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Main Article

Pilot comparison between potassium titanyl phosphate laser and bipolar radiofrequency in paediatric tonsillectomy

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Abstract

Objectives: To compare the advantages and disadvantages of potassium titanyl phosphate laser with those of bipolar radiofrequency techniques, in paediatric tonsillectomy.

Study design: Prospective, randomised, clinical study.

Patients and methods: From July 2004 to April 2006, 80 patients aged between 10 and 15 years, with tonsillectomy planned for chronic tonsillitis, were included in the study. Children were prospectively randomised into two equal groups: potassium titanyl phosphate laser tonsillectomy and bipolar radiofrequency tonsillectomy. Operative time and intra-operative blood loss were recorded. Patients were scheduled for follow up during the first, second and fourth post-operative weeks. They were asked to record their pain and discomfort on a standardised visual analogue scale, from zero (no pain) to 10 (severe pain). Post-operative complications were also recorded and managed.

Results: The potassium titanyl phosphate laser group showed a slightly longer operative time (mean 12 minutes) than the bipolar radiofrequency group (mean 10 minutes). Intra-operative blood loss was significantly less in the potassium titanyl phosphate laser group (mean 21 cm^3) than in the bipolar radiofrequency group (mean 30 cm^3). In the first week, post-operative pain scores were less in the potassium titanyl phosphate laser group than in the bipolar radiofrequency group (means 7.5 and 8.5, respectively). However, in the second week pain scores increased more in the potassium titanyl phosphate laser group than in the bipolar radiofrequency group (means 8.5 and 6, respectively). In the fourth week, both groups showed equal and nearly normal pain scores. No case of reactionary post-tonsillectomy haemorrhage was recorded in either group. Only one case of secondary post-tonsillectomy haemorrhage was recorded, in the potassium titanyl phosphate laser group (2.5 per cent), managed conservatively.

Conclusion: Both the potassium titanyl phosphate and the bipolar radiofrequency techniques were safe and easy to use for tonsillectomy, with reduced operative time, blood loss and complication rates and better post-operative general patient condition. Potassium titanyl phosphate laser resulted in reduced operative bleeding and immediate post-operative pain, compared with the bipolar radiofrequency technique. However, potassium titanyl phosphate laser required slightly more operative time and caused more late post-operative pain than the bipolar radiofrequency technique. The low rate of recorded complications showed that both techniques cause little damage to the tonsillar bed during dissection, thus minimising complications.

Key words: Tonsillectomy; Lasers; Diathermy; Complications; Post Operative Pain

Introduction

Worldwide, tonsillectomy is one of the most common paediatric otolaryngology surgical procedures. Technological advancements have increased the efficiency of surgical techniques, reducing operative time, intra-operative blood loss, post-operative pain and the risk of haemorrhage.

Lasers have been used in otolaryngology for many years. The CO_2 laser has been a popular tool for tonsillectomy and adenoidectomy.[1] However, the instrumentation is cumbersome and therefore not routinely used nowadays. Potassium titanyl phosphate (KTP) laser is an easily manipulated type of laser which can be delivered by an Endostat^{TM} fibre. Some authors have questioned the benefits of using KTP laser in tonsillectomy procedures,[2] while others consider it an ideal technique.[3]

Bipolar radiofrequency tonsillectomy uses radiofrequency tissue heating to dissect the tonsil out of its bed, with the main aims of reducing operating

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time and bleeding. Unlike electrosurgery, heat increases in the tissues (in response to the high frequency radio waves passing through them) but not in the probes. The electrosurgical circuit includes the radiofrequency generator, active electrode, grounding pad and the patient. Five distinct wave forms are produced and used: fully filtered, fully rectified, partially rectified, fulguration and bipolar. Each of these modes uses a combination of frequency, power, waveform, electrode size and time of application to produce high tissue temperatures with predictable tissue effects.[4,5]

The application of radiofrequency techniques in the airway was first demonstrated in an *in vivo* porcine animal tongue model.[6] Recently, radiofrequency techniques have been shown to be safe and effective in bipolar tonsillectomy procedures.[7]

The aim of this study was to compare the advantages and disadvantages of these two new, advanced surgical techniques, within paediatric tonsillectomy procedures.

Patients and methods

This study was conducted between July 2004 and April 2006 on patients in the ENT departments of Tanta University Hospital, Tanta, Egypt, and Al Hammadi Hospital, Riyadh, Kingdom of Saudi Arabia. We designed a prospective, randomised, clinical study to compare KTP laser tonsillectomy with bipolar radiofrequency tonsillectomy. The study protocol was approved by the local ethics committees. All patients included in the study, and their parents, were fully informed about the nature of the tonsillectomy operation but not about the method of tonsil extraction (either KTP laser or bipolar radiofrequency). Written, informed consent was obtained before inclusion in the study.

Eighty patients were included in this study, 35 boys and 45 girls, aged between 10 and 15 years (mean 13 ± 1.3 years). All had suffered recurrent attacks of acute tonsillitis and showed symptoms and signs of chronic tonsillitis. All patients underwent full ENT history-taking, a thorough clinical examination and full pre-operative laboratory investigations. Forty patients were operated upon using KTP laser and 40 using bipolar radiofrequency.

All the operating surgeons had the same surgical qualification and were almost at the same level of surgical training. All participated in the surgical procedures, prospective evaluation and statistical analysis of both groups.

Patients with bleeding disorders, previous quinsy, debilitating diseases or combined surgeries (e.g. adeno-tonsillectomy) were not included in this study.

Techniques

All procedures were performed under general anaesthesia using a cuffed oral endotracheal tube. The child was placed in a supine position with the table head at 20° below horizontal and a sand bag underneath the shoulders. The mouth was opened by a self-retaining Boyle–Davis mouth gag.

In the KTP laser group, a KTP 532 laser (Laserscope, San Jose, California, USA) was used. The laser was set to 10 W continuous beam for the initial dissection, and a defocused beam was used for haemostasis. The laser beam was delivered via a 0.6 mm Endostat fibre (Laserscope®, Endostat™ 0.6 mm 12 Ft disposable, San Jose, California, USA). During laser use, all appropriate precautions were taken to protect the safety of theatre personnel.

In the bipolar radiofrequency group, a 3.8 MHz, FFPF model Ellman Surgitron (Ellman International, Hewlett, New York, USA) was used. The bipolar (partially rectified) mode, with an intensity of five, was used for tonsillar dissection, while bleeding points were controlled using the bipolar mode with an intensity of six.

All patients received standard post-operative care. They were discharged after one day, with home medications comprising antibiotics, analgesic and mouth wash for seven days. Patients were scheduled for follow up during the first, second and fourth post-operative weeks. They were asked to record their pain and discomfort on a standardised visual analogue scale, from zero (no pain) to 10 (severe pain). Patients' parents were asked about the smoothness of early post-operative recovery, fever, emesis, neck stiffness, and the time taken to return to the patient's normal diet and daily activities. Post-operative complications were also recorded and managed.

The main outcome measures in this study were as follows. Firstly, operative time (measured from the introduction to the removal of the Boyle–Davis mouth gag), which reflects the time taken for excision of tonsils and haemostasis. Secondly, intra-operative blood loss (calculated from the weight of saturated swabs, added to the blood volume as measured by an accurate paediatric container attached to the suction bottle). Thirdly, post-operative pain and discomfort with eating and drinking, measured (by the patients using a visual analogue scale) at various intervals during the first, second and fourth post-operative weeks (note that the patients were blinded to the operative technique). Fourthly, rate of post-operative complications, such as reactionary or secondary bleeding and/or infection.

Statistical analysis

To maintain exactly equal treatment numbers in both groups, randomisation was performed using random blocks. Neither the patient not the investigators were aware of patients' group assignment, and, post-operatively, neither the patient nor the examining surgeon was able to tell the difference on throat inspection. Statistical analysis was performed using the Statistical Package for the Social Sciences Windows statistical software package (SPPS, Chicago, Illinois, USA). Data were expressed as means $\pm$ standard deviation. P values of less than 0.05 were considered significant. Parametric tests, such as the t-test, were applied for data that followed a normal distribution. Non-parametric tests, such as the Mann–Whitney U test and the chi-square test,

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were applied for data that did not follow a normal distribution.

Results

Operative time

There was a tendency for shorter operative time in the radiofrequency group, but this did not reach statistical significance ($p > 0.05$) (Table I). Operative times ranged from 6 to 14 minutes in the radiofrequency group and from 9 to 15 minutes in the KTP laser group. The mean operative time was two minutes less in the radiofrequency group compared with the KTP laser group.

Blood loss

Blood loss ranged from 21 to 30 ml in the KTP laser group, compared with a range of 25 to 35 ml in the radiofrequency group (mean significant difference of 9 ml; $p < 0.05$) (Table I).

Visual analogue scale

In the first post-operative week, the visual analogue scale score for pain and discomfort ranged from 6 to 9 in the KTP laser group (mean 7.5 ± 1.11) and from 7.5 to 9.5 in the bipolar radiofrequency group (mean 8.5 ± 0.5); there was no statistically significant difference between the two groups ($p > 0.05$) (Table I). However, at the second week follow-up visit, the visual analogue scale pain score had increased in the KTP laser group to a mean of 8.5 ± 0.47 (range 7.5–9.5), compared with a decrease in the bipolar radiofrequency group to 6 ± 0.31 (range 5 to 7); however, this difference was not statistically significant ($p > 0.05$). In the fourth post-operative week, both groups showed an equal improvement in pain score, with a reduction in pain to normal levels.

Post-operative sequelae and complications

There was no statistically significant difference between the two groups regarding post-operative emesis, fever, neck stiffness, administration of analgesia, and time needed to return to pre-operative diet and activities. There was no recorded reactionary haemorrhage in either group. Only one case, in the KTP laser group (2.5 per cent), developed secondary haemorrhage; this occurred two weeks post-operatively and was managed conservatively by broad spectrum intravenous antibiotic and povidone iodine mouth wash. This case did not represent a significant difference between the groups.

Discussion

The implementation of new surgical technologies has encouraged surgeons to aim to achieve their surgical goals. The principal aim of the tonsillectomy procedure is complete, easy extraction of the tonsils, together with a short operating time, minimal blood loss, minimal post-operative pain and discomfort, reasonable financial cost and no complications. Previously, studies have separately compared KTP laser tonsillectomy and bipolar radiofrequency tonsillectomy with traditional cold steel dissection.[7,8] To our knowledge, no previously published studies have compared these two new technologies with each other.

In this series, patients' ages ranged from 10 to 15 years. This age group was selected in order to obtain as accurate an estimation as possible of patients' post-operative pain and discomfort, and of the changes in such pain over the follow-up period.

In this study, the operative time was slightly longer in the KTP laser group (mean 12 minutes) compared with the bipolar radiofrequency group (mean 10 minutes). This could be attributed to the greater time required to prepare the laser system, to observe the necessary intra-operative precautions and possibly to rectify laser malfunctions. The mean operative times recorded for both techniques are consistent with those recorded in previous trials of KTP laser (median 12 minutes)[8] and bipolar radiofrequency (mean 8.5 minutes).[7]

There was a significant decrease in intra-operative blood loss in the KTP laser group (mean 21 cm^3) compared with the bipolar radiofrequency group (mean 30 cm^3). This indicates that KTP laser could be beneficial in special tonsillectomy cases involving children or patients with bleeding disorders, in whom it is important to reduce significant blood loss. The mean intra-operative blood loss recorded for the KTP laser group is consistent with that recorded in previous trials of KTP laser (median 20 cm^3;[8] mean 20.2 cm^3).[2] However, the mean intra-operative blood loss recorded for our bipolar radiofrequency group was greater than that recorded in another study (mean 13 cm^3).[7]

The KTP laser group reported slightly less post-operative pain and discomfort, using the visual

TABLE I

MAIN PARAMETERS FOR KTP LASER AND BIPOLAR RADIOFREQUENCY TONSILLECTOMY GROUPS

Parameters	KTP laser* (mean ± SD)	Bipolar radiofrequency† (mean ± SD)	*p*
Operating time (min)	12 ± 1.59	10 ± 1.73	>0.05‡
Blood loss (cm^3)	21 ± 2.02	30 ± 4.01	<0.05**
VAS score			
Post-op wk 1	7.5 ± 1.11	8.5 ± 0.5	>0.05**
Post-op wk 2	8.5 ± 0.47	6 ± 0.31	>0.05**

*$n = 40$; †$n = 40$. ‡Two-sample *t*-test; **Man–Whitney U test. KTP = potassium titanyl phosphate; SD = standard deviation; min = minutes; VAS = visual analogue scale; post-op = post-operative; wk = week

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analogue scale, from the first to the seventh post-operative day (mean 7.5); in the bipolar radiofrequency group, the mean score was 8.5. However, during the second post-operative week, the mean pain score for the KTP laser group was greater than that for the bipolar radiofrequency group (8.5 and 6, respectively). By the fourth post-operative week, both groups' pain scores had improved to a nearly equal level.

The pain scores in our bipolar radiofrequency group were consistent with those found by Ragab,[7] who reported a mean pain score of 8.5 on the first post-operative day (compared with a mean pain score of nine in a cold steel dissection group). Our KTP laser group pain scores differed from those reported by Kothari *et al.*,[8] who found high post-operative pain scores in their KTP laser group on the first post-operative day, which gradually normalised by the end of the first post-operative month.

It is claimed that the KTP laser can reduce immediate post-operative pain because of its effect of desensitising the terminal nerve endings.[8] Oas and Bartels[9] reported that this benefit is lost by the end of the first post-operative week, and pain tends to last longer in a significant number of patients before disappearing completely later on. Kulaskar[10] suggested that one of the causes of increased post-operative pain may be surgical technique, and recommended that the laser beam be directed to the tonsil tissue and not to the tonsillar fossa laterally, as this causes thermal damage to the muscle bed and hence post-operative pain. Strunk and Nichols,[11] in their KTP laser group, observed a great amount of exudate on the first to second post-operative week follow-up visits. Auf *et al.*[2] reported that wound healing was slower on their KTP laser side, with increased slough after two weeks and a reduced rate of healing. The above statements could explain the higher pain scores reported by our patients in the second post-operative week.

- **The aim of this study was to compare the advantages and disadvantages of paediatric tonsillectomy using potassium titanyl phosphate (KTP) laser versus bipolar radiofrequency dissection**
- **The incidence of post-operative complications was minimal for both techniques**
- **Post-operative pain was greater in the first week in patients treated with bipolar radiofrequency. In the second week, post-operative pain was greater in the KTP laser group**

The use of bipolar radiofrequency waves for dissection and haemostasis during tonsillectomy minimised lateral heat and thermal damage to the tonsillar bed. Hence, post-operative pain and scarring were decreased. It should also be noted that the device is substantially cheaper compared with the laser apparatus (by a ratio of almost one to nine, respectively).

The incidence of post-operative complications was minimal in both our study groups. Reactionary haemorrhage was not recorded in either group, while secondary haemorrhage occurred in only one patient, in the KTP laser group (2.5 per cent). There was no need for power analysis of the rates of post-operative bleeding, as subject numbers were too small to show a significant difference.

Conclusion

Both KTP laser and bipolar radiofrequency are simple and safe new tonsillectomy techniques which result in reduced operative time, blood loss and complication rates and improved general post-operative condition of patients.

The KTP laser causes less intra-operative bleeding and immediate post-operative pain and discomfort than the bipolar radiofrequency technique. However, it is more expensive, requires slightly more operating time and causes more late post-operative pain and discomfort, compared with the bipolar radiofrequency technique (which also requires less training). The low rate of complications shows that both techniques cause minimal damage to the tonsillar bed during tonsil dissection.

From these findings, we would recommend the following in future comparative studies. Firstly, an increased number of patients in each group, to allow more accurate statistical analysis. Secondly, inclusion of the cold steel dissection technique as a third group, as it is considered the tonsillectomy gold standard, in order to allow better evaluation. Thirdly, early and late histopathological examination of the tonsillar bed and tissue, to evaluate the effect of each technique.

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