Premiere Publications from The Triological Society

Read all three of our prestigious publications, each offering high-quality content to keep you informed with the latest developments in the field.

The Laryngoscope

Editor-in-Chief: Samuel H. Selesnick, MD, FACS
The leading source for information in head and neck disorders.
Laryngoscope.com

Investigative Otolaryngology

Editor-in-Chief: D. Bradley Welling, MD, PhD, FACS
Rapid dissemination of the science and practice of otolaryngology-head and neck surgery.
InvestigativeOto.com

ENTtoday

Editor-in-Chief: Alexander Chiu, MD
Must-have timely information that Otolaryngologist-head and neck surgeons can use in daily practice.
Enttoday.org
How I Do It

“Parachute” Technique for Reconstruction of Small Skull Base Defects of the Ventral Skull Base

Valentin Favier, MD; Johnny Youssef, MD; Romain Kania, MD, PhD; Benjamin Vérillaud, MD, PhD; Philippe Herman, MD, PhD

Key Words: Skull base, clinical, allergy/rhinology, adult rhinology, clinical, cranial base.

Laryngoscope, 130:2791–2794, 2020

INTRODUCTION
Cerebrospinal fluid (CSF) rhinorrhea is a consequence of a breakdown of the layers of the arachnoid membrane, dura matter, the bony skull base and periosteum, and the nasal mucosa. In the past few years, several endoscopic techniques have been described to close ventral skull base CSF leaks. These include local pedicled flaps (e.g., nasoseptal flap, turbinates), regional pedicled flaps (e.g., pericranium, fascia temporalis), free grafts (e.g., abdominal fat, fascia lata), microanastomosed free flaps as well as synthetic grafts. Nowadays, most authors use multiple-layer reconstruction by combining these techniques to improve the success rate of endoscopic skull base reconstruction.

The choice of skull base reconstruction technique depends on the location and the size of the defect, as well as intracranial pressure. The graft can be placed in the extracranial or extradural spaces that are often used, or in the intradural space, which is technically more demanding.

In cases of small-size CSF leaks, we propose a new surgical technique, with a good success rate, that allows centering the intradural graft adequately on the defect. This "parachute" placement can be used with both autologous free grafts and synthetic materials.

MATERIALS AND METHODS
A retrospective chart review was performed to identify patients who had undergone endoscopic-guided transnasal duraplasty for small low-flow CSF leaks (<2 cm) of the ventral skull base in the Lariboisière University Hospital in Paris, France. Leaks that were reconstructed with other techniques were excluded. We report on the surgical technique, graft materials, and outcomes. All patients were imaged preoperatively with skull base computed tomography and magnetic resonance imaging.

The procedure (Supporting Video S1) is done under general anesthesia. The patient is positioned supine, with the patient's head in a neutral position. An anterior and posterior ethmoidectomy is performed, associated most often with a middle turbinate removal. Then, the CSF leak site is identified endoscopically and measured.

Site preparation begins by removal of the overlying mucosa. Abraction of the adjacent and involved bone is generally advocated to stimulate osteoneogenesis. If needed, the bone defect is enlarged to see the limits of the dura defect. Then, an intradural and extradural circular dissection is performed with angled elevators to allow an underlay and overlay placement of the graft.

The parachute technique allows the use of both fascia lata and synthetic materials. We present here a skull base reconstruction of a 1.5-cm defect of the planum sphenoidale (Fig. 1).

Additional supporting information may be found in the online version of this article.

From the Department of Otorhinolaryngology–Head and Neck Surgery (V.F.), University Hospital of Montpellier, Montpellier, France; Otorhinolaryngology Department–Skull Base Center (J.Y., R.K., B.V., P.H.), Lariboisière Hospital, Paris, France.

Editor's Note: This Manuscript was accepted for publication on March 14, 2020.

The authors have no funding, financial relationships, or conflicts of interest to disclose.

Send correspondence to Valentin Favier, MD, Department of Otorhinolaryngology, University Hospital of Montpellier, 80 Avenue Augustin Fliche, 34090 Montpellier, France. E-mail: valentin_favier@hotmail.com

DOI: 10.1002/lary.28660

Laryngoscope 130: December 2020

Favier et al.: “Parachute” Technique for Small CSF Leaks

Fig. 1. Small cerebrospinal fluid leak of the planum sphenoidale.
A Biodesign duraplasty graft (Cook Biotech, West Lafayette, IN) in a size that was approximately 30% larger was designed. A nonabsorbable polypropylene suture (3/0) is passed through the graft near the center in a U shape (Fig. 2). The two strands must be long enough to easily exit the nose. Then, the graft is placed in the subdural space using classic microsurgical instruments (angled endonasal blunt hook and seeker, spoon curettes, blunt angled elevators). A slight tension on the strands allows centering the graft on the defect, and then it is applied against the dura without any pucker (Fig. 3), hence the name parachute technique. It should be noted that the role of the suture is not to anchor the graft but to center it on the defect. The graft is then covered with fibrin glue to seal the reconstruction and the suture is removed, with back pressure being maintained on the graft with a blunt instrument to avoid displacement (Fig. 4). Fibrin glue sealing should be used sparingly between the two reconstruction layers to avoid dead space during resorption.

Then, a second graft designed like the first graft is placed in the extradural space, as a “sandwich” to maintain the dura between two graft layers. At the end of the procedure, fibrin glue sealant is applied (Fig. 5). With this parachute closure technique, it is possible to associate a multilayer reconstruction using a mucosal graft or mucosal flaps to cover the graft and surrounding bone. We did not use any nasal packing or postoperative antibiotics.

Patients must follow common postoperative advice such as avoiding Valsalva-like maneuvers and do not strain. Acetazolamide was prescribed only in case of suspicion of intracranial hypertension. We did not use any lumbar drain.

Fig. 2. Placement of the Biodesign graft transfixed with a suture.

Fig. 3. Subdural placement of the graft applying a slight tension on the suture.

Fig. 4. Suture removal after fibrin glue sealing.

Fig. 5. Final view of the two-layer reconstruction using the “parachute” technique.
TABLE I.
Epidemiology, Etiologies, and Location of the Leaks With
Materials Used.

<table>
<thead>
<tr>
<th>Location</th>
<th>Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cribriform plate</td>
<td>3 (18.8%)</td>
</tr>
<tr>
<td>Ethmoidal roof</td>
<td>11 (68.8%)</td>
</tr>
<tr>
<td>Planum sphenoidale</td>
<td>2 (12.5%)</td>
</tr>
<tr>
<td>Graft material</td>
<td></td>
</tr>
<tr>
<td>Synthetic</td>
<td></td>
</tr>
<tr>
<td>Fascia lata</td>
<td>12 (75%)</td>
</tr>
</tbody>
</table>

Values are presented as number (percent) unless otherwise indicated.

RESULTS
Sixteen patients were included in the study from 2005 to the present. All patients were operated on by the same surgeon (P.H.). The main results are summarized in Table I.

Iatrogenic CSF leaks were addressed by other centers and then closed during another surgical procedure. The mean postoperative follow-up was 24 months (range = 1–101-months). We did not notice any leak recurrence.

DISCUSSION
It was difficult to find in our database all of the patients who were treated with the parachute technique, and we probably missed some. In addition, only 25% of the population described here had a spontaneous CSF leak, which is at higher risk of recurrence. However, in our mind, we did not notice any recurrence after this type of reconstruction, which is used for small defects of the ventral skull base, regardless of the medical history.

Small CSF leaks are not so easy to close. Dot-shaped leaks are accessible through a simple bipolar cauterization of the dura mater and a common fibrin glue sealing. Then, a graft or flap can be used extracranially to secure the repair. If the dura defect is greater than a few millimeters, this technique may not be enough to achieve a watertight closure.

Many techniques have been proposed with good results. Among them, we can cite the “bath-plug” reconstruction, which consists in introducing a fat plug intracranially, secured with a Vicryl suture into the intradural space, and placing traction to seal the defect.

This is a unique layer transdural technique with some disadvantages. The amount of intracranial fat is difficult to quantify, the reconstruction is not anatomical as it does not reproduce the dura mater layer, and the Vicryl suture remains in the fat plug until its absorption. The sandwich technique requires the placement of a layer of fascia lata in the epidural space (first layer), then a layer of cartilage or bone fitted to close the bony defect (second layer), and finally another piece of fascia lata extracranially. In a comparison of these two techniques, the parachute closure allows an anatomical reconstruction of the dura mater and a guided healing of the dura defect between two layers of reconstruction material, with a complete removal of the suture at the end of the procedure. A third layer can also be placed (mucosal graft or mucosal flap) extracranially but is not mandatory. The gasket seal technique can also be used. It consists in an autologous fascia lata or synthetic graft used to create a gasket seal around a bone buttress, gently applying a countersunk on the bone graft into the defect. If the bone graft is not perfectly sized up, it can lead to a lack of support of the fascia lata (if too small) or in excessive force applied on the defect (too large). If the margins of leak are not surrounded by bone, this technique is not easy to achieve. Again, it is transdural and does not reproduce the anatomical layers. Furthermore, in cases of small defects, the gasket seal technique may require an enlargement of the primary defect so as to place the reconstruction.

The parachute technique may also be used in second-intention surgeries in failures of skull base reconstruction, even after chemoradiotherapy (two patients in our experience). We believe that this technique can be part of a surgical arsenal for small CSF leaks closure, and that is complementary to the techniques already described.

CONCLUSION
The surgical technique described here can be a suitable alternative to other closure techniques for small, first-intention CSF leaks of the ventral skull base and is a minimally invasive option for small CSF leak recurrences after oncologic resection. It allows a multilayer reconstruction in the intradural and extradural space to guide the healing of the dura mater.

ACKNOWLEDGMENTS
The authors gratefully acknowledge the technical support of Mr. Clément Jourdaine from the Otorhinolaryngology Department–Skull Base Center of Lariboisière Hospital, and Mrs. Pamela Combastet for the English-language editing.

BIBLIOGRAPHY