A New Hemostatic Clip:

2-Year Review of 1007 Cases

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IN 1911 Harvey Cushing reported in this journal the invention of a hemostatic clip. He described its use in cerebral surgery and mentioned several instances in which it was used in general surgical procedures. He predicted wide-spread general surgical usage of clips. The eminence of their originator, notwithstanding, the Cushing clips and their modifications to date have never found favor with general surgeons.[2, 3, 4]

In this report, a hemostatic clip will be described that is useful in every area of surgery.

The clip outfit consists of two applying forceps, a plastic cartridge containing 25 hemostatic clips, a heavy base on which one or more of the cartridges may be mounted and a clip removing forcep.*

The hemostatic clip is shaped and then coined out of tantalum wire. Tantalum was chosen as the material for the clip because of its proved biological inertness, its strength equals that of stainless steel, and its malleability guarantees complete closure. Appropriate lengths of wire, triangular in cross section, are bent into a shape similar to a horseshoe. Instead of the clip having straight sides, the tips of the clip are bent in toward each other, beginning at a point about half way down the sides. The final shape resembles a diamond with one side opened out. The base of the triangular cross section forms the occlusive surface of the clip.

The occlusive surface has a longitudinal groove running down its center which is crossed at intervals by transverse depressions. Dimensions of the clip are shown in the accompanying figure (Fig. 1 A–C).

These seemingly minor changes in the clip profoundly affect the ease of loading, the efficiency of the applying forceps and, most important, the security of hemostasis.

The applying forceps are basically of conventional design. There are, however, important differences. The inner surface of each jaw is channelled by a triangular depression which runs the length of the jaw and ends at the tip where it is closed over. This slot fits the triangular outer surface of the clip exactly. The forceps jaw in loading surmounts rather than encloses the clip and is thus exactly as wide as the clip. The jaws of these forceps are narrower than any other hemostatic instrument. Since the clip lies flush with the jaw it enables extremely accurate lateral or point application and allows insinuation of the forceps into constricted areas. The tips of the forceps are bent at approximately 45° to the axis of the instrument, easing transverse placement of clips. Between the shafts of the applying forceps a spring maintains appropriate tension on the jaws. To prevent

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* The clips are presently manufactured by the Edward Weck & Co., Inc., 49-33 31st Place, Long Island City, New York.

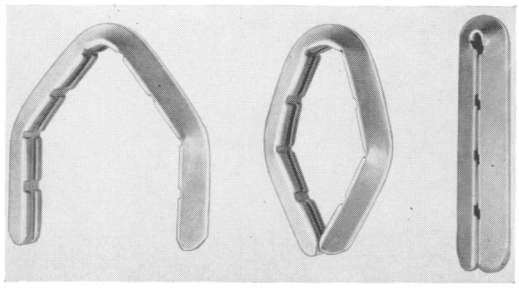

FIG. 1. **A.** The open clip is depicted showing the multi-faceted occlusive surface. **B.** The shape assumed by the partially closed clip; tips closed to form an oval. **C.** Closed clip. Length is .200 inch or approximately 3/16 of an inch.

overstretching or bending the spring, a stop in the box lock prevents opening the forceps too widely (Fig. 2, 3).

The individual clips are preloaded into high temperature plastic disposable racks, which may be autoclaved. The clip fits into an individual slot in the rack exactly matching its configuration. The arms of the clip grip the floor of the slot so that it will not fall out if the rack is turned over (Fig. 4).

The clip forceps is loaded by firmly pressing the jaws of the forceps into the slot over a clip. The groove in the jaw slides down over the triangular clip until the closed end of the forceps clears the end of the clip and engages it with an audible click. The forceps is now withdrawn with the clip locked in place and stable in all dimensions. Lateral stability is afforded by the triangular grooves and the clip is prevented from sliding forward by the closed end (Fig. 5 A–D).

When the jaws of the forceps are partially closed the tips of the clip approximate first. The reason this occurs is that the angle at the apex of the clip is narrowed while the angles at the sides of the clip remain constant. This brings the tips together. As closure continues the remainder of the clip closes from the tips, backward. Conventional clips close from behind forward,

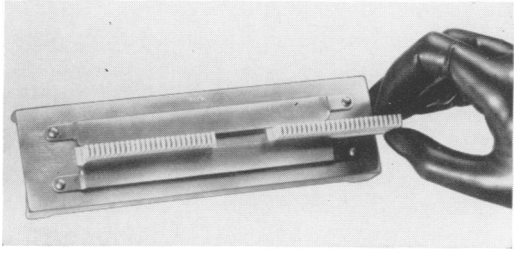

FIG. 4. Cartridges, each containing 25 clips, are attached to a heavy base. The cartridges are high temperature resistant plastic which may be autoclaved. The blue-black tantalum clips contrast sharply with the white cartridge.

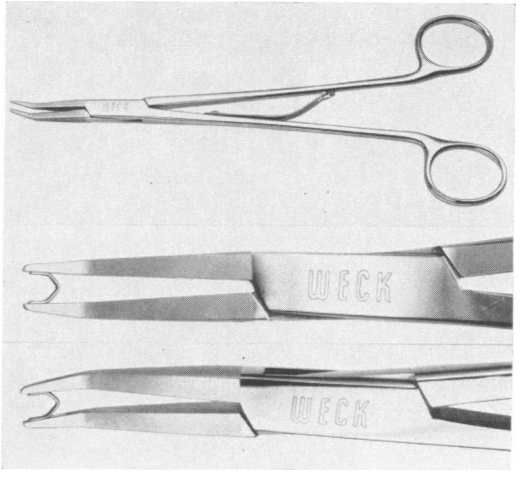

FIG. 2. (Top) The applying forceps has a conventional pattern. However, the slenderness of the jaws set at a convenient angle are unique.

FIG. 3. (Bottom) Jaws of the applying forceps are shown with a clip loaded.

forcing the tissue forward to the weakest part of the clip. The structure to be occluded is then first encircled by tantalum wire. At this point one may test by moving the forceps to ensure that encirclement is complete. This preliminary encirclement makes impossible extrusion of the structure as the clip closes. The clips have been tested on rubber tubing and have withstood pressures of 15 pounds per square inch which is far beyond any pressure encountered physiologically.

Results

The prototypes of the present type clip outfit have been used for the past 2 years. They have been used routinely on our serv-

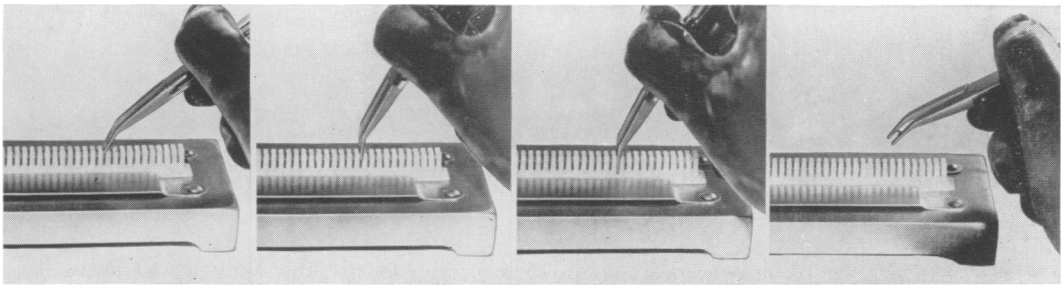

FIG. 5. Steps in the loading of a clip from the clip cartridge are depicted. The forceps is held like a soup spoon. It is held over the box lock so as not to interfere with the movement of the shafts.

ice and at a neighboring Veterans Administration Hospital by one of us (RK). They have also been used during this period at four community hospitals and by six individual surgeons. The clips have been used in a total of 1007 cases. Of these, 161 cases were at the Sepulveda VAH, 58 cases at the San Fernando VAH, 205 cases were personal (PBS), and 583 cases at the community hospitals.

Applications. Cholecystectomy, vagotomy, varicose vein surgery, and retroperitoneal dissection were the four procedures in which the clips had been used most frequently. They have also been used in the following procedures listed according to region.

Head and neck: neck dissection, thyroidectomy, upper thoracic and cervical sympathectomy, scalene node biopsy, scalenotomy.

Chest: segmental resection of lung, lobectomy, pneumonectomy, esophagectomy, and gastro-esophagectomy, radical mastectomy.

Abdomen: cholecystectomy, vagotomy, pancreatectomy, pancreatic biopsy, abdominal perineal resection, resection of aortic aneurysm, aortofemoral bypass, renal artery surgery, nephrectomy, superior mesenteric arterial surgery, portocaval shunt, inferior vena cava ligation, lumbar sympathectomy.

Scrotal: vasectomy.

Lower extremity: saphenous vein ligation and stripping, femoro-popliteal bypass, excision and graft of popliteal aneurysm.

The clips may be used for temporary occlusion of vessels such as small collaterals in arterial surgery and may be removed with a special clip remover (Fig. 6). They may also be used as a radiopaque tag to mark the site of an intestinal anastomosis or pyeloplasty or to outline a tumor mass. The clips are unequalled for the occlusion of vessels deeply placed or inaccessible. They may be placed prior to the division of a vessel or to secure a bleeding point. The visibility and exactitude of clip placement necessitates less exposure and minimizes the necessity for vigorous retraction.

Clips may be placed at any desired point on a vessel, a maneuver which is sometimes difficult with a ligature. The situation is exemplified by a short cystic artery or in a plexus of venae comittantes, such as those surrounding the popliteal artery. Very fragile retroperitoneal veins constitute a special problem in shunt surgery for portal hypertension; the clips allow easy hemostasis without excessive loss of time. The cystic duct may be clipped flush with the common duct with far less constriction of the common duct than is possible by ligature. In cholecystectomy for acute cholecystitis where it may be difficult to distinguish lymphatics, small veins, arteries, sympathetic fibers, and edematous connective tissue, the structure in question may be quickly double clipped and cut, minimizing blood loss. A more routine situation in which time is saved is saphenous vein ligation and stripping where each of the major

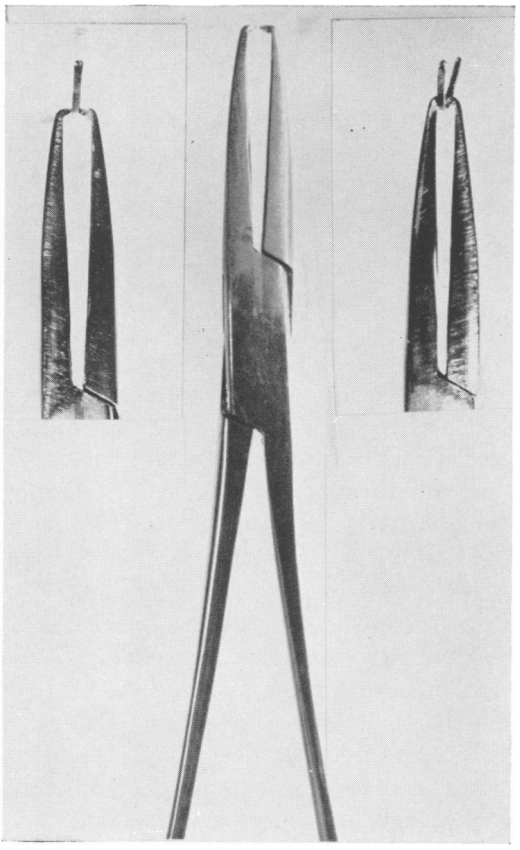

FIG. 6. (Left) The teeth of the clip remover are inserted between the arms of the clip at its apex prior to spreading the clip open. (Center) The clip remover is shown. A single wedge shaped tooth on each jaw seeks the slit between the arms of the closed clip. (Right) The clip is spread open by the wedge shaped teeth as they close down between the arms of the clip.

branches of the saphenous vein is clipped and transected and the saphenous trunk itself may be divided between clips. As the individual surgeon becomes more familiar with and confident in the clips, other situations in which they may be useful will suggest themselves.

Advantages. In our hands there has been improvement in the continuity of surgery. Preliminary clipping of small blood vessels and suspected blood vessels allows work to be carried out in a dry field without periodic interruptions to clamp and tie bleeders or to suction away accumulated blood. Constructive activity progresses without intermission. Following 2 years of clinical use there have been no immediate or late complications attributable to the clips. In several late re-explorations, clips have been found at the exact site where they were previously applied with no inflammatory reaction in the area.

Discussion

Among the objections by surgeons to the clip outfits available in the past is the difficulty of loading the clips into the forceps, the tendency of the clip to fall out of the forceps prematurely and the fact that its grip is too weak for secure hemostasis.

These objections are all invalidated by the present technic.

In the old loading method, the clip is held in the forceps only at its tips. It is precariously balanced and easily dislodged.

In the new outfit, half the surface of the clip is securely bedded in the forceps, preventing lateral and forward motion. Loading of the clip is completely positive, requiring neither practice or special skill.

Secure hemostasis is afforded—both through the strength of the clip and by the preliminary closure of the tips of the clip which, in effect, locks the structure in a ring of tantalum. The special scoring of the occlusive surface resembles that of an atraumatic arterial forceps and enables the wall of the vessel to be held without crushing. The lumen is completely occluded, but necrosis of wall is minimized by the hypotraumatic surface. In this way, both delayed and immediate hemorrhage as result of disruption of the wall is avoided. An additional advantage is that the occlusive action of the clip occurs in one plane. It is sometimes difficult to tie at depth without pulling up or to one side with subsequent avulsion of the tie or the vessel. The present clip may be applied without any pull or tension on the vessel.

Some surgeons will concede the advantages of the new clip, but balk at the idea

of leaving a metallic foreign body in the tissue. The specters which rise when one considers using clips include the disastrous results following the early use of corrodable metals and alloys in orthopedic surgery; the prolongation of infection by foreign bodies embedded in contaminated wounds; the penetration of hollow organs by ingested foreign bodies and the migration of pointed foreign bodies in mobile tissues such as muscle. Fortunately, none of these objections apply to the present clip.

Metals in the tissue are only capable of inducing inflammation and necrosis if they corrode. When this occurs metallic ions are discharged into the surrounding tissues. These ions may either destroy tissues directly or through disturbance of local pH and other parameters.

The introduction of tantalum to surgery by Burke [1] has resolved problems occurring with other metals. Since tantalum is inert chemically and can only be corroded by strong acids and alkalies at high temperature it is unaffected by oxidizing agents found in living tissue. The biologic inertness of tantalum has been reported [4] and confirmed by our experience. Since the clips are blunt and fixed to tissue in placement they do not migrate. The nonporous metal of which the clips are fabricated should present no more problem in the presence of infection than monofilament stainless steel wire.

Summary and Conclusions

A new clip outfit is described which eliminates the shortcomings of previous devices.

The types of surgical procedures in which the hemostatic clip may be used are described.

The clips have been used in 1007 cases for 2 years without early or late complications.

Objections to previous clip outfits are reviewed and shown to be inapplicable to the present method.

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