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Use of the harmonic scalpel in thyroidectomy

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Abstract

Thyroidectomy is a surgical procedure that requires meticulous dissection, safe anatomical exposure and effective haemostasis. Use of the harmonic scalpel in thyroidectomy may assist in achieving these goals, particularly in respect to enabling efficient haemostatic coagulation and division of small vessels. This report demonstrates the results of utilizing the harmonic scalpel in a series of 88 prospective thyroidectomies in patients under the care of two surgeons over a 2-year period recording a number of parameters, including operative times and post-operative complications. These data were compared with a retrospective cohort of 57 patients who underwent thyroidectomies by the same two surgeons prior to the introduction of the harmonic scalpel. The results of this study show that the use of the harmonic scalpel decreased surgical operating time by 20 min (22.5%) for a hemithyroidectomy and 13.5 min (12%) for a total thyroidectomy. Harmonic scalpel use was not associated with an increased complication rate and has been demonstrated to be a very efficient and safe tool in assisting with the conduct of a thyroidectomy.

Introduction

Harmonic scalpel is an alternative to traditional diathermy for achieving coagulation during surgical dissection. The harmonic scalpel utilizes ultrasonic energy to produce vibrations which cut and coagulate tissues. As a result, there is less spread of heat than with traditional diathermy, so that significant lateral thermal tissue damage should extend to no more than 1–3 mm, approximately half the distance of the thermal injury caused by bipolar diathermy.[1] Other advantages of this system are smokeless dissection and safety to the surgeon.[2,3]

These advantages have been used to great effect in laparoscopic surgery, where the harmonic scalpel was pioneered.[4] However, there are great potential advantages in other areas of surgery, particularly where dissection in a very vascular area is conducted with haemostasis being critical, but where other vulnerable structures near the field of dissection must be protected.

One such area where harmonic scalpel is of potential benefit is in thyroid surgery. Thyroid surgery generally delivers excellent results with negligible morbidity and mortality. Operative principles in thyroid surgery have changed little since Kocher and Halsted described the procedure over a century ago.[5] Meticulous haemostasis is important, but utilization of the conventional clamp-and-tie technique can be laborious and tedious. Dissection through a very vascular area is required and haemostasis must be secure to ensure no post-operative bleeding occurs, a complication that can severely compromise the patient's airway. At the same time, the parathyroid glands and the recurrent and external laryngeal nerves lie very close to the dissection plane and can be damaged by thermal energy from traditional bipolar dissection because of the wide spread of thermal energy. The harmonic scalpel has the potential to be of benefit in securing haemostasis while at the same time reducing the risk of injury to these structures.

To demonstrate the safety and efficacy of the harmonic scalpel in thyroid surgery, its use over an approximate 2-year period by two surgeons from our institution was analysed prospectively and compared to a similar 2-year cohort of retrospective data from the pre-harmonic scalpel era. In particular, data were reviewed in relation to operative time and observed post-operative complications for both cohorts.

Methods

All patients under the care of two consultant surgeons (IB, PV) and one surgical fellow (KK) undergoing thyroid surgery in 2004 and 2005 at one public and one private hospital in Brisbane were included in the study. These patients were all operated on using the short handle (14 cm) harmonic scalpel coagulating shears (Harmonic Scalpel System; Johnson & Johnson, Ethicon-Endosurgery

North Ryde, Sydney, NSW, Australia). Monopolar diathermy was used superficially to raise subplatysmal flaps and to separate the strap muscles. The harmonic scalpel shears were used to seal vessels encountered during capsular dissection of the thyroid gland as well as in division of thyroid isthmus and dissection of the thyroid off of the trachea (Fig. 1). It was left to the discretion of the operating surgeon as to the upper limit of the size of the vessel to be sealed and divided with the harmonic scalpel and whether or not the superior pole vessels were divided with the harmonic instrument or tied. In the majority of patients the superior pole was transected with the harmonic shears, but it was usually performed in a step-wise fashion, progressively separating out and picking off smaller sub-branches individually rather than trying to ablate the main trunk of the superior pole vessels in one action. In so doing, this technique was also undertaken with a view to avoiding injury to the superior laryngeal nerve. Although not regularly recorded in this study, most patients in this series were able to have their thyroidectomies performed via a small incision placed at the base of the neck usually in the order of 4–5 cm in length.

For comparative analysis, a cohort of patients undergoing thyroid surgery in 1998 and 1999 were also retrospectively analysed. This cohort of historical controls represented a series of consecutive patients who underwent thyroidectomies over this time period, performed by the surgeons involved in the current harmonic scalpel study. These patients were operated on with the conventional clamp and tie method as harmonic scalpel was not available. Monopolar diathermy was used for securing smaller vessels.

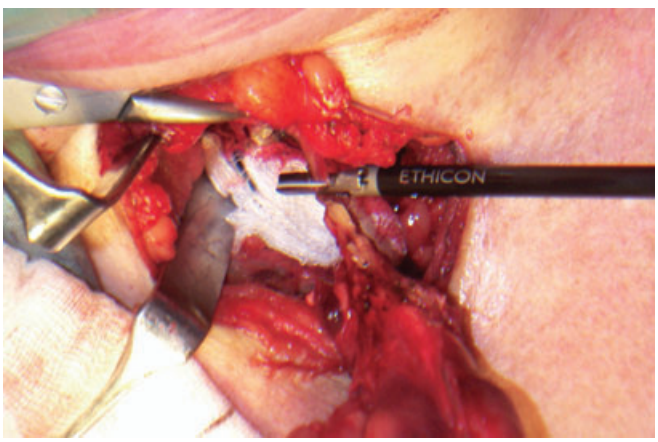

Fig. 1. Harmonic scalpel coagulating shears utilized to coagulate and divide a blood vessel during thyroidectomy.

Both total thyroidectomy and hemithyroidectomy were included irrespective of pathology. Completion thyroidectomies were considered as hemithyroidectomies.

The primary outcome measure was operation time. Secondary outcome measures were post-operative complications including incidence of laryngeal nerve palsy, incidence of hypocalcaemia, infection and haematoma. All patients received pre-operative vocal cord check via nasoendoscopy. Post-operative patients with persistent hoarseness of voice were referred for Otolaryngology review and repeat nasoendoscopy. Hypocalcaemia was defined as calcium less than 2.1 mmol/L.

Results

A total of 88 patients over 2004–2005 underwent thyroid operations using the Harmonic Scalpel. A comparative group of 57 patients from 1998–1999 using conventional techniques was also analysed. (Table 1.) The pathological findings for the two groups were similar as shown in Tables 2 (a) and (b).

The outcome measures for the two study groups are presented in Table 3. The mean operating time for the harmonic scalpel group was 69 min for hemithyroidectomy and 100 min for total thyroidectomy. These durations were significantly shorter than for the conventional group where operating times were 89 and 114 min, respectively. This represents a reduction in operating time of 20 min (22.5%) for hemithyroidectomies and 13.5 minutes (11.9%) for total thyroidectomies.

Table 1 Total patients undergoing thyroid surgery

	Pre-harmonic 1998–99	Harmonic 2004–2005
Hemithyroidectomy	45	50
Total thyroidectomy	12	38
Total	57	88

Table 2a Histological diagnosis

	98/9 HEMI	98/9 TOTAL	98/9 ALL	04/5 HEMI	04/5 TOTAL	04/5 ALL
Follicular carcinoma	3	1	4	1	1	2
Papillary Carcinoma	2	2	4	13	6	19
Follicular variant of Papillary carcinoma	2	0	2	1	0	1
MNG	10	7	17	11	18	29
Follicular adenoma	18	1	19	11	1	12
Colloid nodule	5	0	5	0	0	0
Grave's	0	1	1	0	5	5
Hurthle adenoma	0	0	0	3	3	6
Hashimoto's	1	0	1	1	1	2
Nodular hyperplasia	4	0	4	7	1	8
Amiodarone	0	0	0	0	2	2
Haemorrhagic cyst	0	0	0	2	0	2
	45	12	57	50	38	88

Table 2b Pathology summary

	98/9 HEMI	98/9 Total	98/9 ALL	04/5 HEMI	04/5 Total	04/5 ALL
Malignant	7	3	10	15	7	22
Benign	38	9	47	33	31	66

Table 3 Primary and secondary outcome comparison

	PreHarmonic 1998–1999	Harmonic 2004–2005	Difference
Av.Time hemithyroid	88.5 min	68.6 min	19.9 min (22.5%)
Av.Time total thyroid	113.6 min	100.1 min	13.5 min (11.9%)
Haematoma	2/57 = 3.5%	1/88 = 1.1%	2.20%
Infection	0	0	0
Hypocalcaemia	7/57 = 12.3%	12/88 = 13.6%	–1.30%
Transient RLN injury	1/57 = 1.8%	2/88 = 2.3%	–1.50%

Infection rate for both groups where nil. There was only one haematoma in each group requiring return to theatre within 24 h. In the conventional group, one patient represented with a small haematoma 8 days post operative following a sneeze. This was treated conservatively.

Transient hypocalcaemia was reported in 13.6% of patients in the harmonic group. The conventional displayed transient hypocalcaemia in 12.3% of patients. No patients suffered from permanent hypocalcaemia.

Temporary RLN injury was reported in two patients (2.3%) of the harmonic group and one (1.8%) of the conventional group.

Discussion

The harmonic scalpel was initially pioneered in laparoscopic surgery as a safe and effective method of achieving haemostasis during dissection.[3,4] Since then, its use has been described in numerous fields of surgery, including general, cardiac and gynaecological. Its use in open thyroid surgery has been reported by several authors demonstrating its efficacy and safety.[6–16]

The instrument is ideally suited to dissection around the thyroid gland. The thyroid has a rich blood supply, with vessels entering the gland superiorly, laterally and inferiorly. Each vessel must be securely occluded and divided to perform a safe and expeditious operation. In addition, lying in close proximity to the thyroid and its rich vasculature lie important structures including the parathyroid glands and the recurrent laryngeal nerves which can be damaged not only directly, but indirectly by lateral spread of thermal energy.

The generator attached to the harmonic scalpel produces a natural harmonic frequency of 55 kHz. The acoustic wave is then transmitted down the shaft of the scalpel to the active blade, causing it to vibrate at the very same frequency. When the active blade contacts tissues, the transmitted acoustic wave causes cavitational fragmentation and cavitational cutting. Less heat is generated than with conventional monopolar or bipolar diathermy because it does not operate through electrical energy. Therefore far less thermal energy is transmitted to the surrounding structures and the chance of thermal injury is reduced. As a result, tissue destruction around the instrument extends less than half the distance seen with electrical diathermy.[1] However, the extent of lateral thermal damage is dependent on both the power-level setting and the duration of harmonic scalpel application. Emam *et al.*[2] evaluated aspects of the safety of ultrasonic dissection using the harmonic scalpel by assessing thermal mapping of dissected tissues on various power settings. At the maximal power setting of 5, much greater temperature rises were recorded in the surrounding tissues compared to a power setting of 3. Thus, when using the harmonic scalpel near important structures such as the recurrent laryngeal nerve and parathyroids the surgeon should use power level 3 to ensure ultrasonic dissection with the harmonic scalpel is entirely safe. Using rat abdominal walls, Perko[17] showed that the width of lateral thermal damage was also proportional to the duration of application of the scalpel to the tissues even with standard output power 3; a 5-s application resulting in a mean thermal injury width of 0.0522 mm and a 10-s application producing a mean injury width of 0.1544 mm.

In our study, the use of the harmonic scalpel decreased surgical operating times by 20 min (22.5%) for a hemithyroidectomy and 13.5 min (12%) for a total thyroidectomy. These findings are consistent with several other studies, which have also shown thyroid surgery performed with the harmonic scalpel to be more efficient than that performed using conventional methods.[6–16] For example, Voutilainen *et al.*[6] estimated the average time saving to be 35.8 min for all types of operations for malignant thyroid disease, while Shemen[7] reported time savings of 30 min on average for thyroid lobectomies and 40 min for total thyroidectomy. Kilic[15] reported similar results to our study with use of the harmonic scalpel reducing operative time for thyroid surgery by an average of 18%. When considering the issue of cost/benefit analysis, it is estimated on the basis of local data in Queensland that the hourly cost of running an operating theatre is approximately $2,000 per hour or $33 per minute. Thus if 20 min were saved performing a hemithyroidectomy using the harmonic scalpel, this would represent a saving of approximately $660 in terms of theatre time. Add to this approximately $20 saved in ties, and the total saving using the harmonic scalpel would be in the order of $680 which is comparable to the current cost of the

harmonic scalpel. However, although these costs and savings seem to cancel each other out, the efficiencies created by saving operating theatre time should not be underestimated in respect to allowing additional cases to be performed and in freeing up theatres to enable improved utilization and redeployment of staff. It would also be anticipated that the time savings would improve as surgeons becomes more practised in using the harmonic scalpel and which continues to be our experience.

Injury to the recurrent laryngeal nerve during thyroidectomy is a serious and disabling complication. It may be temporary or permanent, with temporary injury often taking several months to recover.[18] Incidence of recurrent laryngeal nerve injury using traditional surgical methods varies from study to study depending on mix of pathologies, patient group and surgical experience, but is around 5 to 7% for temporary injury and 0.9 to 2.4% for permanent damage.[19,20] Only two patients (2.3%) in our harmonic scalpel group demonstrated evidence of transient nerve injury which resolved completely. There were no cases of permanent recurrent laryngeal injury. Most studies have demonstrated low rates with no difference in recurrent laryngeal nerve injury compared to conventional techniques. One study did demonstrate a significant difference with an increase in transient nerve injury while using the harmonic scalpel (9.7% versus 1.4%).[8] However, there was no difference in permanent injury and the rates decreased with increasing experience.

Our standards also compared favourably with regards to postoperative hypoparathyroidism. Again, incidence of temporary and of permanent suppression of the parathyroid varies from study to study, partly as a result of case mix but also depending on the definition of hypocalcaemia used. Reported incidence of permanent suppression ranges from 0% to 69%,[21,22] but with larger trials of longer duration estimating an incidence typically of between 1 and 6% of patients overall.[23–26] Temporary suppression is similarly variable, but with typically larger numbers of patients affected. In the present study, 12 patients (13.6%) had transient hypocalcaemia, but all of these settled within a short time after surgery and no patients in our cohort suffered from permanent hypoparathyroidism.

Haemostasis is achieved well with the use of the harmonic scalpel. Only one patient in our cohort required a return to theatre for post operative bleeding. This is similar to our comparative group which also had one bleed requiring return to theatre. Other studies have also demonstrated no difference in bleeding between techniques.[10,11,15] One study did demonstrate a decrease in blood loss with the use of the harmonic scalpel.[8]

Similar published studies assessing the harmonic scalpel have looked at other outcomes such as a decrease in incision length;[7] and no difference in post operative pain and length of hospital stay.[13,14] Cost analyses have differed with one study demonstrating a small saving[9] and another study showing the harmonic scalpel to be more expensive despite shorter operating times and less suture ties.[16]

Conclusions

This study has shown the harmonic scalpel to be a safe and effective instrument for use in open thyroidectomy. It is associated with a shorter operating time and no increase in complications. We have shown that this procedure can be carried out in our hands safely and with results comparable to those published in recent world literature.

Disclosures

This study was conducted completely independently and impartially without grants or funding from any institution, and including Johnson & Johnson; Ethicon-Endosurgery, the manufacturer and supplier of the Harmonic Scalpel System; nor do the authors have any affiliation with the supply company.

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