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REVIEW ARTICLE

Comparative Study between Harmonic Scalpel and LigaSure Vessel Sealing System: In Open and Laparoscopic Surgery

Vinayak Mishra

ABSTRACT

Background: Energy sources have been an important part of surgery in achieving hemostasis and bloodless field to operate. Nowadays the most recent and commonly used are the bipolar vessel sealing system (LigaSure) and the harmonic scalpel (HS).

Purpose: To do a comparative review between the LigaSure vessel sealing system and harmonic scalpel to make surgery faster, safer and better.

Materials and methods: The literature regarding this review article was searched online on various websites like Google, PubMed, World Journal of Gastrointestinal Surgeons, YouTube. Search words used were LigaSure *vs* harmonic scalpel, LigaSure vessel sealing system, role of vessel sealer and HS in laparoscopic surgery.

Conclusion: LigaSure vessel sealing system (LVSS) proves to have a hand above the HS as it depends of the surgeon's convenience to use which of the energy sources when it comes to handling and maneuverability during surgery resulting in an overall faster, safer and a bloodless experience.

Keywords: LigaSure *vs* harmonic scalpel, LigaSure vessel sealing system, Role of vessel sealer and harmonic scalpel in laparoscopic surgery.

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INTRODUCTION

Energy sources have been an important part of surgery in achieving hemostasis and bloodless field to operate. The energy sources are required to cut, coagulate, desiccate, dissect and evaporate tissue. There have been tremendous upgrades in the technology used in energy sources which targets on better, faster and safe hemostasis with minimal lateral thermal spread or damage. Lateral thermal damage confers to the damage to the tissues just adjacent to the target site. Nowadays, the two most used energy sources used are the LigaSure vessel sealing system (LVSS) (Fig. 1) and the harmonic scalpel (HS) (Fig. 2).

LVSS manufactured by Covidien under the brand name of Valleylab is a bipolar apparatus for sealing vascular tissues. It seals tissue by administration of high current and low voltage that of 180 V as compared to conventional electrosurgery. Its unique combination of pressure energy causes fusion of vessels. The fusion is because of melted collagen and elastin in the vessels which forms a permanent, plastic like seal. LVSS has a unique property of active tissue response which is a feedback from tissue that controls the energy delivery and automatically discontinues it when the seal cycle completes. This eliminates the guesswork of operating surgeon and provides minimal lateral thermal damage to approximately 2 mm. There is no sticking of the instruments on tissues with least charring of the tissues. The seal withstands thrice of normal systolic blood pressure. The LVSS generator detects the characteristic of the tissue in the jaws of the instruments and delivers energy accordingly to provide a permanent seal. LVSS promises to provide a secure seal of blood vessels measuring up to 7 mm in diameter. Various probes both for laparoscopic and open surgeries are available which are compatible to this electrosurgical generator.

Harmonic scalpel (HS) is manufactured and marketed by Ethicon across the globe. It uses ultrasonic energy as its principle and, hence, dissection by ultrasonic probes is called ultracision. The HS is a high power system which works at a frequency of 55.5 kHz or 55,500 vibrations/sec. It comprises of a generator, blade and a hand piece. The hand piece has an ultrasonic transducer which consists of stacked piezoelectric crystals sandwiched under pressure among metal cylinders. The sealing of the vessels is achieved due to denatured protein coagulum which occurs due to tamponade and coaptation. The ultrasonic generator converts ultrasonic energy into mechanical energy. HS mainly has three compatible probes both for open and laparoscopic surgery that are the shear, blade and a hook. The shear has opposite silicon padding which the blade and hook lacks. The shear can coagulate vessels up to 5 mm, whereas the hook and blade only 2 mm in diameter. The HS probes reach the temperature of 80ºC and even on prolonged use stays below 250ºC which is far less than other electrosurgical and laser energy sources resulting in reduced lateral thermal spread and charring. Vibration of the active probe prevents sticking of coagulated tissue over it.

AIMS AND OBJECTIVES

The present study is designed to compare between HS and LVSS in open and laparoscopic surgery.

MATERIALS AND METHODS

The literature regarding this review article was searched online on various websites, like Google, PubMed, World Journal of Gastrointestinal Surgeons, YouTube. Search words used were LigaSure *vs* HS, LVSS role of vessel sealer and HS in laparoscopic surgery.

DISCUSSION

Kwok SY et al in their double-blinded study did a randomized trial comparing LigaSure and HS hemorrhoidectomy. Forty-nine patients with grades 3 and 4 hemorrhoids admitted for hemorrhoidectomy were selected and randomized into two groups: (1) LigaSure hemorrhoidectomy or (2) HS hemorrhoidectomy. The primary outcomes measured were the analgesic requirement and the postoperative pain score (assessed by an independent assessor). Secondary outcome criteria included the operating time, blood loss, hospital stay, patient satisfaction score, and early and late complications and they concluded that LigaSure hemorrhoidectomy reduces the postoperative pain and operating time compared to the HS hemorrhoidectomy. And, it is a safe, effective procedure for treating grades 3 and 4 hemorrhoids.[1]

Smith et al in a prospective comparison of four laparoscopic vessel ligation devices found that the LigaSure had the best overall performance with the highest burst pressure, low thermal spread, fast sealing time, and low smoke production. By contrast, the HS has the lowest thermal spread and smoke production but was slow and had the lowest mean burst pressure.[2]

Cakan A et al studied the safety and efficacy of the LVSS and HS in sutureless nonanatomical lung resections on 20 adult rabbit lungs in which 1 × 1 cm wedge resections were performed under one-lung ventilation with both LVSS and HS and compared the air tightness and tissue damage caused by them. They found no statistical significant difference when the air tightness for both devices was compared after resection ($p = 0.37$) and concluded that their study LVSS and HS can both be used for peripheral lung resections without any need of further intervention for securing the air tightness, but LVSS was found safer by means of tissue damage when compared with HS in this experimental study.[3]

Zarebczan B et al did a retrospective study to compare the LigaSure and HS in thyroid surgery. Their study included a total of 231 patients of whom 123 underwent total thyroidectomy and 108 underwent lobectomy. They found that there was a significant decrease in the operative time for both thyroidectomies and lobectomies when the HS was utilized. But in regard to complications, there was no statistically significant difference in the number of transient and permanent recurrent laryngeal nerve injuries, percentage of patients developing hypocalcemia or rate of hematoma development. And, concluded that there was no difference in the rate of complications between the two devices. However, the use of the HS significantly decreased operative time for both thyroidectomies and thyroid lobectomies compared with the LigaSure device.[4]

An inference can also be made from a video available online on the site www.youtube.com, which shows the infrared camera recording of the probes of LVSS and HS which compares the lateral thermal spread of both the instruments, which is more in LVSS as compared to HS (Fig. 3). It might be also due to a slightly bigger probe tip of LVSS as compared to smaller probe tip of HS shear.[5]

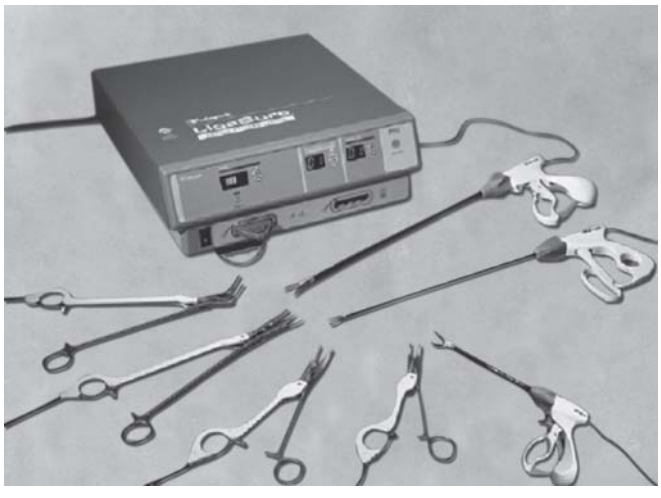

Fig. 1: LigaSure vessel sealing system

Fig. 2: Harmonic scalpel

Two cohort studies comparing a bipolar vessel sealer (BVS) with the ultrasonic coagulating shears (UCS) for laparoscopic colectomy reported a slightly reduced length of surgery and decreased blood loss in the BVS groups.[6] One of these studies included 30 patients with colon cancer who underwent laparoscopic transverse colectomy and sigmoidectomy using either the electrothermal bipolar vessel sealer (EBVS) (LigaSure) or UCS (harmonic scalpel). The EBVS and the UCS were used for the mesocolon dissection in the transverse and sigmoid colon. The incidence of rebleeding was significantly lower in the EBVS group than in the UCS group for both surgical procedures (0.3 *vs* 1.2 in transverse colectomy, 0.3 *vs* 2.0 in sigmoidectomy respectively). The required time for mesocolon dissection was also significantly shorter when the EBVS was used in both laparoscopic transverse colectomy and sigmoidectomy (7.9 *vs* 18.4, 15.0 *vs* 27.6 respectively). Another report demonstrated the outcome of 200 consecutive unselected patients who underwent laparoscopic colorectal resections, of which 100 were performed with EBVS (LigaSure) and 100 with UCS (harmonic scalpel).[7] Only right colectomy (RC), left colectomy (LC) and low anterior resections (LAR) were performed during this study. There were no deaths in either group. One conversion to open surgery and two major complications occurred in the UCS harmonic scalpel group. There were no differences in the mean length of surgery (111 *vs* 133, 140 *vs* 176 and 153 *vs* 201 minutes) or in the mean postoperative hospital stay (5.2 *vs* 6.1, 6.5 *vs* 7.1 and 6.8 *vs* 7.3 days) for RC, LC and LAR between EBVS LigaSure group and UCS harmonic scalpel group respectively. There were, however, differences in the mean blood loss: 115 *vs* 370, 150 *vs* 455 and 185 *vs* 495 ml for RC, LC and LAR between the EBVS LigaSure group and the UCS harmonic scalpel group respectively.[6,7]

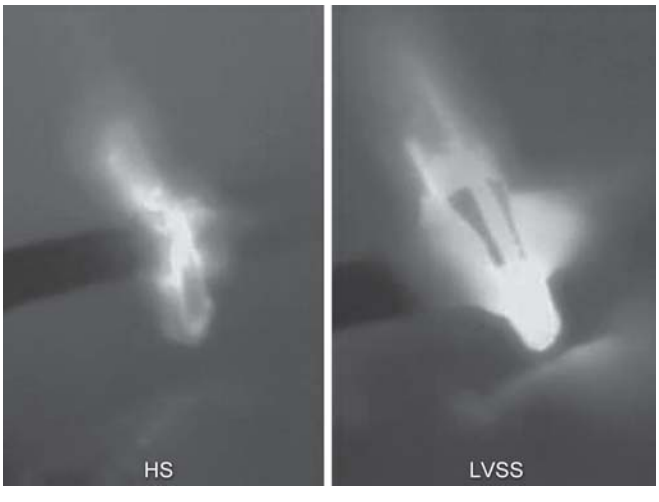

Fig. 3: Screenshots taken from infrared recordings of probes of HS and LVSS respectively

CONCLUSION

After reviewing the above articles, we found that LVSS as compared to HS, LVSS provides a better, safer and much secure seal than HS that is up to 7 mm. The postoperative pain, when used in open surgery, is less as compared to HS. Even blood loss was comparatively less while using LVSS than HS. HS made the surgery faster with low smoke production as compared to LVSS. Lateral thermal spread of HS is quite less as compared to LVSS but LVSS as compared to other electrosurgical generators was quite less. At the end though LVSS proves to have a hand above the HS, it depends of the surgeon's convenience to use which of the energy sources when it comes to handling and maneuverability during surgery resulting in an overall faster, safer and a bloodless experience.

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ABOUT THE AUTHOR

Vinayak Mishra

Laparoscopic Surgeon, Department of Minimal Access Surgery Hanumant Endosurgery Center, Lucknow, Uttar Pradesh, India, Phone: 8853042226, e-mail: drvinayakmishra@gmail.com