Primary Closure of a Cerebrospinal Fluid Fistula by Nonpenetrating Titanium Clips in Endoscopic Endonasal Transsphenoidal Surgery: Technical Note

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ABSTRACT

Postoperative cerebrospinal fluid (CSF) leakage is one of the most common and aggravating complications in transsphenoidal surgery. Although primary closure of the fistula would be the most desirable solution for an intraoperatively encountered CSF leak, it is difficult to achieve in such a deep and narrow operative field. In this article, the authors report endonasal endoscopic applications of non-penetrating titanium clips to repair a CSF fistula following tumor removal. The AnastoClip Vessel Closure System (VCS; LeMaitre Vascular, Boston, MA) was used for closure of a CSF fistula in endonasal transsphenoidal surgery. In all four patients, CSF leakage was successfully obliterated primarily with two to five clips. There was no postoperative CSF rhinorrhea or complications related to the use of the VCS. Metal artifact by the clips on postoperative images was tolerable. Primary closure of the fistula using the VCS was an effective strategy to prevent postoperative CSF leakage in transsphenoidal surgery. Future application can be expanded to reconstruction of the skull base dura via endonasal skull base approaches.

KEYWORDS: CSF leakage, nonpenetrating titanium clip, endoscope, transsphenoidal surgery

Techniques to prevent postoperative cerebrospinal fluid (CSF) leakage remain controversial in transsphenoidal surgery. Although direct repair of CSF fistula by primary suture or patch grafting is the most desirable management, conventional stitching is extremely difficult, particularly through an endonasal route with a deep and narrow surgical corridor. To obliterate a CSF fistula, packing of autologous grafts and/or bioabsorbable materials into the sella turcica and the sphenoid sinus has

generally been employed with or without postoperative CSF lumbar drainage.

The AnastoClip Vessel Closure System (VCS; LeMaitre Vascular, Boston, MA) is an automatic suture device originally invented for microsurgical vascular reconstruction.¹ The clip applier is preloaded with nonpenetrating titanium clips (varied with clip size), allowing repetitive firing. After clinical and experimental evaluations, the device has also been approved for dural

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reconstruction by the Food and Drug Administration (FDA)²; however, its clinical applications have been limited to date.

We have been interested in the use of VCS clips for skull base reconstruction because of their ease of application even in anatomically restricted areas. This report outlines our experience with the VCS clips for repairing a CSF fistula encountered during endonasal transsphenoidal surgery.

PATIENTS AND METHODS

Since March 2008, we have used the VCS for primary closure of intraoperatively encountered CSF fistula in four patients who underwent endonasal transsphenoidal surgery for tumor removal. The diagnoses of the tumors include three nonfunctioning pituitary adenomas and a recurrent craniopharyngioma.

The VCS is an automatic suture device originally developed for microsurgical vascular anastomosis.¹ The FDA has also approved the VCS clips for dural reconstruction.² Although there are four clip sizes available (small, medium, large, extra-large), large or extra-large clips are permitted for dural closure (Fig. 1). The disposable clip applicator contains 25 to 40 (varied with clip size) preloaded nonpenetrating titanium clips. The applicator is low profile and can be held like a pen with three fingers. By squeezing the grip together, preloaded arcuated-legged titanium clips are closed and delivered one after another during repetitive firing.

The surgery for tumor resection was undertaken through an endoscopic endonasal approach without using a nasal speculum. When a CSF leak was observed intraoperatively, the fistula point was accurately located. First, the surrounding tissues of the fistula point, such as the dura, fibrous tissue, the pituitary gland, and the

Figure 1 The different sizes of Vascular Closure System clips. S, small; M, medium; L, large; XL, extra-large.

arachnoid membrane, were approximated together and held in everted position with single-shaft forceps so as to obliterate the fistula. The VCS clips were then applied over the everted tissues under the endoscope (Fig. 2), which was followed by application of polyglycolic acid nonwoven fabric (Neoveil, Gunze, Kyoto, Japan) or absorbable gelatin sponges (Gelfoam, Pharmacia and Upjohn, Kalamazoo, MI) with fibrin glue to reinforce the sealing effect. The Neoveil is absorbable and bio-compatible material, which is converted into recipients'

Figure 2 (A) The fistula point is accurately located. (B) Manipulation of the dura and surrounding tissue to achieve adequate eversion and closure of the fistula. (C) The clip is applied to secure the everted tissues.

Figure 3 Preoperative contrast-enhanced coronal (a) and sagittal (b) magnetic resonance imaging shows a large pituitary tumor involving a cyst extending to the suprasellar region.

own connective tissue in approximately 2 months.³ Finally, the sphenoid sinus was packed with free axillary fat graft. We placed a continuous CSF lumbar drainage for 48 to 72 hours postoperatively.

RESULTS

In all four patients, CSF fistulas were successfully closed primarily with two to five clips with additional reinforcement procedures. There was no postoperative CSF leak or complications related to the use of the VCS. Metal artifacts by the clips on postoperative images were minimal.

Illustrative Case

A 59-year-old woman presented with reduced visual acuity and bitemporal hemianopsia. Magnetic resonance (MR) images demonstrated a large pituitary adenoma with a cystic component extending to the suprasellar region (Fig. 3). Her preoperative pituitary function was normal.

The patient underwent an endoscopic transsphenoidal surgery via a two-nostril approach without using a nasal speculum. The adenoma was mostly soft, but contained fibrous parts. Despite delicate microsurgical procedure, the arachnoid membrane was torn during the removal of the fibrous component. After gross total resection of the tumor, we attempted primary closure of the CSF fistula with the VCS. Remnant normal pituitary gland and the upper edge of the dura were put together so as to obliterate the fistula point with forceps, making their edges evert. The VCS clips were then applied in an interrupted fashion. CSF leakage was remarkably decreased with four tandem clips. To reinforce the sealing effect, gelatin sponges (Gelfoam) with fibrin glue were applied over the suture line (Fig. 4). Finally, the sphenoid sinus was packed with fat graft.

Postoperatively, an external lumbar drain was placed for 2 days. The postoperative course was uneventful except for transient diabetes insipidus, and her visual function remarkably improved. Postoperative computed tomography scans and MR images showed clip artifact that did not prevent interpretation of the images (Fig. 5).

DISCUSSION

Various techniques have been proposed for the repair of CSF leakage in transsphenoidal surgery.⁴⁻¹⁷ Although primary closure of the fistula by stitching would be ideal, it is very difficult to achieve through such a deep and narrow surgical corridor. Therefore, most of the reported techniques employed some kind of graft materials to cover the fistula point or to pack up the free space adjacent to it, usually without secure fixation. Kassam et al indicated that one of the most common causes of failure in reconstruction for CSF leakage is migration of the graft by stretching under pressure of neighboring tissue or CSF, and this event might occur early in the wound-healing phase before generating a biological seal. They reported that use of the balloon to apply pressure on the graft within the sphenoid sinus was highly effective to prevent graft migration.¹⁰

Recently, we used the VCS for dural reconstruction in various types of skull base approaches (unpublished data). The motivation for its use in skull base reconstruction emerged from the following characteristic features of the device: (1) nonpenetrating nature virtually eliminates CSF leak from the suture holes and reduces the risk of damaging underlying neurovascular structures; (2) titanium clips are MR compatible and show minimum metal artifact on postoperative images; (3) low-profile clip applicator facilitates maneuverability in anatomically restricted areas. We therefore easily applied the VCS when we encountered CSF leakage during the endonasal transsphenoidal surgery. Applying the VCS

Figure 4 Composition of intraoperative endoscopic views demonstrate primary closure technique with Vascular Closure System (VCS). (a) After gross total resection of the tumor. The right optic nerve (ON) is observed through the defect between the dura (D) and normal pituitary gland (P). (b) After the first VCS clip (VC) was applied. Normal pituitary gland (P) is lifted up by grasping forceps and adhered to the upper edge of the dura (D) to make eversion. (c) The VCS clip is applied to secure the dura and the pituitary gland. (d) The fistula is closed tightly by the clips (VC). (e) Primary closure is reinforced by Gelfoam (G) with fibrin glue.

clips to surrounding tissues of the fistula significantly reduced liquorrhea, and complete watertight closure could be made with additional reinforcements. Meanwhile, we found the device needed to be modified to use via an endonasal route; the shaft of the applier was not sufficiently long to comfortably reach the sellar region through a nostril, and the grip interfered with the surgical view when used under the operating microscope. There are some other limiting factors, such as the size of the fistula or flexibility of the neighboring tissues. And, at present, this technique is not a stand-alone method for sellar reconstruction. We believe, however, that the VCS is an effective tool for repairing a small fistula to help the

prevention of CSF leakage in endoscopic transsphenoidal surgery.

Recent advances of the extended endoscopic endonasal skull base approach have increasingly demanded more secure reconstruction procedures for larger dural defects. Watertight closure by patch grafting with nylon sutures is one excellent and ideal method.¹¹ However, this procedure is cumbersome and takes much time in a deep and narrow surgical field. It also carries a potential risk of damaging underlying neurovascular structures by needles. Recently, the U-clip anastomotic device (Medtronic, Minneapolis, MN) has been used for endoscopic suturing to fix a graft patch through an endonasal route.⁶

Figure 5 Postoperative bone-window computed tomography (a) and enhanced axial (b), coronal (c), and sagittal (d) magnetic resonance imaging demonstrate the clips (white arrows) in the sphenoid sinus. Metal artifact from the titanium clips is minimal.

The U-clip consists of a self-closing clip attached to a conventional surgical needle, eliminating knot-tying. Although this device will reduce the suturing time, it still requires piercing a needle through deep tissues. Gardner et al reported this problem had not been resolved by this device particularly when working around the cavernous sinus.⁶ In this regard, the VCS may be able to overcome these drawbacks. If the device were optimally modified for endonasal skull base surgery, its future applications would be widely expanded.

CONCLUSION

Based on our preliminary results, the VCS is a safe, simple, and effective tool for primary closure of CSF fistulas via an endonasal route and is superior to conventional suture technique with needle in many aspects. Its future applications can be expanded to reconstruct larger defects of the skull base dura in combination with graft materials through the extended endonasal approach, when optimal refinements of the device are achieved.

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