

WHAT IS A VESSEL SEALING SYSTEM?

A vessel-sealing system is a surgical tool that can easily occlude vessels exposed by clamp crushing or an ultrasonic dissector. Thus the use of the vessel-sealing system can shorten the transection time and reduce the amount of blood loss. By improving the energy generator, the sealing power can be strengthened while minimizing damage to adjacent tissues and increasing the speed of the procedure.

TYPES OF VESSEL SEALING SYSTEMS

Text modified from: Entezari K, Hoffmann P, Goris M, Peltier A, Van Velthoven R. A review of currently available vessel sealing systems. *Minim Invasive Ther Allied Technol.* 2007;16(1):52-7. doi: 10.1080/13645700601181414. PMID: 17365677.

Text modified from: Tremp M, Hefermehl L, Largo R, Knönagel H, Sulser T, Eberli D. Electrosurgery in urology: recent advances. *Expert Rev Med Devices.* 2011 Sep;8(5):597-605. doi: 10.1586/erd.11.26. PMID: 22026625.

[1] Glineur D, Hendrikk M, Krievins D, Stradins P, Voss B, Waldow T, Haenen L, Oberhoffer M, Ritchie CM. A randomized, controlled trial of Veriset™ hemostatic patch in halting cardiovascular bleeding. *Med Devices (Auckl).* 2018 Mar 8;11:65-75. doi: 10.2147/MDER.S145651. PMID: 29563844; PMCID: PMC5846302.

ELECTROTHERMAL BIPOLAR VESSEL SEALERS (EBVS)

Using bipolar electrothermal energy, a vessel-sealing system can seal the vessel wall by denaturing the collagen and elastin in the wall and completely occluding the blood vessel.



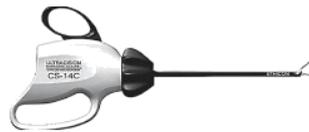
EBVS (LigaSure®, Valleylab, Boulder, CO, USA) was developed for laparoscopic and open surgery. This device produces a haemostatic seal by applying high current (4A) and low voltage (v200V) to the vessel.

ULTRASONIC DISSECTORS

Ultrasonic dissectors work at operating frequencies between 23–55 kHz. A vibrating blade is driven by an ultrasound transducer and oscillates longitudinally against a non vibrating pad and thus disrupts hydrogen bonds in proteins and forms a coagulum which subsequently seals the vessels

There are two types of ultrasonic dissectors:

1. Low power dissectors which cleave water containing tissues by cavitation (e.g. vessels) and leave organized structures with low water content intact (Cusa®, Cavitron Ultrasonic Surgical Aspirator, Valleylab, Boulder, CO, USA; Selector®, Surgical Technical Group, Hampshire, GB)
2. High power dissectors which cleave all the tissues (Autosonix® Autosuture, Norwalk, CT, USA; Ultracision®, Ethicon Endo-Surgery, Norderstedt, Germany)



ADVANTAGES

1. Diminished thermal injuries
2. Less tissue necrosis
3. Up to 7 mm vessel diameter (FDA approved)
4. Less instrument traffic (coagulating and cutting, ONLY 10 mm, Atlas)
5. Visual control of sealing (translucent seal of the vessel walls)
6. No foreign material left behind
7. Reduced charring
8. Burst strength comparable to the clip (controversial)
9. Best bipolar sealing system available

DISADVANTAGES

1. Cost
2. Firing time 3 to 6 second per cycle
3. Less effective than clips (controversy)
4. More thermal spreading than clips
5. Poor grasp (unlike harmonic forceps)
6. More time consuming to achieve vessel occlusion

ADVANTAGES

1. Diminished thermal injuries
2. Less tissue necrosis
3. Less smoke generation
4. Less instrument traffic (coagulating and cutting)
5. No electrical current
6. No foreign material left behind
7. Reduced charring

DISADVANTAGES

1. High cost
2. Temperature by harmonic scalpel 80–100°C (2–3 mm)
3. Maximum vessel diameter 3 mm (FDA approved)
4. More thermal spreading than clips

COMPARISON OF DIFFERENT DEVICES

SEALING STRENGTH

Strength of LigaSure is superior to that of harmonic scalpel and equivalent to mechanical clips. LigaSure creates seals in the larger vessel sizes that have burst strengths at least three times the normal physiologic blood pressure.

Unlike the harmonic forceps, the LigaSure device performs poorly as a grasper.

LigaSure requires approximately 20 seconds for sealing and transecting a vessel compared to only 4–8 seconds for the harmonic scalpel.

THERMAL SPREAD

Heat of the device increases up to 97°C for LigaSure 5 mm versus 35°C for LigaSure 10 mm.

Iatrogenic damage can be caused for as long as 14 seconds after stopping coagulation with the 5 mm LigaSure.

OTHER HAEMOSTATIC TOOLS

ELECTRICAL HAEMOSTASIS

1. High frequency monopolar
Not very precise in dissection and haemostasis due to erratic electricity which can create irreversible burns on surrounding tissues.
2. Bipolar diathermy
It reduces travelling electricity in the restricted area of the device's jaws. Standard bipolar electro-coagulation can spread thermal injury as far as 22 mm.

MECHANICAL HAEMOSTASIS

1. Classic ligatures
Requires manual knotting
2. Titanium clips (Ethicon)
More efficient than electrothermal bipolar vessel sealer, particularly on larger vessels (6 or 7 mm)
3. Plastic laparoscopic clips (Hem-O-Lok®, Weck, Raleigh, NC, USA)
Comparable to titanium clips, except that the jaws of the clips include a toothed grasping surface and that slipping is prevented by locking the system. Anecdotal reports showed that clips can slip off due to increased blood pressure.
4. Staple type devices (Endo-GIA, United States Surgical, Stamford, Connecticut)
It seals arteries up to 17 mm and veins up to 22 mm in diameter

ADJUNCTIVE HAEMOSTATIC AGENTS

1. PerClot® (CryoLife, Inc.) – Polysaccharide Hemostatic System
Molecular structure that rapidly absorbs water from blood, creating a high concentration of platelets, red blood cells and coagulation proteins at bleeding site, which accelerates the physiologic clotting cascade. Upon contact with blood, PerClot rapidly produces a gelled matrix that adheres to and forms a mechanical barrier with the bleeding tissue.
2. TachoSil® (Takeda) -human fibrinogen/human thrombin
Sponge sealant patch that is coated with the active substances human fibrinogen and human thrombin. TachoSil is an off-white sealant matrix. The active side of the matrix, which is coated with fibrinogen and thrombin, is marked by a yellow colour.
3. Veriset™ (Covidien/Medtronic)- Fibrin Sealant Patch
It promotes hemostasis through a dual mode of action, serving as a tamponade to physically stem blood flow, while concentrating platelets and other clotting factors at the bleeding site to accelerate coagulation
A RCT showed[1] median time to hemostasis was 1.5 min with Veriset™ hemostatic patch, compared to 3.0 min with TachoSil® (p<0.0001).
4. Surgicel® (Ethicon)
Hemostat that is derived from plant matter and is composed of an oxidized cellulose polymer. It can even be used outside of the operating room as a means of controlling bleeding and causing coagulation in certain wounds.
5. FloSeal® (Baxter) Hemostatic Matrix
It is formed of bovine-derived gelatin granules coated in human thrombin. It is supplied as a gelatin matrix and human-derived thrombin component that require mixing prior to application. It is applied to the surgical site from a syringe as a high-viscosity gel that is adherent to wet surfaces.