

## Recent medical devices for tonsillectomy

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### Abstract

The most frequent and probably the earliest described surgical intervention of ENT field is tonsillectomy. Various methods were described and devices were invented up to now in order to increase safety and decrease time consumption and complications. All new created devices promises lower intraoperative blood loss, intraoperative time, postoperative pain and bleeding. But with their widely use it is seen that they cannot fulfill what they promise. Debate also continues as to which technique yields the best outcome. This study reports a summary for common medical devices which were previously used in tonsillectomy. Hippokratia. 2012; 16 (1): 11-16

**Key words:** tonsillectomy, cold dissection, electrocautery, thermal welding, ligature vessel sealing system, harmonic scalpel, laser, review

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The first description of tonsil surgery came from Hindu medicine in 1000BC<sup>1</sup>. Around AD30 Aulus Cornelius Celsus was believed to have performed tonsillectomy using his fingernails<sup>2</sup>. Since then a continuing evolution has been observed in surgical technique and devices over the years<sup>3</sup>. The ancient technique followed by the use of instrumentation which includes snare, guillotines, tonsillotomes, ligatures etc. In the 19<sup>th</sup> century cold steel dissection and recently hot techniques were introduced to ENT practice. Modern hot techniques were introduced in 1973 with the use of CO2 laser. Later came the Nd:YAG laser and KTP laser, diathermy, plasma excision or coblation, radiofrequency ablation and harmonic scalpel thermal welding<sup>4</sup>.

Tonsillectomy technique which is dissection of the tonsillar tissue from underlying pharyngeal constructor muscles is almost same for 60 years. Despite the use of various methods and devices Cold dissection tonsillectomy /CDT) is still regarded as the gold standard<sup>5</sup>. It allows maximum preservation of the oral mucosa. Mechanical injury to the oral mucosa is less when compared with thermal injury<sup>6</sup>. Literary data also states that with CDT postoperative healing is quicker, and post-operative complications like pain and delayed bleeding also reduce. Simultaneous homeostasis is not an option in this technique which increases operative time and the amount of intra-operative bleeding<sup>7</sup>.

Electrocautery (ECT) decreases the operative time and intraoperative bleeding. Monopolar electrocautery creates an electric arc between the instrument and tissue

which ablates the tonsillar tissue. A degree of thermal injury to adjacent structures serves as a major problem with its use which will be related with postoperative morbidity. Thermal injury to the pillar mucosa can delay healing and can increase postoperative pain and late complications which include postoperative bleeding<sup>8</sup>.

The thermal injury attempted to lessen with some basic solutions. One is focusing the energy to tonsillar tissue and lessen the energy which is transmitted to adjacent structures. This is the basis of radiofrequency ablation. Coblation technology is also a form of radiofrequency which perform tonsillectomy in lower temperatures. Using focused heat limited to the tip of the instrument and simultaneous pressure is the basis of thermal welding system and finally using ultrasonic energy instead of direct heat is the basis of harmonic scalpel tonsillectomy. Intracapsular tonsillectomy with lasers or microdebrider which is the refinement of a historical surgery, namely partial tonsillectomy, that was previously performed with tonsillotomes and guillotines. This is also a change in tonsillectomy philosophy which emphasizes the need of entire tonsil removal.

Variant Creutzfeldt-Jakob disease (vCJD), which is a result of previous exposure to bovine spongiform encephalopathy (BSE) prions, has also an impact on recent tonsil surgery techniques. vCJD disease is related with tonsillar prion infection and previous studies demonstrated its isolation from tonsil specimens before the clinical manifestation of the disease<sup>9</sup>. Since these prions are resistant to standard sterilization techniques, re-usable

standard tonsillectomy/adenoidectomy instruments also have a theoretical vector potential which will transmit the prion infections from one patient to other. The risk of transmission via the surgical instrument is far high from transmission with food products. UK Department of Health predicted that 5-10% of vCJD in future will be related with reusable surgical instruments<sup>10</sup>. This important acknowledgement suggests the use of disposable instruments.

All new created devices promises lower intraoperative blood loss, intraoperative time, postoperative pain and bleeding. But with their widely use it is seen that they can not fulfill what they promise. Debate also continues as to which technique yields the best outcome.

This study reports a summary for recent medical devices which were previously used in tonsillectomy.

### Coblation

Coblation base devices use radiofrequency energy. This energy excites the electrolytes in a saline solution which is resulted with precisely focused plasma. These energized particles break molecular bonds and dissolves the tissue. Unlike the conventional electro-surgical devices, coblation-based devices produce significant less heat when performing the tonsillectomy. The heat decreases 40-90 C which is far less from the standard electro-surgical devices. Minimal tissue penetration and less surrounding tissue damage were proposed the advantages of the device<sup>11-13</sup>. In 2007 a survey on 120 surgeons indicate that Coblation tonsillectomy (CT). is the second most common method for total tonsillectomy after monopolar cautery<sup>14</sup>.

Burton and Doree performed a Cochrane database review to evaluate the usefulness of CT. The review indicate that there is no adequate evidence exists whether the CT is better and worse than previous tonsillectomy techniques<sup>15</sup>. A recent review indicated that no definite conclusion will be made when the literature reviewed. This study also stated the adversity of calculation the cost effectiveness of this expensive technique as a standard tonsillectomy technique<sup>16</sup>.

The major concern about CT is posttonsillectomy bleeding which is well published in the literature. A previous audit on 11796 subjects indicated that, when compared with cold dissection tonsillectomy, for postoperative bleeding the relative risk for coblation tonsillectomy is 3.4 times higher than CDT<sup>17</sup>. In a previous study 34.9% of subjects experienced post tonsillectomy bleeding (total 24 subjects, 6 major, 16 minor bleeding episode). This incidence is far high from the same centers documented bleeding incidence with conventional instruments which is lower than 0.8%<sup>18</sup>. A more recent study on 61 subjects which underwent CT also supported this finding. Bleeding was seen in 33% of the subjects (in 20 subjects 7 major 15 minor episode). This study is terminated due to this undesired complication. Another center which has terminated CT in tonsillectomy reported that after the CT terminated primary bleeding rates decreased 1.8% to 1.4%

and secondary bleeding rate decreased 15.4% to 5.8%<sup>19</sup>.

In a large study on 1762 tonsillectomies for postoperative bleeding no significant difference could be find between coblation and noncoblation tonsillectomy (%5.4 vs %6.1). Two recent studies comparing CT with conventional electrocautery (CE) did not find any significant benefit for surgical time, intraoperative blood loss and postoperative complications with CT<sup>12,20</sup>. However postoperative period is better with CT by means of less pain, early oral intake and early return to activity. When compared coblation tonsillectomy with coblation tonsillectomy the bleeding rates increases from %5.4 to %5.9, but this difference is not significant. A contrary result of this study is that when the postoperative bleeding is the outcome measure no learning curve could be identified<sup>11</sup>. A more recent study on 1997 pediatric subjects (745 CT, 1252 electrocautery) also could not find any significant difference between electrocautery tonsillectomy and CT for primary and secondary post tonsillectomy bleeding<sup>21</sup>. More recent study also did not reported any significant difference between CT and CDT with bipolar haemostasis for postoperative pain, early oral intake<sup>2</sup>.

Controversial findings were presented in the literature. When compared CDT with CT faster operative time and lower intraoperative blood loss was observed. Postoperative comfort parameters (early oral feeding, early return to activity) were also better with CT<sup>13,23-25</sup>. For postoperative pain a study on 134 subjects indicated that CT have less pain scores than Harmonic scalpel tonsillectomy (HST) and conventional electrocautery<sup>26</sup>. A more recent study on adults comparing monopolar electrocautery with CT demonstrated that patients with CT return to normal diet earlier but pain scores did not differ<sup>27</sup>. A recent study on pediatric subjects CT resulted with less pain scores, less analgesic use and early return to activity<sup>28</sup>. On 48 subjects, in which one tonsil removed with CT and other with unipolar electrocautery no significant difference was found for intraoperative blood loss, post-tonsillectomy bleeding and healing of the tonsillar fossa. An only significant lower level of pain was noted with CT. An important data in this study is 9 (18%) coblation hand piece wires thinned during surgery and a second new hand piece is needed to complete tonsillectomy<sup>29</sup>.

The thermal injury to tonsillectomy specimens was similar with HST, ECT and coblation. The skeletal muscle presents significantly high when tonsillectomy was performed with HST and ECT. When the tonsil removed by this three methods only (ECT) with a needle point allow a more precise dissection of the tonsil. However an earlier study comparing bipolar diathermy tonsillectomy with CT indicated that CT resulted with less thermal injury, intraoperative blood loss and postoperative pain. This study also conducted that less thermal injury is resulted with less postoperative morbidity<sup>30</sup>. An earlier study also supports this finding. In this study CT produced less thermal injury when compared with monopolar electrocautery and CO2 laser tonsillectomy<sup>31</sup>.

The need of training was addressed in a study which

reported a 22.7% of post tonsillectomy bleeding incidence<sup>32</sup>. In this study the presence of PTH is directly effected with the surgeons experience which means in inexperienced hands PTH increases. An audit from Australia also demonstrated a significant learning curve with respect to PTH<sup>33</sup>.

### Harmonic scalpel

HS uses ultrasonic energy to vibrate the dissecting blade at a harmonic frequency of 55,000 hz<sup>4</sup>. This device creates intracellular pressure waves that creates intracellular cavities. Advantages of the technique are minimal intra-operative blood loss and the disposable blade. Notable disadvantages are that a long learning curve is required resulting in increased operative time at the beginning and increased medical costs. Leape et al.<sup>34</sup> reported 204 cases which were treated with either HST or tonsillectomy (BPT). HST increased post-operative pain but postoperative hemorrhage rates were similar. Potts et al.<sup>35</sup> performed a retrospective study on 605 patients' medical charts and compared HS to EC. Average operative times, recovery time, postoperative pain scores did not differ between the methods. Overall bleeding rates were not found to be statistically significant either. Willging and Wiatrak<sup>36</sup> also compared HS with EC and found that the Harmonic scalpel increases mean operative time (8'42'' vs. 4'33''). For intra-operative blood loss both techniques were found to be equivalent. They noted only 2 individuals in the HS group and 1 individual in the EC group lost more than 1 ml blood during the procedure. Post-operative pain scores showed HS displayed a gradual decrease from day 2-4. Parsons et al.<sup>26</sup> compared 3 techniques (HS, Coblator, EC) for post-tonsillectomy pain. They found that for postoperative pain scores EC and HS did not statistically differ from each other.

### Thermal welding

Thermal welding system (TWS) uses direct heat and pressure to divide the tissues. The heat is localized at the tip of the instrument. With pressure the protein molecules are dissolved and fused together resulting with a tight seal formation<sup>37</sup>. Few recent studies were performed to asses the usefulness of this new technique<sup>38</sup>. These studies introduced this new technique as a safe method for tonsillectomy. They also reported that it provides sufficient homeostasis during dissection and decreases the operative time.

Karatzias et al<sup>38</sup> reported 50 children who underwent tonsillectomy using TWS. Bleeding during the surgery was insignificant and no postoperative hemorrhage occurred. They noted the mean operative time as 23 minutes. Karatzanis et al<sup>39</sup> performed TWT on 60 children. Bleeding during the operation was minimal and the mean operative time was 20 minutes. Postoperative hemorrhage occurred in only one patient. Starvroulaki et al<sup>40</sup> compared TWT with CDT. In their study, when compared with CDT, TWT showed significantly lower intra-operative hemorrhage rates. Pain scores were also significantly

lower in the TWT group for the first to fourth postoperative days. The postoperative hemorrhage rates did not differ between the groups. Mean operative time between the groups was not noted in the study. In another study Karatzias et al<sup>37</sup> compared TWT to BPT. In the TWT group intra-operative bleeding was insignificant but in the BPT group they found intra-operative mean blood loss to be 16ml. Mean operative time was equal in both groups. For mean postoperative pain score, the TWT group showed significantly lower pain scores for all days.

### Ligasure vessel sealing system

Ligasure vessel sealing system (LVSS) is a new and safe method for tonsillectomy with specific advantages. It is a bipolar electrosurgical device that uses scissor mechanisms that grasp and seal the vessels<sup>41</sup>. The response generator of system senses the density of compressed tissue<sup>42</sup>. The energy which is delivered to the tissue is directly related with this tissue bundles density and automatically calculated, delivered and terminated by generators computer<sup>43</sup>. Systems sealing power is equal to conventional ligatures and hemoclips but higher than bipolar cautery and ultrasonic coagulator devices. This precise controlled energy deliver resulted with less thermal damage to surrounding structures. It is accepted that this system can seal vessels which are up to 7 mm and thermal spread of energy is no more than 1,5-3,3 mm beyond the tissue<sup>44</sup>.

The preliminary report on 83 subjects showed that no measurable bleeding was observed during surgery. Mean operative time was 16 minutes and in 18 children limited peritonsillar edema was the sole complication. No postoperative haemorrhage was observed in this study<sup>43</sup>. A prospective study on 200 subjects comparing LVSS with CDT demonstrated significant advantages for technique. LVSS is superior for intraoperative blood loss, operative time, and postoperative pain scores<sup>45</sup>. When compared with modern techniques, a previous study on 161 subjects, comparing CDT, LVSS and HST showed that HST and LVSS are both comparable and superior than CDT for intraoperative blood loss, postoperative haemorrhage and pain<sup>44</sup>. A more recent study on 143 subjects comparing LVSS and TWT demonstrated that both techniques provide sufficient haemostasis and both reduce the operative time. Postoperative pain is lower with TWT<sup>42</sup>.

### Microdebrider

Powered instruments, also known as microdebriders or shavers, were developed to increase the precision of surgical procedures and to improve the surgeon's comfort. Microdebriders use small, disposable rotating blades to cut the tissue, and also have irrigation and aspiration functions<sup>46</sup>. Otolaryngologists use powered instruments to perform partial intracapsular tonsillectomy. In the case of tonsillar hypertrophy, when compared with standard tonsillectomy, microdebrider intracapsular tonsillectomy (MIT) is quite effective for relieving the patient's symptoms. A biological dressing or residual tonsillar tis-

sue was left on the capsule. Underlying muscles nerves and vessels were preserved<sup>47</sup>. Decreased operative time, lower postoperative pain and better postoperative healing process are the advantages of MIT however intraoperative blood loss and tonsillar re-growth are the main problematic issues

A study compared MIT, CT and ECT showed that all techniques were similar for surgeon's perception of difficulty, average pain scores and postoperative complications. Patients in MIT and CT group return to a normal diet and activity much earlier than electrocautery. MIT has the shortest operative time and less cost and presented as the most cost effective technique between these three methods<sup>48</sup>. A meta analysis including 253 MIT vs. 248 ECT showed that patients in MIT group return to activity and diet much earlier. Operative times were similar and intraoperative blood loss is in average 5 ml less in MIT group<sup>49</sup>.

A previous study reported more intraoperative blood loss with MIT when compared with ECT. But an important issue in this article is although the intraoperative bleeding with MIT is high this not clinically important. MIT bleeding is in acceptable limits and intraoperative blood loss will not solely use an argument for accepting or refusing the technique<sup>50</sup>.

In a center which performing MIT, CT and ECT reported 3362 subjects results which indicated that MIT related with less post tonsillectomy bleeding and dehydration when compared with ECT and CT<sup>51</sup>. The initial report on 312 children with OSA indicated that MIT has less postoperative pain and fewer episodes of dehydration and secondary bleeding<sup>52</sup>.

On 2994 subjects MIT related with less postoperative bleeding rate and pain level when compared with electrocautery<sup>53</sup>. A study comparing MIT, HST and ECT indicated that HST has longest operative time. MIT has highest intraoperative blood loss and MIT and HST is related with early oral intake<sup>54</sup>. Higher levels of PTH were also reported in the literature in different studies<sup>55</sup>.

Residual tonsillar tissue is an important issue in MIT. A previous study on 278 OSAS subjects indicated a 3.9% complication rate<sup>56</sup>. The majority of the complication is tonsillar regrowth. A previous study noted 5 times high incidence of residual tissue when compared with ECT after 1 month period. It is still needed clarify long term re-growth or infection with this residual tissue<sup>57</sup>.

## Laser

Initially, mentioned modern hot techniques were introduced to tonsillectomy practice with lasers. The safety of the lasers is well described and earlier studies indicated that laser tonsillectomy decreases the operative time and intraoperative blood loss<sup>58,59</sup>. The difficulty to make a clear conclusion is due to the use of different laser types in studies.

On 528 subjects radiofrequency and ultrasonic dissector- compared with laser. The mean operative time, intraoperative blood loss and postoperative pain scores were

significant less than laser but PTH did not differ<sup>60</sup>. On 31 subjects decreased intraoperative blood loss and delayed healing was also well described in a previous study<sup>59</sup>. A recent study on 748 subjects indicated that gold laser tonsillectomy has comparable bleeding rates with CDT and less bleeding rates than CT<sup>61</sup>. A study on 80 pediatric patients compared between potassium titanyl phosphate laser and bipolar radiofrequency. The results indicate that this laser increases operative time but decreased intraoperative blood loss and the pain for early postoperative period<sup>62</sup>. But the most recent study did not find any difference for pain scores and PTH between LT and RFT<sup>63</sup>.

Another common use of lasers is the tonsillotomy which was regarded as safe and suitable technique in the case of tonsillar hyperplasia in snoring and sleep apnea. A previous study on 19 subjects reported that laser can ablate up to 70% of the tonsillar tissue and suitable for subjects which did not accept standard surgery or patients not suitable for general anesthesia. This study reported a 74% response rate which is quite comparable to standard surgery<sup>64</sup>. Laser will also be used with local anesthesia in outpatient basis. On 33 children with tonsillar hypertrophy which causing obstructive symptoms CO2 laser tonsillectomy found effective for relieving symptoms. The follow up period changed between 20 -33 months and no recurrence was observed<sup>65</sup>. A study comparing 460 subjects which underwent conventional tonsillectomy with 150 patients who underwent CO2 laser tonsillotomy indicated that a slight difference exists for PTH. But serious bleedings requiring general anesthesia significantly reduced with laser. Morphologic evaluations of tonsil specimens were obtained and it is reported that with laser less peritonsillar tissue was observed in specimens<sup>66</sup>. Diodide laser was also found effective for outpatient tonsillotomy in OSA subjects with high success, minimal pain and perioperative morbidity<sup>67</sup>. An earlier study on 58 subjects comparing diodide laser with monopolar cautery indicated that Diodide laser reproduced less pain and postoperative discomfort than MPC<sup>68</sup>.

A double-blind randomized controlled trial on 151 subjects indicated that KTP laser did not presents a major advantage over standard tonsillectomy except intraoperative bleeding<sup>69</sup>. On 18 subjects on which one tonsil removed by conventional tonsillectomy and other with KTP laser, laser reduced operative time and blood loss but resulted with prolonged pain and slow wound healing which will be related with secondary infection<sup>70</sup>. In a previous study 38 patients underwent tonsil removal with KTP laser on one side and standard on the other. Delayed healing in tonsillar bad is observed in this study. The results also reported 15% of secondary bleeding rate<sup>71</sup>. A previous study on 51 subjects which evaluating the KTP laser for possible technique for day case surgery reported a 31% of overall complication rate and 19% of secondary bleeding rate<sup>72</sup>. In a previous well designed study on 81 subjects also supports the delayed healing problem. The only advantage was noted as minimal intraoperative blood loss which will be useful in patients with coagul-

opathy. It also increases costs and operative time and it is noted that laser malfunctions is also serves a problem<sup>73</sup>.

### Conclusion

- Although many authors have evaluated surgical treatments for tonsillectomy few randomized prospective trials exist in which treatments are compared. This makes the literature less useful than it be.
- In the light of current literature no single technique can be recommended as an ideal method.
- However as stated in previous literature the learning curve and the increase in medical costs are disadvantages of modern hot techniques.
- It will be stated that there is a need of audits rather than personal studies. Because the complications such as bleeding are relatively low and the studies including hundreds of cases is not sufficient to obtain a meaningful data for bleeding.
- An adverse data in a study will not be used against any device. Same is true for opposite. An experienced center's low complication rates did not mean the individuals low complication rates. Clear decisions will be made after enough experience with the device.
- It is still needed to perform randomized prospective and comparative studies to establish the efficiency and safety of these new techniques and devices and also to ascertain whether any of these new technique is superior to another.

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