablation is similar to that for other soft tissue ablation procedures. It depends on the injection of fluid or electrolytes into the tissue before treatment. Treatment involves six to eight sites as illustrated in Figure 1. If somnoplasty (Somnus Medical Technology, Sunnyvale, CA) equipment is used, a double wand is used to apply two lesions at a time (1000 J). This is repeated three or four times for a total number of six to eight lesions (6000–8000 J). If the ENTec System (ENTec, Sunnyvale, CA) is used, eight lesions (15 s for each lesion) are used (Fig. 1). In the initial postoperative period the amount of swelling exceeds the initial reduction, so tonsil size is equal to or larger than the preoperative size. Tonsil shrinkage occurs between the first and third weeks (Fig. 2). Initially, a pilot study comparing ablation using the Somnus and the ENTec machines was performed. The right-side tonsil was ablated with the ENTec machine, and the left-side tonsil with the Somnus machine. Results indicated comparable reduction of tonsillar size and shorter operative times using the ENTec machine. Hence, the majority of our patients underwent ablation using the ENTec machine.

As for coblation, no electrolyte injection is needed because this is a surface technique that includes a saline irrigation. The EVAC-70 handpiece (ENTec) is used, and the tonsil is ablated from the surface inward with retraction of the pillar (Fig. 3). Tonsil reduction is immediate. Meticulous care is taken to preserve the anterior and posterior pillars. A thin layer of tonsillar tissue is left in situ to avoid penetration of the tonsillar capsule and exposure of the underlying muscle. A postoperative view at 3 weeks is shown in Figure 4.

Classic tonsillectomy was performed with electrocautery technique. Unipolar electrocautery with a blend II set at 20 W was used.

RESULTS

Results were analyzed in three areas: complications, efficacy, and morbidity. All our results are summarized in Table III and Figures 5 and 6.

Safety

Both radiofrequency reduction procedures (ablation and coblation) are safe, and no intraoperative, or postoperative complications occurred in these two groups of patients. Intraoperative blood loss ranged from minimal (<20 mL) to none in all cases of either ablation or coblation (groups A and B). Blood loss for classic tonsillectomy (group C) was occasionally greater, but no record indicated significant blood loss (>1000 mL) or a drop in hemoglobin values. There was no postoperative bleeding in any of the three groups of patients. Dehydration did not occur, and no patient required hospitalization or intravenous fluids for more than 23 hours. There were no readmissions. Although postoperative fevers did occur, they required no specific treatment in any case.

Normally, the risk of airway obstruction is not a concern after tonsillectomy because the tonsillectomy opens the previously obstructed pharynx. However, this is not true with the tonsil ablation technique. Because no tonsil is removed with ablation and postoperative edema does occur, the airway can be more obstructed postoperatively than preoperatively. Therefore, we admitted all ablation patients for overnight observation. Despite our concern, no complications with respect to upper airway obstruction occurred.

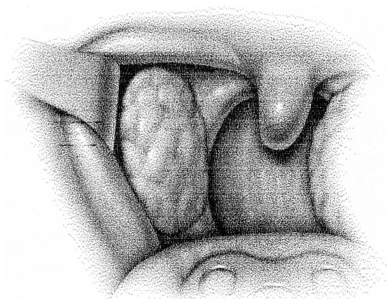

Fig. 2. Tonsil appearance 3 weeks after tonsil ablation. A smaller, normal-appearing tonsil is present.

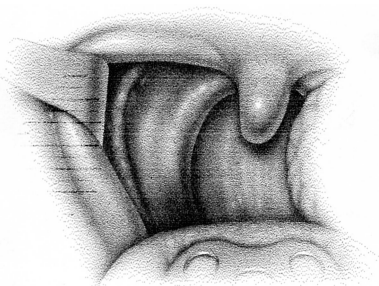

Fig. 4. Postoperative view 3 weeks after tonsil "coblation." Minimal tonsil tissue may be recognizable in the fossa.

TABLE III.
Comparison of Tissue Volume Reduction and Morbidity Among Three Groups.

	Tonsil Shrinkage	Pain POD 1 (0-10)	Total Meds‡
Group A—RF tonsil ablation			
Adults	53.6 ± 11.4*	1.6 ± 1.7*	29.6 ± 27.8†*
Children	51.1 ± 12.3*	1.4 ± 1.2*	0.9 ± 2.7†*
Group B—RF tonsil coblation			
Adults	90.0 ± 0.0†*	2.8 ± 1.0*	53.0 ± 33.3†*
Children	86.1 ± 5.2†*	2.5 ± 0.5*	7.6 ± 19.8†*
Group C—cold dissection			
Adults	100 ± 0.0*	7.2 ± 2.4†*	130.0 ± 22.0†*
Children	100 ± 0.0*	5.3 ± 1.2†*	12.2 ± 2.0†

*Significant difference between groups.
†Significant difference within group.
‡Volume of codeine in cc used. Each 5 cc represents 12 mg codeine.

Efficacy

The efficacy of tonsil reduction was compared between groups A and B (ablation and coblation, respectively) and between each of these groups and classic tonsillectomy (group C). The assumption is made that classic tonsillectomy results in 100% reduction of tonsil tissue (Table III). The results of each group were separated into pediatric and adult subgroups. In the pediatric group (Table III), tonsil reduction ranged from 30% to 70% in the ablation group with a mean reduction of 51.1% ± 12.2%. Coblation shrinkage ranged from 75% to 95% with a mean shrinkage of 86.1% ± 5.2%. In the adult subgroup, ablation ranged from 40% to 70% with a mean ablation of 53.6% ± 11.4%, whereas coblation shrinkage has a similar range of 75% to 95% with a mean shrinkage of 90% in all adult patients.

Overall, the coblation group was statistically more effective in tonsil removal ($P < .0001$ in both children and adults), but more important, had significantly more predictable results as demonstrated by smaller variances in comparison with ablation procedures in both adults and children. The Levine Test for Equality of Variances demonstrated F values of 29.2 (children) and 61.3 (adults), which were significant to a P value less than .0001.

Morbidity

Morbidity was assessed in both pediatric and adult populations in each treatment group (six subgroups). Five variables were studied for each subgroup. The five variables studied included the following:

1. Mean pain level on postoperative day (POD) 1 based on a visual analogue scale of 1 to 10. We arbitrarily chose POD 1 because this was clearly the highest pain day for our group of patients (*pain POD 1*).
2. The number of days for which patients reported pain levels of 1 or greater (*pain days*)
3. The number of days in which narcotic medications were used (*med days*)

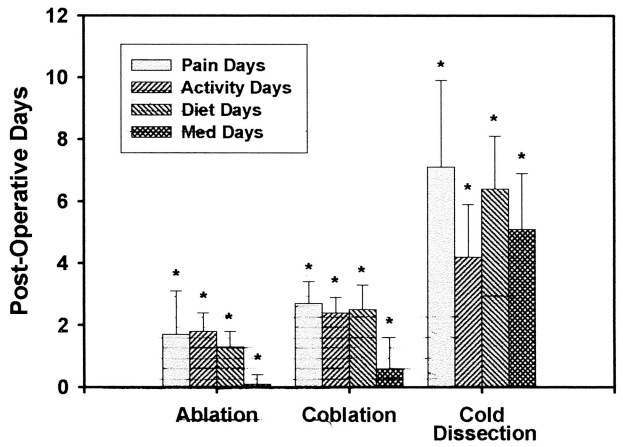

Fig. 5. Comparison of mean (± SD) postoperative days of pain (pain days) or narcotics use (med days), reduced activity (activity days), and altered diet (diet days) in children after radiofrequency tonsil ablation, radiofrequency tonsil "coblation," and cold dissection tonsillectomy.

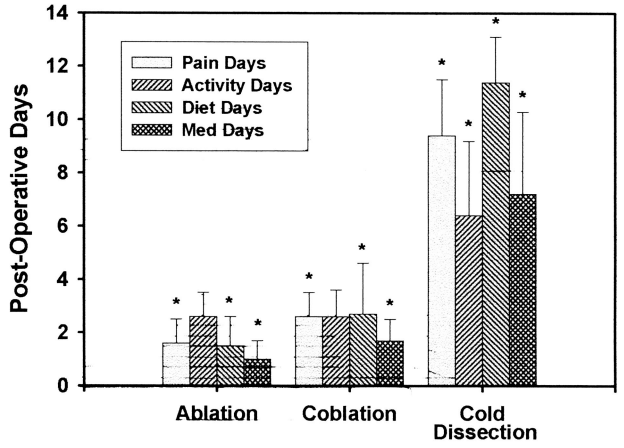

Fig. 6. Comparison of mean (± SD) postoperative days of pain (pain days), narcotics use (med days), reduced activity (activity days), and altered diet (diet days) in adults after radiofrequency tonsil ablation, radiofrequency tonsil "coblation," and cold dissection tonsillectomy.

4. The number of days before resumption of normal diet (solid food) (*diet days*)
5. The number of days until normal activity was resumed (*activity days*)

The results of variables 2–5 are shown in Figure 5 for pediatric patients and in Figure 6 for adult patients. In pediatric patients, pain on POD 1 (Table III) ranged from 0 to 10 with a mean value of 1.43 ± 2.15 after ablation, between 2 and 3 with a mean of value 2.49 ± 0.51 after coblation, and from 2 to 10 with a mean value of 5.3 ± 1.2 after classic tonsillectomy. All these values were significantly different from each other ($P < .0001$). In adults, pain on POD 1 (Table III) ranged from 0 to 5 with a mean value of 1.55 ± 1.74 after ablation, from 0 to 4 with a mean value of 2.80 ± 1.01 after coblation, and from 2 to 10 with a mean value of 7.2 ± 2.4 after classic tonsillectomy. All these values were significantly different from each other ($P < .0001$).

The mean number of days for which pediatric patients experienced pain was 1.7 ± 1.4 days following ablation, 2.7 ± 0.7 days following coblation, and 7.1 ± 2.8 following tonsillectomy. In adults, the mean number of days for which patients experienced pain was 1.6 ± 0.9 days following ablation, 2.6 ± 0.9 days following coblation, and 9.4 ± 2.1 following tonsillectomy. These values were all different from each other. In both pediatric and adult patients undergoing ablation, virtually all patients (27 of 28 children and 18 of 22 adults) were pain free by POD 2. Patients undergoing coblation generally had pain persist for an additional day; however, all patients undergoing coblation were pain free by POD 4. Pain persisted beyond POD 6 in all adults and in 30 of 40 children undergoing tonsillectomy. Although both pediatric and adult patients in group B required slightly more narcotics for pain relief than did patients in group A, narcotics were rarely needed after POD 1 in both groups. Narcotic requirements for adults and children undergoing tonsillectomy were significantly higher than in both group A and group B, and narcotic usage lasted well beyond POD 3 in adults and POD 2 in children. Similar findings were demonstrated for both days to return to normal diet and days to return to normal activity (Figs. 5 and 6).

DISCUSSION

The present study demonstrated that both tonsil ablation and coblation have distinct advantages over tonsillectomy. Work by Murthy and Laing[10] and Toma et al.[11] investigated postoperative morbidity in adults after cold dissection tonsillectomy. In both studies, pain was still elevated on POD 4 to a mean level of 6 on a scale of 1 to 10 and continued beyond POD 7. Function was significantly reduced with many patients still not returned to work (78%) between POD 5 and POD 9. Ninety percent of patients also reported swallowing problems in the first 5 days with as many as 25% of patients still complaining of dysphagia on POD 5 to POD 9. These data are similar to our results in group C and are in sharp contrast to our results in adult patients having ablation (group A) or coblation (group B) who had mean pain levels of less than 3 on POD 1 and were pain free by POD 4. More than 90% of patients reported a return to normal activity level by POD 5, and more than 85% of patients resumed normal diet by POD 3, with 100% resuming normal diet by POD 5. In regard to children, much work has been performed in investigating morbidity end points following tonsillectomy.[4,12–16] Our data are summarized in Table III and Figure 5. Pain scores, total narcotic dose, and number of pain days were all lower in children when compared with adults, but children still continued to have pain on POD 7 (mean value, 4.5 ± 1.1). In regard to other end points, mean time to return to normal activity in group C was 2.4 days ± 0.5 days. Mean time to return to normal diet in group C was 6.4 days ± 1.8 days. The children in groups A and B who were studied were virtually all (98%) pain free and returned to normal diet and activity by POD 4.

Originally, our initial application of radiofrequency tonsil reduction was limited to performing tonsil ablation. Nelson[7,8] has recently published two studies investigating this technique's efficacy. His results were similar to ours in that there were no episodes of hemorrhage and patients resumed normal activity within 1 to 2 days. He also noted a 70.8% reduction in tonsil size with an average airway enlargement of 54.5%. Follow-up at 1 year confirmed that there was maintenance of tonsil reduction. However, only five patients were followed up at that time. Although the results in regard to reduced morbidity were promising for tonsil ablation, it was eventually discontinued in our practice in lieu of a more favorable technique, tonsil coblation. We found three distinct advantages of using coblation over ablation. First, the amount of tonsil reduction was found to be unpredictable with results ranging from 30% to 70%. This was despite identical technique in all patients. With coblation, the surgeon has more control over the amount of tissue that is removed. Second, with ablation there were many instances in which patients encountered an initial swelling of the tonsils postoperatively that required close monitoring in a critical care setting overnight, especially in the pediatric group. Third, the use of tonsil ablation is limited to treating airway obstruction, not chronic tonsillitis. As Nelson[7,8] has noted, whether infection reduction could be achieved with tonsil ablation has not been proven, and "procedural modifications may be necessary to treat infected tonsils."[8] We think one can instead use coblation when tonsil tissue is resected more entirely en bloc with immediate removal of diseased tissue.

Back et al.[6] also recently published a report on radiofrequency tonsillectomy. Their report was similar to the current project in investigating morbidity end points and went even further with comparing the technique with a randomized control group that underwent traditional cold dissection. The study concluded that there is no difference in postoperative morbidity between the two techniques as opposed to our hypothesis and that put forward by Nelson. However, the key factor that explains this is that Back et al.[6] were performing neither ablation nor coblation in the manner that we have defined. Instead, they used the third application of this RF device that was discussed earlier in the present study in which one uses the wand as a dissection tool to perform a complete tonsillectomy along the capsular plane. In performing this procedure, the underlying muscle and nerves are exposed, which explains the

lack of difference in postoperative morbidity when compared with traditional tonsillectomy. Herein lies the cornerstone of this essay: It is not the lack of diathermy that makes coblation a superior technique. It is the "nondisruption" of the tonsil capsule that reduces postoperative morbidity. Furthermore, the radiofrequency system is a superior tool for accomplishing this. One needs a device such as diathermy that can coagulate bleeding when proceeding directly through vascular-rich tonsil tissue in a subtotal manner. At the same time, though, this too must act like a cold knife and, unlike diathermy, not spread thermal damage to nearby subcapsular nerve fibers. The concept of subtotal tonsil resection is not new. Hultcrantz et al.[13] published a study that compared traditional total tonsillectomy with subtotal tonsillectomy with the use of CO_2 laser. The subtotal approach resulted, on average, in children being pain free 3 days earlier than the total tonsillectomy group. In addition, the laser group returned to diet 3 days earlier and received less pain medication. Radiofrequency coblation goes further in that the patients in our study were pain free in even less time than with the laser method used by Hultcrantz et al.,[13] thus emphasizing the use of this specific device for a subtotal approach.

We acknowledge drawbacks involved in the design of the present study. It would be much easier to compare the efficacy of the radiofrequency technique with more traditional tonsillectomy if a prospective randomized controlled trial had been set up. In addition, interviewing patients about symptoms 1 week later does introduce the possibility of recall bias. However, given the dramatic reduction in postoperative pain and rapid resumption of normal diet and activity that we have had in our patients since implementing this technique, it has become a standard of practice for us, and we think it unfair not to offer this type of surgery to all patients undergoing tonsillectomy for airway obstruction.

The major disadvantage of these techniques is that they accomplish partial but not total tonsillectomy. The procedure is ideal for patients with hypertrophic tonsils in cases of upper airway obstruction, snoring, and obstructive sleep apnea. There does exist a small risk of regrowth of the tonsillar tissue, but this risk is comparable to that of adenoidectomy in which subtotal removal of the tissues is a standard of practice. Although the technique is simple and can be learned by any otolaryngologist, there is a learning curve and experience is needed to achieve these results. The key errors that may lead to poor results are 1) inadvertent contact of the active wand to oropharyngeal mucosa, which results in a burn and pain; 2) overly aggressive tonsil coblation that exposes pharyngeal muscle to cause pain and potential bleeding; and 3) incomplete coblation that leaves more than 10% of the tonsil intact.

CONCLUSION

We studied two methods of subtotal tonsil reduction using low-temperature radiofrequency energy and compared them with classic tonsillectomy. Tonsil ablation is a relatively simple technique with minimal morbidity but has one major drawback. It is unpredictable in the amount of tissue reduction and can leave up to 70% of the tonsil intact. Therefore, we do not recommend it as a standard technique for tonsil reduction. The present study concludes that tonsil coblation has distinct advantages over tonsil ablation and standard tonsillectomy. The advantages include early elimination of pain and early resumption of normal diet and normal activity levels. Although more controversial for those with chronic tonsillitis, this technique is ideal for patients with hypertrophic tonsils that lead to airway obstruction and has become our standard of practice. The key technical innovation is a subtotal tonsillectomy versus classic tonsillectomy.

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