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Technical Note

Useful 'sliding-lock-knot' technique for suturing dural patch to prevent cerebrospinal fluid leakage after extended transsphenoidal surgery

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Abstract

Background: Postoperative cerebrospinal fluid (CSF) leakage is a major problematic complication after extended transsphenoidal surgery (TSS). Watertight closure of the sellar dura with a fascial patch graft is a method of choice for preventing CSF leakage; however, suturing and knotting in a deep and narrow operative field is technically challenging and time consuming. To present a simple and effective knotting technique named the 'sliding-lock-knot' technique, in which the knot can easily be slid to the suturing point and tied automatically using only a single string, without loosening.

Methods: We use a 6-0 nylon suture and Mosquito forceps. At first, after putting a stitch, a single knot is made by hand out of the nasal cavity. Then the 'sliding-lock-knot' is made using a forceps as shown in the illustration. The knot slides deep into the operative field through the nostril and it is automatically tied only by pulling a string.

Results: A 73-year-old woman presented with progressive visual deterioration. She had an intra-and suprasellar craniopharyngioma that was compressing the optic chiasm. She underwent an extended TSS, and the tumor was totally resected. The dural defect was closed with a fascial patch graft sutured on the dura using this technique, then covered with a vascularized mucoseptal flap. Neither CSF leakage nor meningitis was encountered during the postoperative period.

Conclusion: The 'sliding-lock-knot' technique is simple and useful for dural suturing in microscopic/endoscopic extended TSS. This technique is a helpful tool for preventing CSF leakage after this challenging surgical procedure.

Key Words: Cerebrospinal fluid leakage, extended transphenoidal surgery, fascial patch graft, watertight closure

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INTRODUCTION

Microscopic or endoscopic extended transsphenoidal surgery (TSS) is currently being used more and more widely for various tumors such as pituitary adenomas extending to the parasellar region or anterior skull base, tuberculum sellae meningiomas, craniopharyngiomas, and chordomas, those are traditionally approached via the

transcranial route. Despite a controversy about indication, this approach has a great advantage in terms of not only the reduced invasiveness but also better visualization of the blinded areas through the transcranial approach. However, postoperative cerebrospinal fluid (CSF) leakage is one of major problematic complications after extended TSS. To prevent CSF leakage after TSS, various methods of sella reconstruction have been used, such as a fat and/or fascial graft with or without suturing, on-lay graft of artificial materials, collagen sponge, fibrin glue, autologous bone graft, titanium mesh, and vascularized mucoseptal flap, in addition to the use of postoperative lumbar CSF drainage.[2,6,10,11,15,18] Among these methods, vascularized mucoseptal flap is a standardized method of choice during endoscopic TSS, yet still not perfect; multilayered closure with using mucoseptal flap and abdominal fat/fascial patch graft/inlayed Alloderm is recommended in case of high-flow CSF leakage. In that case, suturing a fascial patch graft is useful for preventing dislocation of the graft. In contrast, during microscopic TSS, a fascial patch graft with watertight suturing is a very effective method of choice; however, performing a suturing and knotting procedure in a deep and narrow operative field is technically challenging and time consuming despite the use of specially designed equipment. There are some reports of suturing technique for dural repair.[8,12] Kitano, *et al*. reported a simple knotting technique called the knot-tying technique, in which the surgeon's knot is made outside of the nasal cavity then slid deep into the operative field using a forceps.[12] Although this technique is simple and effective, the knot is possibly loosened by the traction of the string or the pulsatile movement of the fascial graft. In this article, we present the most simple and effective knotting technique called the 'sliding-lock-knot' technique, in which the knot is easily slid to the suturing point and tied by pulling one string; these knots will never loosen.

TECHNIQUE

We use combined method of the fascia graft and the vascularized nasal mucoseptal flap for reconstraction of large dural defect by extended TSS. The fascia graft is taken from the rectus abdominans fascia and sutured with sellar dura. For the 'sliding-lock-knot' technique, we use a 6-0 nylon monofilament suture (PROLENE; Ethicon, Somerville, New Jersey, USA) and Mosquito forceps (or other small forceps). At first, after placing a stitch, a single knot is made manually out of the nasal cavity [Figure 1a] and string 'B' is pulled to the forefront [Figure 1b]. Then, the end of string 'A' is caught with forceps after the forceps is passed through the string circle as shown in [Figure 1c] (along the gray line). Then the 'sliding-lock knot' is made by pulling back the forceps [Figure 1d]. When string 'B' is pulled, the knot automatically slides deep into the operative field through the nostril [Figure 1e]. Finally, after the knot reaches the suturing point, the knot can be tied only by pulling string 'B' [Figure 1f]. By pulling string 'B' further, the knot will be tied more tightly and will never loosen, in contrast to the situation observed after normal knotting. We put approximately four stitches on the fascial graft to secure the sellar dura. Then the graft is covered by a pedicled mucoseptal flap. To detect occult intraoperative CSF leakage, we occasionally use the Valsalva manoeuvre.

Illustrative case

A 73-year-old woman presented with a 10-month history of progressive visual deterioration. Magnetic resonance imaging (MRI) revealed an intra- and suprasellar mass lesion compressing the optic chiasma [Figures 2a and b]. The results of laboratory studies including hypophyseal function were normal. She underwent an extended TSS and the tumor was completely resected. After resection, high-flow CSF leak with arachnoid defect was encountered. The dural defect was closed with a fascial patch graft sutured with five stitches on the dura margin using specially equipped needle-holder for suturing in a deep operative field using the 'sliding-lock-knot' technique [Figure 2c] then this graft was covered with a vascularized mucoseptal flap for multilayered reconstuction. Neither CSF leakage nor meningitis occurred during the postoperative period. The patient's visual function was restored immediately after surgery. The histological diagnosis was craniopharyngioma. MRI performed 6 months postoperatively demonstrated no residual or recurrent tumor [Figures 2d and e]. This patient experienced new postoperative diabetes insipidus, which resolved by the follow-up visit at 6 months, whereas anterior pituitary function remained normal.

DISCUSSION

Dural repair after extended transsphenoidal surgery is crucial for preventing CSF leakage. Various methods for the reconstruction have been reported in the literature. The incidence of CSF leakage after microscopic or endoscopic extended TSS for tuberculum sellae meningioma or craniopharyngioma has been reported to range between 12.2% and 40%.[3,5,7,12,17] This rate of postoperative CSF leakage is higher than that for general TSS, which ranges from 1.5% to 4.2%.[4] This higher incidence of CSF leakage is due to a large dural and arachnoidal defect after extended TSS. For preventing CSF leakage after extended TSS, the vascularized mucoseptal flap is a reliable and simple method. Saeki, *et al*. stated that the nasal septal flap is useful because it is vascularized by the septal branch of sphenopalatine artery.[16] When using this method, postoperative CSF leakage is reported to be less than 6%.[10,18] However, this method is still not perfect, thus, multilayered reconstruction with abdominal fat/fascial patch graft/Alloderm is recommended in case of high-flow CSF leak after tumor resection. In

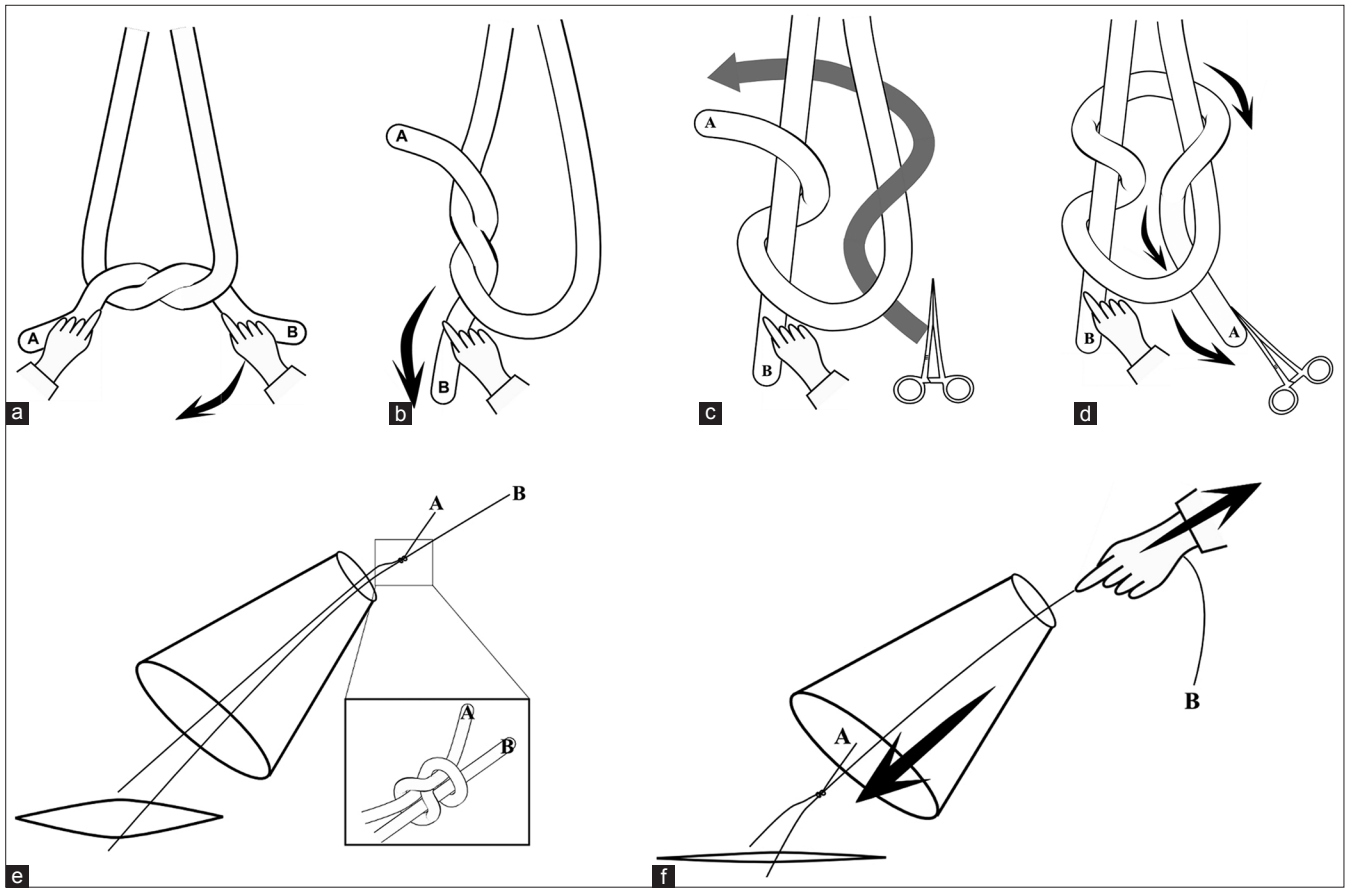

Figure 1: Schematic diagram illustrating the 'sliding-lock knot' technique (a, b) Making a knot, (c) Catching string 'A' with a forceps, (d) Pulling back the forceps, (e, f) The knot slides automatically into the surgical field and be tightened by pulling string 'B'

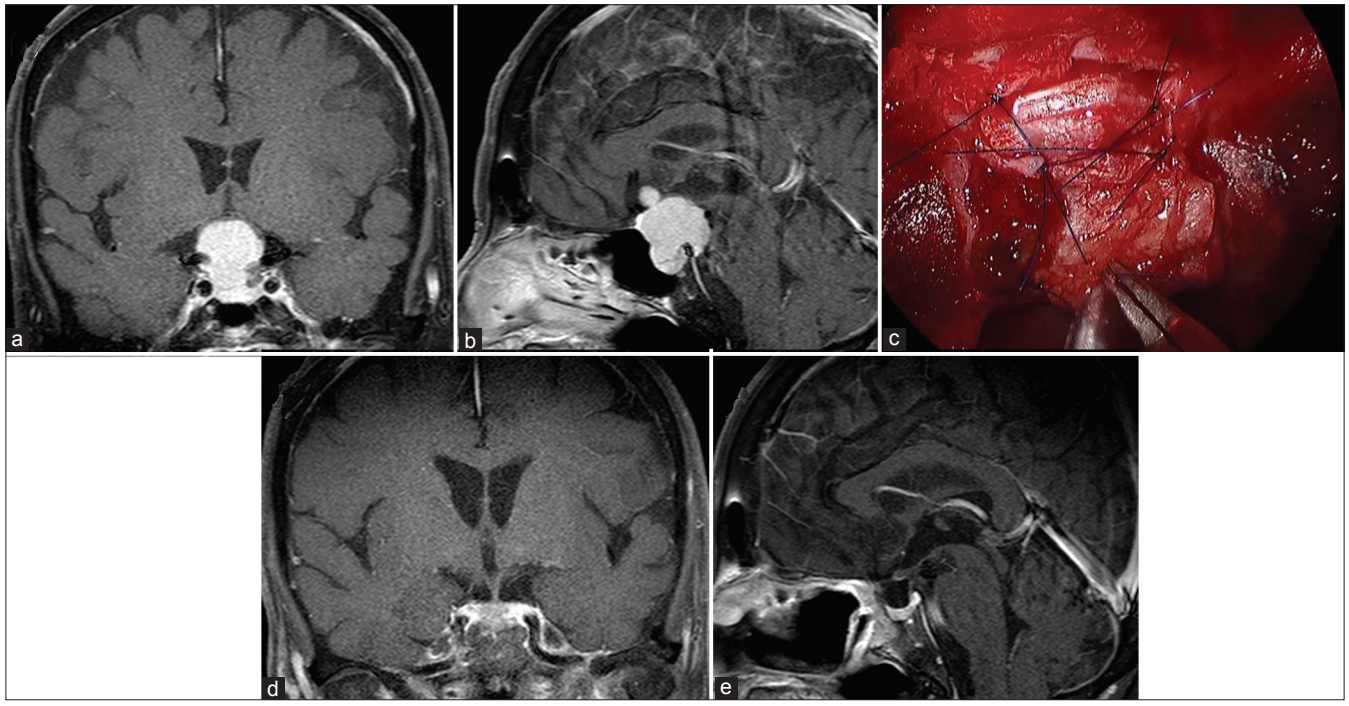

Figure 2: Illustrative case (a) Coronal and, (b) sagittal preoperative T1-weighted MRI after gadolinium administration, (c) Intraoperative photograph. The dural defect was closed by using the 'sliding-lock-knot' technique after removal of the tumor, (d) Coronal and, (e) sagittal postoperative MRI

this situation, suturing the fascial patch graft is useful technique to prevent dislocation of the graft. In addition, mucoseptal flap is not available in some situations such as recurrent cases with septum perforation or pediatric cases. Zanation, *et al*. reported large dural defects (>2 cm^2) as one of the risk factors, even when using a vascularized mucoseptal flap.[18] In contrast, fascial patch graft with watertight-suturing is also a useful method, especially in microscopic TSS, in which harvesting a mucoseptal flap is rather difficult. Ahn, *et al*. reported that the dural suturing technique with fascia graft may be more reliable than the conventional packing technique in achieving watertight dural closure for the prevention of postoperative CSF rhinorrhea.[1] Using this method, postoperative CSF leakage is reported to be 2.3-9%.[9,13] However, in this fascial patch method, the surgeon must create a suture and a knot in a deep and narrow operative field; therefore, this method is technically challenging and time consuming. To solve this problem, using the 'sliding-lock knot' technique can be a helpful tool. The 'sliding-lock knot' is easy to create and is not loosened by traction in any direction. The idea of this knotting technique came from the classical Japanese knot for fixing a fishing hook. This knot never loosens because it will tighten up when the string is pulled. Furthermore, the 'sliding-lock-knot' technique makes this knotting dramatically easier because we can make this knot outside of the nasal cavity rather than in the deep and narrow operative field; the knot slides smoothly through the nostril when the string is pulled. In addition, this technique becomes even easier when using small forceps. One thing a surgeon should take care is to pull the string gently and slowly, not to rip away or create tears in a substitute or dural edges; yet these situation did not occur in our cases. Nishioka, *et al*. reported on the knotting technique, using a knot pusher in a microscopic TSS,[14] but this technique cannot be used in endoscopic surgery because it is difficult to push the knot from outside to inside of the nasal cavity under the endoscope. However, our 'sliding-lock knot' technique can be used not only in a microscopic TSS, but also in an endoscopic TSS. Furthermore, this technique is also applicable for dural repair and suturing a leaking point in an endoscopic/microscopic spinal surgery. This simple 'sliding-lock-knot' technique can be used in a number of situations where a surgeon needs to tie a suture in a deep hole also other than a TSS.

CONCLUSION

The 'sliding-lock-knot' technique is simple and useful for dural suturing in microscopic/endoscopic extended TSS. This technique is one of helpful tools for preventing CSF leakage after this challenging surgical procedure and also applicable for a number of other surgeries.

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