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JNMU

Journal of Nanjing Medical University, 2008, 22(2):102–106

www.elsevier.com/locate/jnmu

Research Paper

Clinical uses of ligasure vessel sealing system(LVSS) in surgery

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Received 30 October 2007

Abstract

This article provides the efficacy of the new device, Ligasure Vessel Sealing System(LVSS) for achieving hemostasis. LVSS is an alternative to suture ligatures, hemoclips, staplers, for ligating vessels and tissue bundles. This new device seals the vessels up to 7 mm in diameter by denaturing collagen and elastin within vessel wall and surrounding connective tissue.

Key words: ultrasonic coagulation; bipolar coagulation; ligasure vessel sealing system; bipolar cautery

INTRODUCTION

Achieving hemostasis is fundamental in all surgical procedures, but sometimes may be challenging in minimal access surgery. Traditionally, several methods have been used, such as using clips, staples, sutures, ultrasonic and monopolar or bipolar coagulation[1].

The ligasure vessel sealing system developed by Valleylab, effectively seals vessels from 1 to 7 mm in diameter and these seals can withstand a minimum of three times normal systolic pressure[2]. It provides sealing by applying high current and low voltage, which differ from the energy used for standard monopolar and bipolar cautery(high voltage, low current)[3]. This system which consists of bipolar surgical generator and handset operated by foot pedal, provides precise energy control with physical compression, including a brief cool down. This mechanism denatures protein within the vessel wall and produces a translucent seal that can be transected by scissors. Thermal alterations are limited to less than 1.5 mm beyond the tissue within the jaws[2]. Positioning of the tips of the instruments approximate to metal clips, forceps or fluid collections and wet tissues(sponge) should be avoided since under such conditions electric energy and heat may be transduced into tissues resulting in organ injury[4]. In recent studies comparing the effects of this device with those of ultrasonic coagulation, bipolar coagulation, and surgical clips and sutures demonstrated that the LVSS creates seals that are stronger than seals obtained with other energy-based ligation methods, and similar in strength to those obtained with the mechanical ligation techniques[2].

This new energy- based ligation device has been successfully used in abdominal, gynecologic, urologic, thoracic surgeries[5](***Fig 1*** and ***2***).

Fig 1 The oval tip of the Ligasure Device

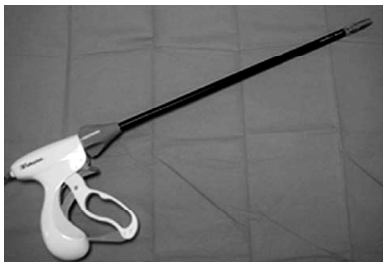

Fig 2 A 10mm Ligasure Device

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Use of LVSS in various surgery

Use of LVSS in cardiothoracic surgery

The experience with ligasure system is limited particularly in thoracic surgery[6-8]. In one particular study the use of coagulation technique in the swine model showed an excellent sealing effect on pulmonary vessels. All the vessel sutures were resistant to a pressure higher than 150 mmHg which is above the pressure occurring in physiologic conditions. Thus this technique can be safely used on vessels less than 7 mm. The effect of the sealing system however on bronchi was not so satisfactory. Their results showed that the sealing effect was unpredictable for bronchi with diameters ranging from 3 mm to 5 mm and negligible for those with diameters more than 6 mm. The good results obtained in smaller bronchi were confirmed by the assessment of suture margins after wedge resections were performed by the system, the sealing capacity of lung tissue was adequate even with large size resections. These results suggest that ligausre is a suitable system for wedge lung resection[9]. The use of Video assisted thoracoscopic surgery; in patients with giant bullae or multiple pulmonary cysts, the large amount of resected and sacrificed functional lung tissue leads to a loss of postoperative pulmonary function, and the need for repeated stapling and use of numerous reloadable cartridges contributes to high consumable costs[10]. To avoid these problems some studies employed LVSS technique for pulmonary resection/ bullectomy that uses an ultrasound driven scalpel[6]. In this study, sealing strength was demonstrated by the absence of air leakage with the application of a pressure of 15 cm H_2O. Results were favorable in all cases except for one case which had a persistent air leak for one week. Thus, this technique may not be optimal for bullae with a broad base[8].

Use of LVSS in general surgery

Laparoscopy Surgery(by Ligasure) has been applied for sealing of the mesentery including inferior mesenteric, middle colic, ileocolic artery and vein, small intestinal branches of superior mesenteric vessels during colorectal and small intestinal surgery[11]. During laparoscopic anti-reflux surgery short gastric and epigastric vessels were sealed by Ligasure technology[3]. In some studies Laparoscopic Splenectomy was successfully performed with the use of LVSS. Conversion was necessary on one case due to damage of hilar vessels by accidental injury with the ligasure system, causing an uncontrolled bleeding from the hilum. No other cases of intraoperative bleeding due to ligasure were recorded, additional clipping was never necessary. This permits easy dissection of the spleen, reducing the risk of damage to the pancreatic tail[12]. One of the means of reducing intraoperative bleeding during laparoscopic splenectomy was the use of LVSS added to the semi lateral approach, permitting a significant reduction in operation time[13]. LVSS for hepatic resection demonstrates that it is a safe and effective instrument for transaction of liver parenchyma[14,15]. It is able to permanently seal hepatic veins and arteries up to several millimeters in diameters, without additional devices or clips and knots[16]. With the ligasures, the cut surface appears even and brownish, making identification of biliary leaks or persistent bleeding easy to detect and suture. The instrument is easy to handle and its application does not require a long leaning curve. It is useful during hepatic surgery due to the modest trauma that the ligasure produces and the controlled dissection of tissue that it permits[15]. Lateral thermal spreading and conduction are significantly lower compared to the electro coagulation ultrasound scalpel and laser[3]. The Ligasure device was used for hemithyroidectomy and total thyroidectomy.It demonstrates that after sealing the vessels by ligasure, no knot-tying was needed for ligation of the superior and inferior pole vessels or the middle thyroid veins. For all hemithyroidecetomies, the isthmic parenchyma was divided by this instrument and there was no need for reconstruction. Ligasure significantly reduced the operating time for hemithyroidectomy and total thyroidectomy[12]. As reported by Horgan et al[14]. Ligasure can be used for sealing of vessels and intrahepatic bile ducts during liver resection .Some studies showed that ligasure is capable of sealing cystic duct during cholecystectomy in pigs[28]. In contrast to that, data from *ex vivo* human and *in vivo* animal studies indicate that bipolar vessel sealer may not sufficiently seal major hepatic cystic duct, as assessed by bursting pressure and histology[17] and suggest not to use this device for bile duct ligation. The lack of sealing with the device could be related to the unique properties of the protein matrix in the bile duct wall or to the absence of the thrombogenic coagulum that occurs when vascular structures are ligated. In some studies for laparoscopic appendectomy, using the ligasure system, the division of the mesoappendix can be performed with stepwise application of the ligasure forceps across the mesoappendix without dissection or vessel isolation, which can cause unnecessary bleeding. The ligasure instruments make it possible to divide the mesoappendix rapidly without bleeding. With the use of the ligasure, spillage of the appendiceal contents into the peritoneal cavity can be prevented because both the appendiceal stump and the severed appendix are closed[29]. In some studies of Pancreaticoduodenectomy(in portal hypertension) LVSS was employed both for opening the abdominal wall and at all the main points in the procedure. Cholecystectomy and sectioning the cystic duct

was by suture ligating, but the sealing of the cystic artery and the dissection of the gallbladder was obtained with the LVSS. Successive sealing of the other arteries were done in the fashion way almost all with the LVSS. Neither intraoperative nor post operative hemorrhagic complications or pancreatic fistulas occurred[30].

Use of LVSS in gynecological surgery

In the past gynecologic surgical studies on the Ligasure vessel sealing system were performed using the handheld Ligasure max. The system facilitated safety and haemostasis in situations of difficult access into the pelvis especially in obese patients, allowing sealing of vessels with great ease. In contrast to conventional methods, there were almost no situations where it was not possible to use the Ligasure device for haemostasis due to access difficulty. The device was used on all pedicles beginning with the cardinal ligament, the broad ligament including the uterine arteries, and the round ligament[18]. The other great advantage is due to minimal lateral thermal damage, so that the device can be safely used near important pelvic vessels and structures[18]. In the laparoscopic radical hysterectomy, the Ligsure Lap successfully sealed the uterine arteries at their origin or above the ureter. Vessel sealing also was adequate on the bladder pillars, the rectal pillars, the cardinal ligaments, and the paravaginal vascular bundles without dissection. In one instance, the system failed in a primary attempt to seal uterosacral ligament vessels in which minor leakage was identified. Since no failures were encountered when using the Ligasure, it is considered safe for cardinal ligament, uterine artery, and infundibulopelvic ligament sealing. The utero-ovarian and utero-sacral ligament as well as the vagina contains more connective tissue, in these structures the LVSS may occasionally fail to provide hemostasis with the first attempt[27]. In some studies radical hysterectomy was performed by using LVSS; conventional clamps and suture ligation in a uniform fashion(with opening of the Para rectal and paravesical spaces) systematic pelvic lymphadenectomy and resection of the parametrical tissue and paracolpos at the pelvic wall. Para aortic lympha-denectomy was performed if frozen section analysis of the pelvic lymph node was positive. The ligasure system appeared useful to reduce blood loss in patients undergoing radical abdominal hysterectomy for stage 1b to 2b cervical cancer. The proportion of patients receiving blood transfusion and the mean number of transfusions both decreased significantly[19]. The differences in operating time did not reach statistical significance, probably because the ligasure does not affect the lymphadenectomy phase of the procedure[19].In hysterectomy, a direct tissue grasping technique is applied on vessel-bearing along each side of the uterus. In contrast, a fenestration before clamping of vessel bearing tissue is the predominant technique in a variety of other types of procedures. The high failure rate of the Ligasure prolonged the operation time and probably reflects that Ligasure is less suitable when direct tissue grasping is applied instead of fenestration prior to tissue clamping [20]. Use of LVSS facilitates the dissection of the distal ureter through the parametrium. The LVSS appeared to be a fast and reliable instrument for the dissection and coagulation of tissue on the lateral and anterior aspects of the vena cava and aorta and around the iliac vessels and the obturator fossa. A small amount of smoke did not obscure the view[20].

Use of LVSS in urological surgery

Ligasure Vessel sealing system is a novel haemostatic device which has gained widespread use in minimally invasive urological procedures such as in laparoscopic nephrectomy[21] and living donor nephrectomy[22] with effective sealing of major renal vessels. The Ligasure device was used in many urological procedures including radical nephrectomies, radical prostatectomies, partial nephrectomy and a nephro-ureterectomy. No additional clips or sutures were required to secure any vessels less than 7 mm in diameter. Vascular pedicles successfully sealed by the Ligasure device included the superficial dorsal venous complex of the penis, lateral vascular bundles of the prostate, pelvic lymphatic bundles, the artery to seminal vesicle, gonadal vessels and adrenal vessels. In addition, the device was successfully used to seal the vas deferens and ureter prior to division and to coagulate vessels in the peritoneum, the peri-renal fat and the cut surface of the kidney and adrenal gland[5]. During Laparoscopic Transperitoneal hemi-nephroureterectomy, mobilization of the colon and identification of the ureter and affected kidney pole was followed by mobilization and identification of its related pedicle. After complete isolation of the ureter without dissection of the ovarian or spermatic vessels and distal suture ligation, complete excision of the affected pole was continued using ligasure. The device separated the impaired kidney pole preserving a good function of the remaining pole. In the same study open heminephrouretectomy was performed retroperitoneally, dissection of pole vessles was performed using suture ligations. The affected ureter was completely isolated and resected just above the urinary bladder. The ureter stump was ligated by a single suture. Excision of the affected pole was performed using monopolar cautery and if required additional hemostatic suturing of the capsule was done. There were no complications during the laparoscopic procedures, while parenchymatous bleeding occurred

in one patient undergoing open nephroureterectomy, where a deep haemostatic capsule were required[23]. In Laparoscopic Adrenalectomy(left) the lateral border of the spleen, and the tail of the pancreas were exposed by sectioning the splenophrenic and splenocolic ligaments. The adrenal vein was identified by starting the dissection using Ligasure atlas on the upper pole of the kidney. The adrenal vein was sealed and transected with the ligasure. The use of Ligasure made the procedure much easier. Ligasure provides an easier vasculature control compared to endoclip application. Furthermore, periadrenal fatty tissues can be dissected without bleeding, especially using the oval tip of the device[24]. Some studies state that this device is more useful in laparoscopic adrenalectomy when compared with the diathermy because it allows both coagulation and division of the tissue bundles, therefore negating the need to constantly change instruments which increases the operating time. It is also more effective than diathermy in coagulating minor vessels while dissecting around the adrenal gland, resulting in a bloodless operating field. This study suggest that the tips of the ligasure device be cleaned after prolonged use as char can develop on the tips causing them to stick together after firing[25].

Conclusion

As previously confirmed by many authors, LVSS presents many advantages that could be helpful. It presents the possibility to operate more safely and more easily in tight or deep spaces. The sealing of blood vessels does not require their direct exposure, which can cause unnecessary bleeding. It saves time and makes it easier to perform a ligasure with difficult vascular pedicles or when there is a difficulty in creating a space between two vessels. It is easy to use and does not require a learning curve or expert surgical skills.

It eliminates the use of appliances in vascular ligation, dramatically reducing - procedural times in open surgery.

Although this pilot study demonstrates the reliability of the ligasure vessel sealing system in various field of surgery, larger studies are needed to evaluate the complication rate and cost effectiveness of this new technology.

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Neuroendocrine differentiation in prostate cancer

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The treatment of choice for advanced/metastatic prostate cancer(PC) is hormonal therapy. Although patients respond initially to this therapy, the tumor will recur and enter the androgen-independent state, which is the major obstacle in therapy. The mechanism by which PC cells proliferate in the androgen-deprived environment is unclear.

PC contains secretory-type tumor cells and a minor component of neuroendocrine(NE) cells. The number of NE cells increases in high grade/stage tumors, particularly in hormonally-treated and androgen-independent tumors. Through in-vitro and in-vivo studies, we and others have shown that NE cells may secret neuropeptides and cytokines to act on the adjacent non-NE tumor cells to promote their androgen-independent proliferation, and this paracrine action may contribute to tumor recurrence. The molecular pathways of NE differentiation and the effectors of NE cells will be discussed.