

Differences between Thunderbeat, LigaSure and Harmonic Scalpel Energy System in Minimally Invasive Surgery

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ABSTRACT

Background: An essential part of surgery is dissection and securing hemostasis. This is easily done by the use of energy. Thunderbeat energy source has superseded the LigaSure and harmonic energy sources in this respect.

Aim: To review literature on the differences between thunderbeat, LigaSure and harmonic energy systems.

Materials and methods: These were drawn from previous research materials online in PubMed, Researchgate, Wikipedia and YouTube.

Conclusion: Thunderbeat has a higher versatility than other instruments. This new energy device is an appealing, safe alternative for cutting, coagulation, and tissue dissection during surgery and decreases time and increases versatility during surgical procedures.

Keywords: Thunderbeat, LigaSure, Harmonic, Energy systems, Versatility.

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INTRODUCTION

Minimally invasive surgery would require an energy source to dissect body tissues and at the same time achieve hemostasis.¹

Over time, there are remarkable improvements in energy sources to increase the speed of surgery while reducing the side effects of energy on surrounding tissues due to lateral thermal spread.²

Lateral thermal spread of energy results in damage to tissues near the target site. Currently, thunderbeat has superseded the two most used energy sources *viz* LigaSure vessel sealing system (LVSS) and the harmonic scalpel (HS).

Thunderbeat (TB) is the World's only integrated form of surgical energy from a single instrument. In January 21, 2013, a published work showed that endoalpha can fully control and directly interface with the revolutionary thunderbeat platform from Olympus (Japan). It simultaneously delivers ultrasonically generated frictional heat energy and electrically generated bipolar energy. Thunderbeat has higher bursting pressure and highly reduced thermal spread than LVSS and HS. It can achieve 7 mm vessel sealing.

The versatility of thunderbeat was based on the following five variables: hemostasis, histologic sealing, cutting, dissection and tissue manipulation. The versatile score is higher than LVSS and HS, and the dissection time with thunderbeat is shorter ensuring a faster surgery.

LigaSure vessel sealing system manufactured by Covidien under the brand name Valleylab is a bipolar apparatus for sealing vascular tissue. 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. In short LVSS applies a high coaptive pressure during the generation of tissue temperature under 1000°C, hydrogen cross-links are first ruptured and then renatured, resulting in a vascular seal that has high tensile strength. Melted collagen and elastin in the vessels forms a permanent plastic like seal. It provides secure seal of blood vessels measured up to 7 mm diameter.

Harmonic scalpel is manufactured and marketed by Ethicon. The HS is a high power system which works at a frequency of 55.5 KHz or 55,500 vibrations/sec.

Dissection by ultrasonic is called ultracision. The ultrasound (US) transducer located in the handpiece is composed of piezoelectric crystal sandwiched under pressure among metal cylinders. The US generator converts ultrasonic energy into mechanical energy. The sealing of the vessels is achieved due to denatured protein coagulum which occurs due to tamponade and coaptation.

It has three compatible probes 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 8°C and even on prolonged use stays below 250°C which is far less than other electrosurgical sources resulting in reduced lateral thermal spread and charring. Vibration of the active probe prevents

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sticking of coagulated tissues over it however mist production could minimally affect visibility.

AIMS AND OBJECTIVES

This study is designed to highlight differences between thunderbeat and the two other energy sources: LigaSure and harmonic.

MATERIALS AND METHODS

An extensive literature search online was done through PubMed, Wikipedia, Researchgate and videos via YouTube and video conferencing. References was made to available research and conference materials located at the World Laparoscopy Hospital, Gurgaon, Haryana, India.

RESULTS

The Figures 1 to 3 depict the jaws of LigaSure, thunderbeat and harmonic probe respectively. Table 1 shows the differences in visibility, operation time, burst pressure and thermal spread among the three energy sources. Graph 1 shows the differences in bursting pressure between thunderbeat and LigaSure as demonstrated with a 7 mm blood vessel. Harmonic was not depicted in this figure because it cannot secure sealing of a 7 mm blood vessel. Graph 2 shows the differences in the duration of surgery performed with the three different energy sources.

DISCUSSION

The question arises what actually are the properties of an ideal energy system? An ideal energy system is one that offers precise and rapid dissection of tissues without compromising hemostasis and visibility. It is not clear whether the current energy systems are ideal. The LigaSure and harmonic predicate systems have been in use, but the revolutionary thunderbeat supersedes them as its qualities approaches an ideal energy system.

Thunderbeat provides fast dissection, fast cutting and immediate sealing of blood vessels. It is an integration of advanced bipolar energy and harmonic energy delivered through a single multifunctional instruments allowing a surgeon to simultaneously seal and cut vessels up to and including 7 mm in size with minimal thermal spread.^{3,4}

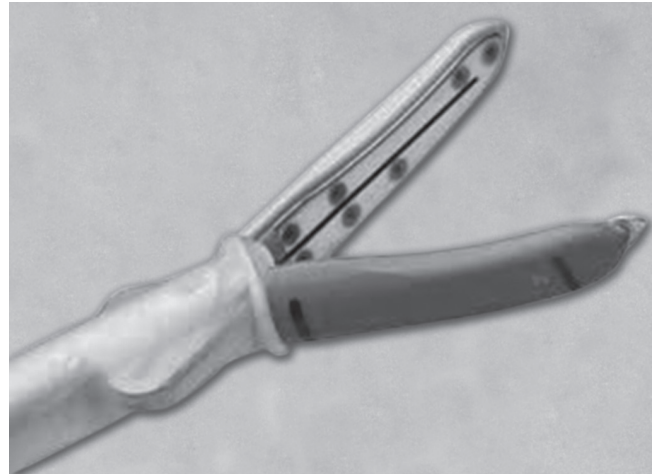


Fig. 1: View of LigaSure jaw

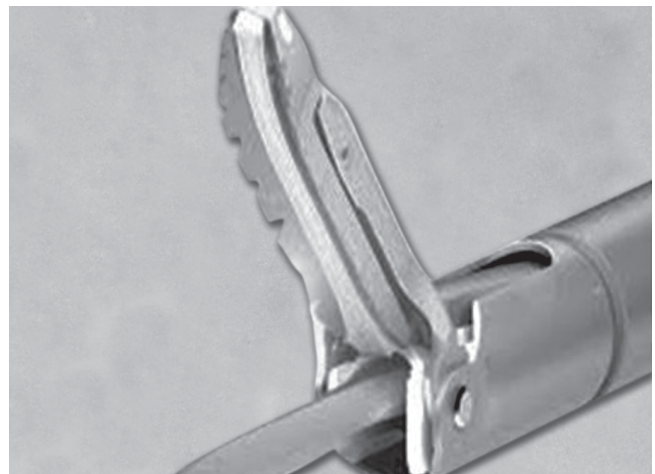


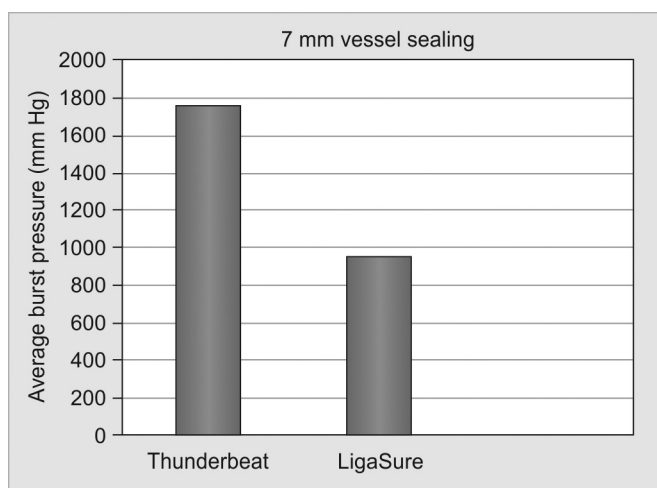
Fig. 2: View of thunderbeat jaw



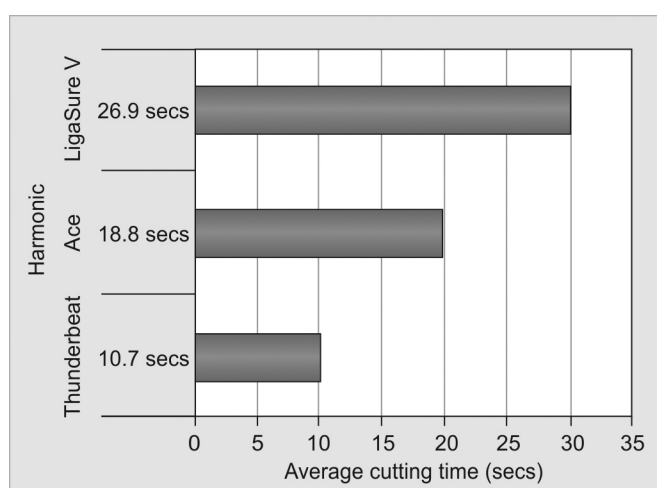
Fig. 3: View of harmonic jaw

Table 1: Differences in visibility, operation time burst pressure and thermal spread

Energy system	Visibility	Operation time	Burst pressure	Thermal spread
Thunderbeat	Unimpaired visibility	Fastest in class cutting	Highest mean burst pressure	Least lateral thermal spread
LVSS	Smoke production affecting visibility	Slow surgery	Moderate mean burst pressure	2 mm lateral thermal spread
HS	Mist production affecting visibility	Slower surgery	Lowest mean burst pressure	Less than 1 mm thermal spread



Graph 1: Differences in bursting pressure



Graph 2: Differences in duration of surgery

The patented Jaw design provides precise, controlled dissection and always bipolar coagulation without sacrificing grasping ability.

Surgeons no longer need to choose between rapid dissection and reliable hemostasis when selecting an advanced energy device.

Benefits of the unprecedented versatility thunderbeat provide the following:

1. Fastest in class cutting speed thereby reducing operation time.
2. Reliable 7 mm vessel sealing.
3. Precise dissection with fine Jaw design.
4. Always available bipolar energy for hemostasis without cutting.
5. Minimal thermal spread.
6. Fewer instrument exchanges.
7. Reduced mist generation helps to maintain visibility.

The surgical tissue management system subject device which thunderbeat represents is a modification to an ultrasonic generator to allow for independent or synchronistic use with previously cleared electro-surgical unit.

The predicate devices use either high frequency bipolar or ultrasonic energy to seal and/or cut vessels. When compared to the predicate electrical surgical instruments, the subject device thunderbeat instruments have similar technological features, such as the shaft length, shaft rotation and shaft diameter. The main difference is that the subject device thunderbeat does not require a mechanical blade for cutting and had a higher versatile score than the present US and LigaSure energy systems.

Generator: When compared to the ultrasonic energy, the thunderbeat has similar technological features, such as the number of instrument sockets, footswitch options, output levels and waveforms. There are subtle differences in the input current PF bipolar frequency, RF bipolar constant voltage and maximum wattage.

Combining and activating the ultrasonic output and the HF bipolar output simultaneously enable to seal and cut vessels and to cut and coagulate soft tissue. Activating the HF bipolar output enables vessels sealing and hemostasis. Activating the ultrasonic output enables to seal and cut vessels and to cut and coagulate soft tissues.

To use the thunderbeat, the handpiece plug of the thunderbeat transducer which converts drive current into ultrasonic output is connected to the thunderbeat socket of the USG-400. The HF bipolar current and drive current are supplied to the transducer via a cable eliminating the need to connect a cord of the ESG-400.

LVSS has a unique property of active tissue response which is a feedback from the tissue that controls the energy delivery and automatically discontinues it, when the seal cycle completes. This may eliminate the guesswork of operating surgeon; however, there is a minimal lateral thermal damage of 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 characteristics of the tissue in the Jaws of the instruments and delivers energy accordingly to provide a permanent seal.^{5,6}

However, the LVSS produces smoke which may affect visibility, unlike the thunderbeat with its highly versatile characteristics.

An inference can also be made from a video available online on the site, www.youtube.com, which is a documentary highlighting the obvious differences in bursting pressure and operation time between the thunderbeat and the predicate devices.

The operation time of LigaSure electro-surgical bipolar sealing system is less than that of the ultrasonic device.⁷⁻¹⁰ The operation time of the thunderbeat is less than that of LigaSure and harmonic devices.

CONCLUSION

After a literature search, we found that TB is different in many ways to LVSS and HS. Thunderbeat is more versatile than LVSS and HS as evidenced in its fastest in class cutting speed thereby reducing the operation time, reliable 7 mm vessel sealing, precise dissection with fine jaw design, insignificant thermal spread and best visibility at time of surgery. The safety efficacy and versatility of TB is very useful in other to achieve perfection in modern day surgery.

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