ORIGINAL ARTICLE

Use of Harmonic Scalpel in Open thoracic surgery

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ABSTRACT

Aim: To compare the use of the Harmonic scalpel with traditional clamp and knot tying in open thoracic surgery.
Study Design: Retrospective case-controlled study
Place and duration of study: Cardiothoracic Surgery Unit, Post Graduate Medical Institute, Lady Reading Hospital, Peshawar, from June 2011 to December 2011.
Patients: One hundred and fifty two consecutive patients undergoing open thoracic surgery by one surgeon.
Interventions: Seventy-six patients underwent open thoracic surgery with the conventional clamp-and-tie technique (oesophagectomy, n=51; upper lobectomy, n=20; excision of retro sternal goiter, n= 5) and 76 with the harmonic scalpel (oesophagectomy, n=51; upper lobectomy, n=20; excision of retro sternal goiter, n= 5).
Main Outcome Measures: Operative time and blood loss using a 2-tailed *t* test, _2 test, and Wilcoxon rank sum test.
Results: The 2 groups were similar regarding age and sex. Mean ± SD operative time was shorter in the harmonic scalpel group compared with the conventional technique group for oesophagectomy (89±20 minutes vs. 115±25 minutes; *P*_.01), upper lobectomy (50±21 minutes vs. 80±28 minutes; *P*_.01) and excision of retrosternal goiter (54± 16 minutes vs. 88± 16 minutes *P*_.01) procedures. Mean ± SD blood loss was minimal in the harmonic scalpel group compared with the conventional technique group for oesophagectomy (250 ± 58mls vs. 480 ± 65mls; *P*_.01), upper lobectomy (280±21 ml vs. 488±28mls; *P*_.01) and excision of retrosternal goiter (154 ± 16mls vs. 318± 26mls; *P*_.01) procedures.
Conclusions: The use of the harmonic scalpel is safe, and it shortens the operative time by almost 30 minutes and blood loss by almost 200 ml compared with the conventional technique for open thoracic surgical procedures.
Key words: Harmonic scalpel, traditional clamp and knot tying, open thoracic surgery,

INTRODUCTION:

The Harmonic scalpel is a new device that has been introduced to surgery during the last decade. It is a device that uses high frequency mechanical energy to cut and coagulate tissues at the same time.[1] Laparoscopists were the first ones to use this method widely. It has been proven to decrease operation time and complications in studies of abdominal solid organ surgery[2-5], adrenalectomy[6] and thoracic surgery[7, 8] as well as many other procedures[9-11].

Oesophagectomy, lobectomy and thyroidectomy, in essence, is devascularization by double ligating and dividing the branches of the vessels followed by excision, as is true for all resectional surgical procedures. The unique features of these operations are richest blood supplies, with numerous blood vessels and plexuses entering the

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parenchyma. These need to be controlled with ligatures. The ligation and division of these vessels is time consuming. Reduction of the time spent with the conventional clamp-tie technique can significantly reduce the operative time in this procedure. Since time spent in the operating room is expensive,[12] this will both decrease the operation time and the operative costs. In this sense, we hypothesized that the use of the harmonic scalpel could lead to a significant reduction of the operative time and minimal blood loss in open thoracic surgeries and report the results of an initial case-controlled study comparing the use of conventional suture tying vs. the harmonic scalpel in patients undergoing open thoracic procedures regarding decrease operative time and blood loss.

METHODOLOGY:

Between June 2011 and December 2011, in Cardiothoracic Surgery Unit, Post Graduate Medical Institute, Lady Reading Hospital, Peshawar, more than 600 patients underwent various open thoracic surgical procedures. Those patients undergoing oesophagectomy, upper lobectomy and total thyroidectomy form the subject of this study for practical considerations. There were seventy-six patients underwent open thoracic surgery with the conventional clamp-and-tie technique (oesophagectomy, n=51; upper lobectomy, n=20; excision of retro sternal goiter, n= 5) and 76 with the harmonic scalpel (oesophagectomy, n=51; upper lobectomy, n=20; excision of retro sternal goiter, n= 5).The choice between the type of surgery for a given patient depended on the availability of the equipment.

All patients had routine preoperative workup for their disease and the same anesthetic and hospital care regardless of the surgical technique employed. The patients were positioned and draped in the conventional manner.

Medical records of the patients enrolled in the study were reviewed and the patients in the 2 surgical groups were compared regarding operative time and estimated blood loss using a 2-tailed *t* test, χ^2 test, and Wilcoxon rank sum test. Statistical significance was reached at $P<0.05$. Patients with previous neck, thoracic and abdominal surgeries and those undergoing an accompanying additional procedure were not considered for analysis.

RESULTS:

The 2 groups were similar regarding age and sex. Mean ± SD operative time was shorter in the harmonic scalpel group compared with the conventional technique group for oesophagectomy (89±20 minutes vs. 115±25 minutes; *P*_.01), upper lobectomy (50±21 minutes vs. 80±28 minutes; *P*_.01) and excision of retrosternal goiter (54± 16 minutes vs. 88± 16 minutes *P*_.01) procedures. Mean ± SD blood loss was minimal in the harmonic scalpel group compared with the conventional technique group for oesophagectomy (250 ± 58mls vs. 480±65mls; *P*_.01), upper lobectomy (280±21 ml vs. 488±28mls; *P*_.01) and excision of retrosternal goiter (154± 16mls vs. 318± 26mls; *P*_.01) procedures.

DISCUSSION:

The development of ultrasonically activated coagulating shears in the early 1990s has provided an alternative to other methods of controlling blood vessels. The device divides tissue by using high-frequency (55 000 Hz) ultrasonic energy transmitted between the instrument blades. The active blade of the instrument vibrates longitudinally against an inactive blade over an excursion of 50 to 100 μm[13]. This mechanical action disrupts protein hydrogen bonds within the tissue. This takes place at a relatively low temperature (80°C) causing a lesser tissue injury (<1.5 mm) compared with both electrocautery and laser[14, 15]. Because the water in the tissue does not boil due to this mild increase in temperature, the proteoglycans and collagen fibers in the tissue become denatured and mix with intracellular and interstitial fluids to form a glue like substance (a coagulum)[16].

One edge of the active blade is relatively sharp for cutting, and the other is blunt for coagulation purposes. The device is operated using foot pedal control in 5 power settings. The "full power" mode, level V, is used for cutting; and the "variable power" level, level III, is for coagulation. The blades are opened and closed using a scissor grip. The speed of cutting is increased by increasing the force of grip.[15] Each vessel is divided using the "double welding" technique, in which each end of the vessel is sealed using power level III just to the point before division, and then the vessel is divided in between again with the harmonic scalpel. It is important to wait patiently until the tissues fall apart by themselves for complete homeostasis.

The security of vessel control obtained with ultrasonically activated shears has been demonstrated in many animal and human studies. The ultrasonically activated device has been shown to provide a mean bursting pressure of 1204 mm Hg at 70%, and 1193 mm Hg at 100% power level in small- to medium-sized intraperitoneal arteries of anesthetized living pigs—much greater than the normal intravascular pressure.[16] In humans, the security of coapting vessels up to 6 mm with a tissue-welding technique has been demonstrated during laparoscopic spleenectomy, colonic resections, and Nissen fundoplication procedures, during which bleeding is seldomly seen even with division of major arteries and veins.[17] The harmonic scalpel has also been shown to decrease bleeding and operative time compared with the multifire clip applier for the division of the short gastric vessels during laparoscopic Nissen fundoplication in a randomized study[2].

Homeostasis is of utmost importance in thyroid surgery to control and divide the numerous vessels before excision of the gland. Traditional surgery involves hand-tied ligatures to control the 2 ends of a vessel before division. Although many sophisticated means of achieving vessel control (eg, bipolar electrocautery, lasers, clips, and staples) found widespread applications in many other types of procedures, the only modification of the thyroidectomy technique during the past decades included the use of monopolar electrocautery for dissection due to various technical, anatomical, and practical reasons. Clips work for large vessels and are subject to dislodgment; whereas staples are wasted and costly for multiple single-vessel applications. Lasers are hindered by the risk of injury to many vital structures (such as the recurrent nerves) in the operative field, and bipolar electrocautery does not give the surgeon the freedom of applicability at different angles.[18]

In our study both groups were comparable with regard to demographics .These results have implications for significant hospital cost savings. By shortening the general anesthesia time, the use of the harmonic scalpel might also accelerate postoperative recovery. Voutilainen et al[19] observed a mean advantage of 54 minutes with the use of the harmonic scalpel vs. use of the conventional technique in an initial matched-pair study for thyroidectomy (n = 6 pairs) and lobectomy (n = 1 pair). They subsequently randomized 36 patients undergoing thyroidectomy or lobectomy into ultrasonically activated shears (n = 19) and conventional surgery (n = 17) groups.[20] The Voutilainen and Haglund study reported that average operating room time savings with the Harmonic scalpel was 35.8 minutes, with no difference in complications between harmonic scalpel and traditional groups[20]. In a French study, Meurisse et al[21] randomized 34 patients with euthyroid multinodular goiter undergoing total thyroidectomy to either ultracision or conventional homeostasis and demonstrated an average 26-minute reduction in operating time as well as reductions in blood loss, postoperative analgesic consumption, and the incidence of transient hypothyroidism. They also reported that the use of the harmonic scalpel was no more expensive than conventional homeostasis as long as a minimum of 15 patients shared the initial unit cost of the device.[21] In our study we observed the mean advantage of 30 minutes with the use of the harmonic scalpel vs. use of the conventional technique .To our knowledge, the present study is the first south Asian study in the literature reporting the use of the harmonic scalpel in open thoracic surgery. There was significant difference in the amount of estimated blood loss between the 2 techniques in our study because we used the harmonic scalpel for vessel ligation, as well as for dissection as well.

In conclusion, with this initial case-controlled study, we demonstrated that the use of the harmonic scalpel for the control of vessels during open thoracic surgical procedures is safe, shortens operative time by almost 30 minutes and minimize blood loss by almost 200mls compared with the conventional technique. This represents a refinement of our current technique, with decreased anesthesia and operating time, and significant cost savings. As the next step, we are in the process of starting a randomized clinical trial to further assess the use of the harmonic scalpel in various open thoracic surgical procedures.

CONCLUSIONS:

The use of the harmonic scalpel is safe, and it shortens the operative time by almost 30 minutes and blood loss by almost 200 ml compared with the conventional technique for open thoracic surgical procedures.

REFERENCES:

1. Amaral JF. The experimental development of an ultrasonically activated scalpel for laparoscopic use. *Surg Laparosc Endosc.* 1994;4: 92-99.

2. Laycock WS, Trus TL, Hunter JG. New technology for the division of short gastric vessels during laparoscopic Nissen fundoplication: a prospective randomized trial. *Surg Endosc.* 1996;10: 71-73.

3. Takao S, Shinchi H, Maemura K, Aikou T. Ultrasonically activated scalpel is an effective tool for cutting the pancreas in biliary-pancreatic surgery: experimental and clinical studies. *J Hepatobiliary Pancreat Surg*. 2000;7: 58-62.

4. Gertsch P, Pelloni A, Guerra A, Krpo A. Initial experience with the harmonic scalpel in liver surgery. *Hepatogastroenterology.* 2000;47: 763-766.

5. Erian M, McLaren GR, Buck RJ, Wright G. Reducing costs of laparoscopic hysterectomy. *J Am Assoc Gynecol Laparosc.* 1999;6: 471-475.

6. Siperstein AE, Berber E, Engle KL, Duh QY, Clark OH. Laparoscopic posterior adrenalectomy: technical considerations. *Arch Surg*. 2000;135: 967-971.

7. Ohtsuka T, Wolf RK, Wurnig P, Park SE. Thoracoscopic limited pericardial resection with an ultrasonic scalpel. *Ann Thorac Surg.* 1998;65: 855-856.

8. Aoki T, Kaseda S. Thoracoscopic resection of the lung with the ultrasonic scalpel. *Ann Thorac Surg.* 1999;67: 1181-1183.

9. Deo SV, Shukla NK. Modified radical mastectomy using harmonic scalpel. *J SurgOncol.* 2000;74:204-207.

10. Inaba H, Kaneko Y, Ohtsuka T, et al. Minimal damage during endoscopic latissimus dorsi muscle mobilization with the harmonic scalpel. *Ann Thorac Surg.*2000;69: 1399-1401.

11. Lopoo JB, Paek BW, Maichin GA, et al. Cord ultrasonic transection procedure for selective termination of a monochorionic twin. *Fetal Diagn Ther.* 2000; 15:177-179.

12 Viapiano J, Ward DS. Operating room utilization: the need for data. *Int Anesthesiol Clin.* 2000;38: 127-140

13. McCarus SD. Physiologic mechanism of the ultrasonically activated scalpel. *J Am Assoc Gynecol Laparosc.* 1996;3: 601-608.

14. Hambley R, Hebda PA, Abell E, Cohen BA, Jegasothy BV. Wound healing of skin incisions produced by ultrasonically vibrating knife, scalpel, electrosurgery, and carbon dioxide laser. *J Dermatol Surg Oncol.* 1988;14: 1213-1217.

15. Armstrong DN, Ambroze WL, Schertzer ME, Orangio GR. Harmonic scalpel vs electrocautery hemorrhoidectomy: a prospective evaluation. *Dis Colon Rectum.* 2001;44:558-564.

16. Kanehira E, Omura K, Kinoshita T, Kawakami K, Watanabe Y. How secure are the arteries occluded by a newly developed ultrasonically activated device? *Surg Endosc.* 1999;13: 340-342.

17. Swanstrom LL, Pennings JL. Laparoscopic control of short gastric vessels. *J Am Coll Surg.* 1995;181: 347-351.

18. Kennedy JS, Stranahan PL, Taylor KD, Chandler JG. High-burst-strength, feedback-controlled bipolar vessel sealing. *Surg Endosc.* 1998;12: 876-878.

19. Voutilainen PE, Haapiainen RK, Haglund CH. Ultrasonically activated shears in thyroid surgery. *Am J Surg.* 1998;175: 491-493

20. Voutilainen PE, Haglund CH. Ultrasonically activated shears in thyroidectomies: a randomized trial. *Ann Surg.* 2000;231: 322-328.

21. Meurisse M, Defechereux T, Maweja S, Degauque C, Vandelaer M, Hamoir E. Evaluation of the ultracision ultrasonic dissector in thyroid surgery: prospective randomized study. *Ann Chir.* 2000;125: 468-472