The Laryngoscope

HOW I DO IT

Carolyn's Window Approach to Unilateral Frontal Sinus Surgery

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Objectives: Due to the complexity and variety of the frontal recess and sinus anatomy, traditional Draf 2a frontal sinus surgery is challenging. The thickness of the nasofrontal beak and anterior–posterior dimensions of the frontal recess contribute to this complexity. Carolyn's window technique eliminates the limitation of anterior–posterior depth to facilitate a Draf 2a frontal sinusotomy. The approach is a 0° endoscope technique and provides an excellent view of the frontal sinus and recess. We describe Carolyn's window approach to frontal sinus surgery and the perioperative outcomes.

Methods: Consecutive adult patients in whom Carolyn's window technique was applied for frontal sinus dissection as part of the endoscopic management of both inflammatory and neoplastic disease were assessed. The primary outcome was frontal sinus patency. Secondary outcomes were surgical morbidity, defined as early (<90 days) or late (>90 days).

Results: Forty-five patients (49.1 ± 17.9 years, 48.9% Female) were assessed. All patients had successful frontal sinus patency (100% [95CI: 92.1%–100%]). Morbidities were adhesion (4.8%), crusting (2.4%), pain (1.2%), and bleeding (1.2%) in the early postoperative period. There were no other morbidities in the early and late postoperative periods.

Conclusion: Carolyn's window approach to frontal sinusotomy is a technique that evolves from previously described approaches. Successful frontal sinus patency with very low morbidities is achieved while still working with a 0° endoscope. The "axillectomy" performed simplifies frontal recess surgery by removing the anteroposterior diameter limitation and the dexterity required in angled endoscopy and instrumentation. The inferior-based lateral wall mucosal flap and free mucosal grafting expedite the mucosal healing process.

Key Words: endoscopic endonasal surgery, frontal sinus, frontal sinusitis, paranasal sinus diseases, sinusitis.

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INTRODUCTION

The traditional Draf 2a frontal sinus surgery is challenging due to the complexity and variations of the frontal recess and sinus anatomy.[1] In particular, the thickness of the nasofrontal beak and anterior–posterior dimensions of the frontal recess make surgery challenging. These limitations affect the ease of Draf 2a surgery.[1] Several prior techniques have been described to help manage this issue, including an axillary flap, removal of the anterior agger nasi[2] and an agger nasi punch-out procedure.[3] Carolyn's window approach aims to remove the limitation created by the anterior–posterior depth to make a Draft 2a frontal sinusotomy easier for the surgeon. The approach is entirely a 0° endoscope technique and provides an excellent view of the frontal sinus and recess.

The concept of an "axillectomy," or removal of the axilla, includes removal of the entire frontal process of the maxilla and nasofrontal beak. This differs from axillotomy, or simply removing the front wall of the agger nasi. The utilization of high-speed powered instruments makes this technique rapid and efficient. The inferior-based lateral wall mucosal flap (modified-Woodworth flap) and free mucosal grafting of any exposed bone make for rapid mucosal healing. After Carolyn's window approach, the enlarged middle meatus provides enhanced frontal sinus access and irrigation.[4] We describe Carolyn's window approach to frontal sinus surgery and the perioperative outcomes.

MATERIALS AND METHODS

Population

Consecutive adult patients in whom Carolyn's window technique was applied for frontal sinus dissection as part of the endoscopic management of both inflammatory and neoplastic disease

From the Rhinology and Skull Base Research Group, St Vincent's Centre for Applied Medical Research (K.S., A.S., L.H.P., L.K., R.G.C., R.A., R.J.H.), University of New South Wales, Sydney, Australia; Department of Otolaryngology, Faculty of Medicine (K.S.), Chulalongkorn University, Bangkok, Thailand; Endoscopic Nasal and Sinus Surgery Excellence Center (K.S.), King Chulalongkorn Memorial Hospital, Bangkok, Thailand; Faculty of Medicine and Health Sciences (K.S., R.G.C., R.J.H.), Macquarie University, Sydney, Australia; School of Clinical Medicine, St Vincent's Healthcare Clinical Campus, Faculty of Medicine and Health (A.S., R.A., R.J.H.), University of New South Wales, Sydney, Australia; Department of Otorhinolaryngology-Head and Neck Surgery (L.H.P.), Singapore General Hospital, Singapore; Department of Otolaryngology, Head and Neck Surgery (L.K.), Concord General Hospital, University of Sydney, Sydney, Australia; Faculty of Medicine (L.K.), University of Sydney, Sydney, Australia; and the Department of Otolaryngology, Head and Neck Surgery (R.G.C.), Royal Prince Alfred Hospital, Sydney, Australia.

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were assessed. This study was approved by St. Vincent's Hospital's human research ethics committee (2019/PID13822).

Outcomes

The primary outcome was frontal sinus patency. Secondary outcomes were surgical morbidity, defined as early (<90 days) or late (>90 days). Early morbidity included bleeding (requiring intervention), pain (requiring additional analgesia), crusting (requiring an additional post-op visit), adhesions (any), cerebrospinal fluid leak, periorbital edema or hematoma, and skin changes. Late morbidity included epiphora, smell reduction from baseline, retained frontal recess partitions, and any external cosmetic change.

Preparation

An endotracheal tube was positioned in the lower right commissure. The patient was prepared topically with 1% ropivacaine and 1:2,000 adrenaline-soaked cotton pledgets. Endoscopically, the mucosa was injected with 1% ropivacaine and 1:100,000 adrenaline across the lateral wall anterior to the middle turbinate and the root of the middle turbinate. The patient's head was at an extended 30–40°, and the patient was in a 15–20° reverse Trendelenburg position with total intravenous anesthesia and bradycardia.

Surgical Technique

A middle meatal antrostomy and at least an anterior ethmoidectomy are performed to identify the medial orbital wall. The approach is often combined with sphenoethmoidectomy or "neo-sinus" or "full-house" surgery. Carolyn's window commences with the creation of the inferior-based lateral wall mucosal flap (modified-Woodworth flap). The incision on the lateral wall begins at the nasal cavity roof, high above the axilla, by needle-point diathermy, setting 12 (0016 AM Megadyne, NJ, USA). The posterior incision, at a depth of the middle turbinate insertion, is carried vertically down to the middle turbinate. The superior incision is carried along the apex of the nasal cavity forward to the pyriform aperture and then vertically down, just behind the pyriform aperture, to a level that approximates the midpoint of the middle meatus. These incisions are to the bone, and the inferior-based lateral wall mucosal flap is elevated subperiosteally, with the flap retracted down and exposing the axilla and lateral wall bone. (Fig. 1).

Drilling proceeds with a 0° endoscope and a 4-mm 15° diamond burr, at 30,000 revolutions-per-minute (Straightshot M5 Micordebrider, Medtronic, FL, USA), removing the entire axilla-agger nasi-maxillary-frontal process complex (Fig. 2). First, the periosteum of the frontal process of the maxilla bone and the nasolacrimal sac are identified as the lateral limits. These were discovered to widen the surgical field. Then, drilling proceeds to remove the entire axilla, lateral to the middle turbinate insertion but medial to the periosteum that was just defined. Although the first olfactory neuron can be found to define the extent of medial dissection, as commonly performed in a Draf 3, this is generally not required, and the insertion of the middle turbinate serves as

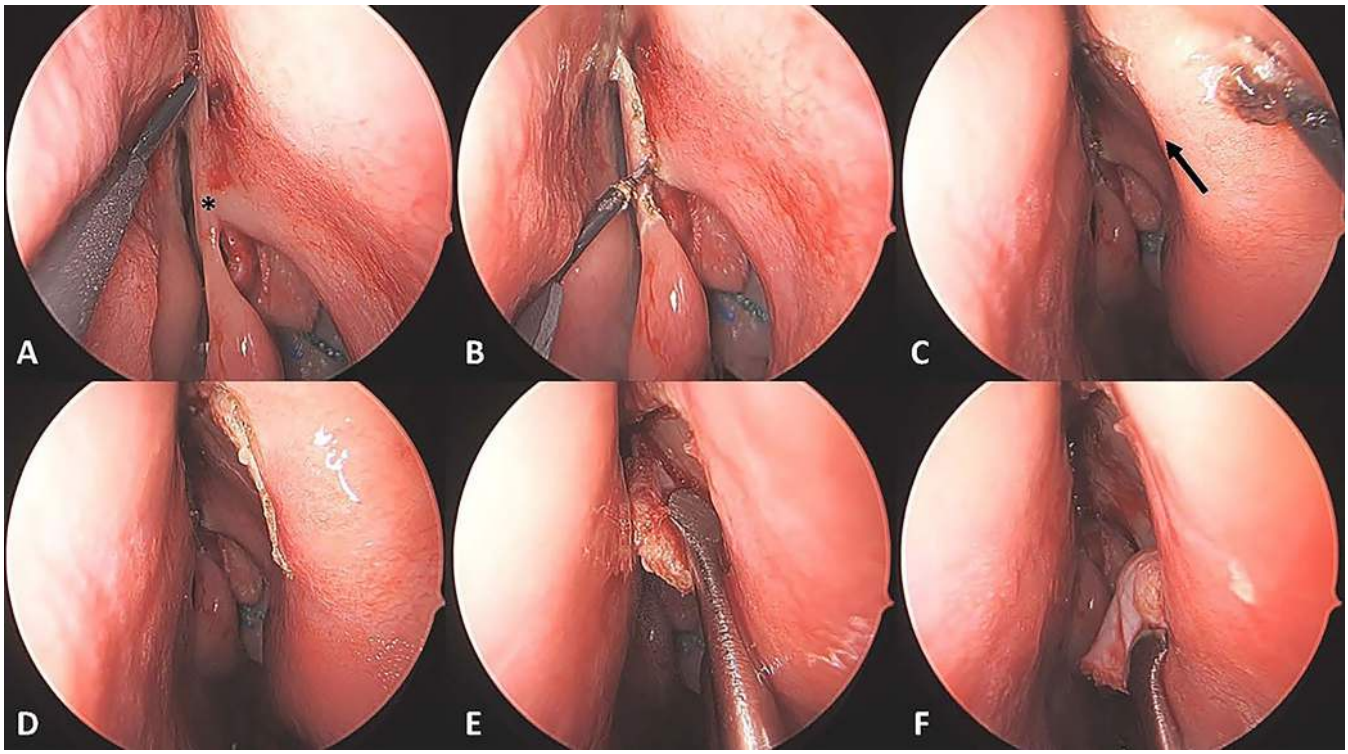


Fig. 1. The inferior-based lateral wall flap creation. Representative intraoperative endoscopic imaging of the left nasal cavity. (A) The incision on the lateral wall begins high above the axilla (asterisk) at the nasal roof. (B) The posterior incision is carried vertically down to the middle turbinate. (C) The superior incision is carried at the very apex of the nasal cavity forward to the pyriform aperture (black arrow). (D) The anterior incision is carried vertically down, just behind the pyriform aperture, to a level approximating the midpoint of the middle meatus. (E) The inferior-based lateral wall mucosal flap is elevated subperiosteally. (F) The flap is retracted down.

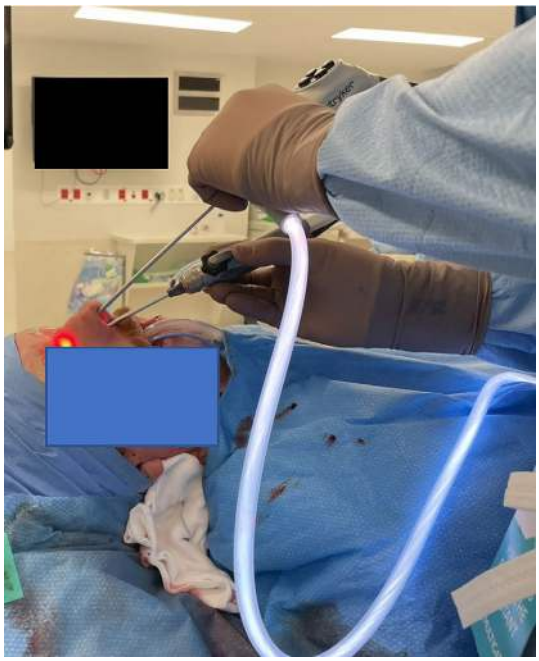


Fig. 2. The angulation of the high-speed drill with 0° endoscope during axillectomy.

the medial landmark. The triangular bone anterior to the frontal recess is removed until the "blue lining" of the mucosa is seen, thus preserving the frontal recess itself. Drilling continues anteriorly and superiorly to remove the nasofrontal beak in a vertical orientation relative to the apex of the frontal sinus. Once the remaining bone is thin, the frontal recess partitions are removed with the 2.5-mm 45°cutting forceps and 4.3-mm quadcut straight microdebrider (Straightshot M5 Micordebrider, Medtronic, FL, USA). The 5-mm 70° Hosemann frontal sinus punch can complete the removal of bone edges but is used with a 0° endoscope. At the end, a giant middle meatus is created with all frontal sinus walls that can be seen through the 0° endoscope (Fig. 3).

The inferior-based lateral wall mucosal flap is returned to cover the lateral wall. A free mucosal graft from the inferior turbinate tail is thinned and covers any exposed bone (Fig. 4). The middle meatus is stented with hyaluronic acid gel (Bioregen, Changzhou, China) and a Merocel (Medtronic, FL, USA) finger glove spacer with no other packing. The surgical steps were illustrated in Video 1.

Postoperative Care

Spacers were retained for 7–14 days, and irrigation commenced on the first postoperative day. Patients are managed via day surgery. Amoxicillin/clavulanic acid was given for 10 days, and prednisone was given at 25 mg maximum daily for 7–21 days to reduce oedema/congestion and varies on pathology.

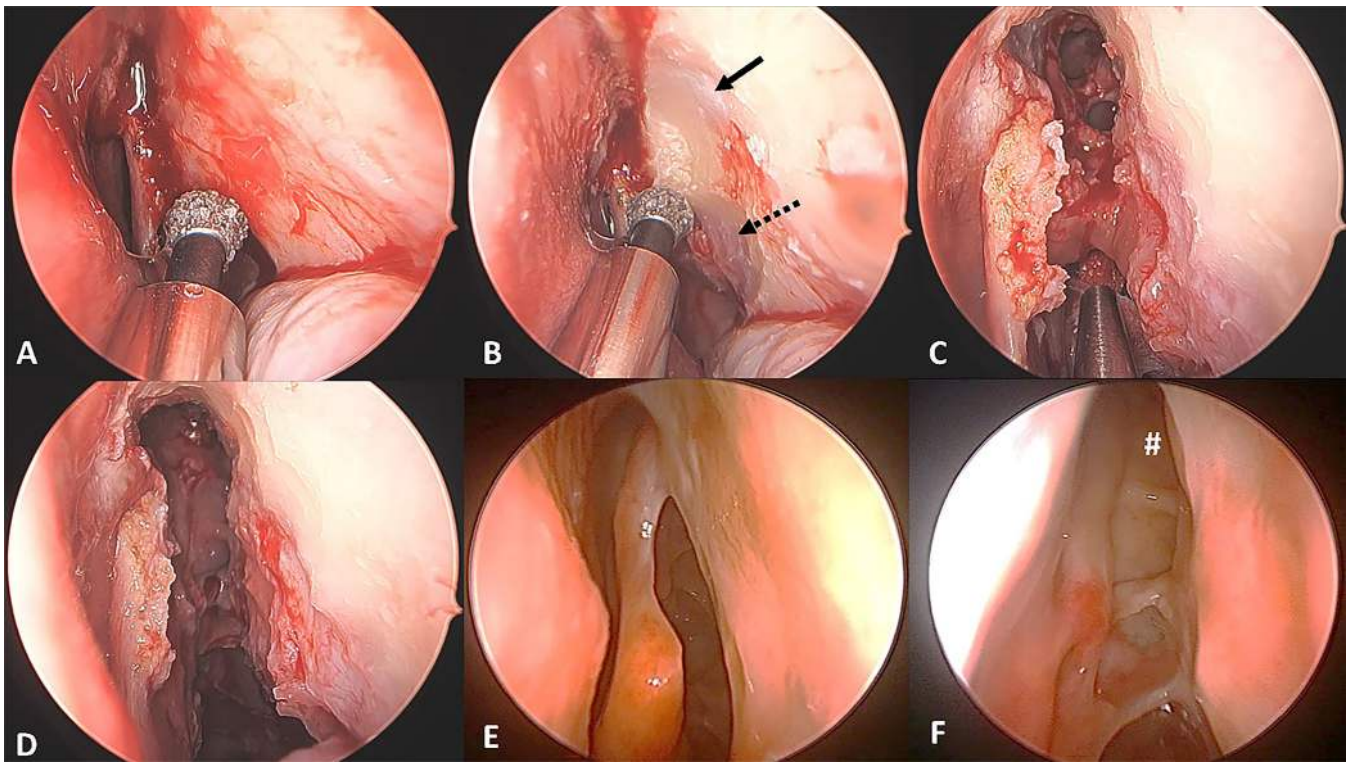


Fig. 3. Axillectomy. Representative intraoperative endoscopic imaging of the left nasal cavity. (A) The axilla and lateral wall bone are exposed after the inferior-based lateral wall mucosal flap is created. (B) The frontal process of the maxilla bone periosteum (black arrow) and nasolacrimal sac periosteum (black dash arrow) are defined as the lateral limits. (C) Drilling removes the entire axilla-agger nasi-maxillary frontal process complex lateral to the middle turbinate. (D) A giant middle meatus with all frontal sinus walls that can be seen through the 0° endoscope is created. (E, F) 3-month postoperative view of enlarged middle meatus and frontal sinus that can be seen through the 0° endoscope. Posterior table of the frontal sinus (number sign).

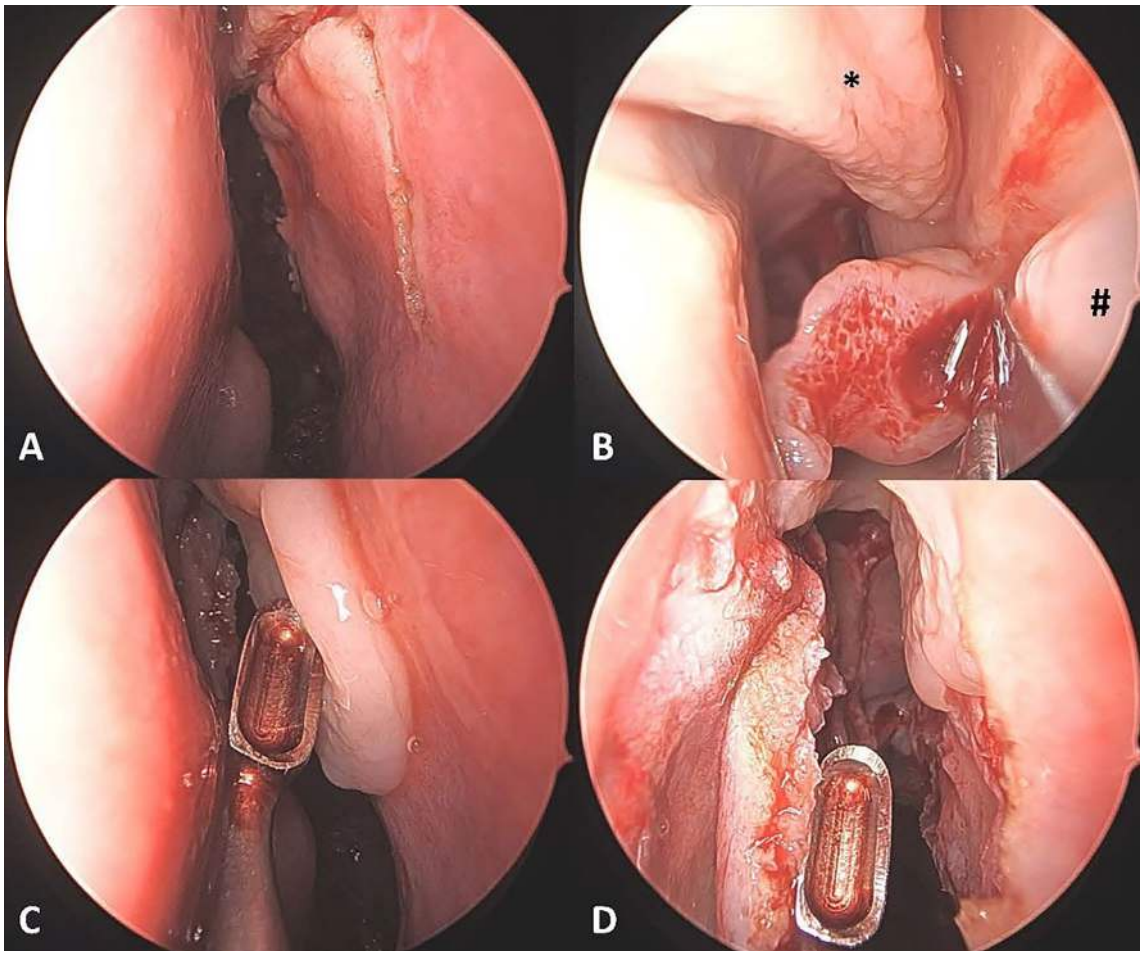
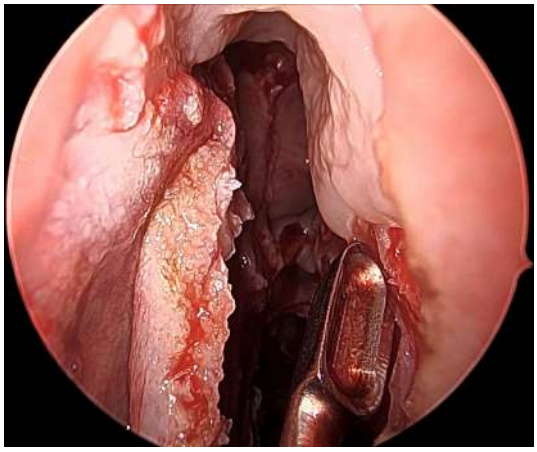


Fig. 4. The inferior-based lateral wall mucosal flap and free mucosal graft placement. Representative intraoperative endoscopic imaging of the left nasal cavity. (A) The inferior-based mucosal flap was returned to cover the lateral nasal wall. (B) A free mucosal graft was taken from the inferior turbinate (number sign) tail. (C, D) A free mucosal graft from the inferior turbinate tail is thinned and covers any exposed bone. Middle turbinate (asterisk).



Video 1. Left Carolyn's window Draf 2a frontal sinus surgery was done in 33 years old male with central compartment atopic disease.
Video content can be viewed at https://onlinelibrary.wiley.com/doi/10.1002/lary.30569

TABLE I.
Baseline Characteristics of Carolyn's Window Case Series.

	Carolyn's window ($N = 45$)
Gender, *N* (%)	
Male	23 (37.5)
Female	22 (48.9)
Age (years), mean ± SD	49.1 ± 17.9
Prior surgery, *N* (%)	18 (40.0)
Diagnosis, *N* (%)	
Allergic fungal rhinosinusitis	2 (4.4)
Osteomeatal complex occlusion	2 (4.4)
Central compartment atopic disease	12 (26.7)
Eosinophilic chronic rhinosinusitis	8 (17.8)
Non-eosinophilic chronic rhinosinusitis	7 (15.6)
Benign neoplasms	11 (24.4)
Primary ciliary dyskinesia	1 (2.2)
Cystic fibrosis	2 (4.4)

N = number of patients; SD = standard deviation.

RESULTS

Forty-five patients (49.1 ± 17.9 years, 48.9% Female) were assessed. Baseline characteristics were described in Table I. All patients had successful frontal sinus patency (100% [95CI: 92.1%–100%]). Follow-up was 39.2 ± 9.0 months. Morbidities were adhesion (4.8%), crusting (2.4%), pain (1.2%), and bleeding (1.2%) in the early postoperative period. There were no other morbidities in the early (cerebrospinal fluid leak, periorbital edema or hematoma, and skin changes) and late (epiphora, smell reduction from baseline, retained frontal recess partitions, and any external cosmetic change) postoperative periods.

DISCUSSION

Carolyn's window is a simple and robust approach for frontal recess surgery. All cases in our series had successful frontal sinus patency with low surgical morbidities. Surgery proceeds with the 0° endoscope, which provides excellent visualization of the frontal recess and sinuses. The straight (15°) power instruments are generally all that is required. The high-speed drill can remove the entire axilla-agger-nasi complex rapidly and efficiently. Moreover, straight microdebrider blades are used to preserve the mucosa of the frontal recess and sinus.

The surgical concept of an "axillectomy" is removing the entire frontal process of the maxilla and nasofrontal beak, performed via Carolyn's window. It differs from a commonly performed "axillotomy," either by axillary flap[2] or Kerrison rongeur.[3] The frontal recess is often made narrow by the bone removed in the technique. By removal, Carolyn's window makes frontal recess surgery technically less demanding by taking the anteroposterior limitation of frontal recess anatomy out of the surgical dissection. The axillectomy in Carolyn's window approach removes the entire bone, not just the frontal wall of the agger nasi. The resulting postoperative appearance is that of an enlarged middle meatus. The frontal sinus should be visualized through a 0° endoscope, which differs from the traditional axillotomy, which facilitates angled frontal dissection but still needs an angled endoscope to approach the frontal sinus. Topical irrigation delivery to the frontal sinus is believed to be superior with 0° endoscopic visualization than traditional Draf 2a sinusotomy.[4] The distinction between Draf 2b and Carolyn's window is still more about the nasofrontal beak removal than the excision of the frontal sinus floor to the midline. For many patients, a "hemi-lothrop" and this approach may be similar, but a Draf 2b does not always imply a 0° endoscope visualization of the frontal sinus.

Carolyn's window frontal recess surgery is still conceptually a Draf 2a, not a Draf 2b, because this approach is lateral to the middle turbinate and does not always involve removal of the frontal sinus floor to the septum. However, the approach is flexible, allowing the surgery to continue bone removal with a Draf 2b, Hemi-Lothrop, or Draf 3. The lateral limits of the dissection are easy to define, using the periosteum and nasolacrimal sac, similar to the outside-in approach to the modified endoscopic Lothrop procedure.[5] Drilling continues lateral to the insertion of the middle turbinate, thus the surgeon always remains safe from the olfactory cleft in the midline. However, the first olfactory neuron may be identified as the posterior limit in some cases if the root of the middle turbinate cannot be identified or is missing.

Drilling creates raw bone and thus adding the mucosal flap and free grafting is essential for good mucosal healing. The inferior-based lateral wall mucosal flap (modified-Woodworth flap) remains out of the surgical field. These mucosal flaps and free mucosal grafts create rapid mucosal healing and prevent bone scar adhesion.

Carolyn's window provides an enlarged middle meatus appearance, creating excellent access to the frontal recess and sinus. This enlargement makes instrumentation easier at the time of surgery, improves post-surgical access, and enhances irrigation postoperatively.[4] The approach is also suitable for the hypopneumatization of the frontal sinus, where a Draf 3 is not appropriate, but access to the upper ethmoid is still required. This approach is commonly adopted for sinus barotrauma, central compartment atopic disease, or unilateral benign tumors in the frontal sinus. However, Carolyn's window does not replace the wide common frontal sinusotomy provided by a modified endoscopic Lothrop procedure for lateral frontal access or hyper-secretory conditions such as eosinophilic chronic rhinosinusitis.

CONCLUSION

Carolyn's window approach to frontal sinusotomy is a technique that evolves previously described approaches and is a product of high-speed drill development. Successful frontal sinus patency with very low morbidity is achieved with a 0° endoscope working channel for most frontal sinuses. The "axillectomy" simplifies frontal recess surgery by removing the anteroposterior diameter limitation and the dexterity required in an angled endoscope. The inferior-based lateral wall mucosal flap and free mucosal grafting create rapid healing.

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CONFLICT OF INTEREST

Richard J Harvey is consultant/advisory board with Medtronic, Novartis, Glaxo-Smith-Kline and Meda pharmaceuticals. He has been on the speakers' bureau for Glaxo-Smith-Kline, Astra-zeneca, Meda Pharmaceuticals and Seqirus. Larry Kalish is on the speakers' bureau for Care Pharmaceuticals, Mylan, and Seqirus Pharmaceuticals. All other authors have no personal, financial, or institutional interest in any drugs, materials, or devices described in this article.

BIBLIOGRAPHY

1. Wormald PJ, Bassiouni A, Callejas CA, et al. The international classification of the radiological complexity (ICC) of frontal recess and frontal sinus. *Int Forum Allergy Rhinol*. 2017;7(4):332-337. https://doi.org/10.1002/alr.21893.
2. Wormald PJ. The axillary flap approach to the frontal recess. *Laryngoscope*. 2002;112(3):494-499. https://doi.org/10.1097/00005537-200203000-00016.
3. Pletcher SD, Sindwani R, Metson R. The Agger nasi punch-out procedure (POP): maximizing exposure of the frontal recess. *Laryngoscope*. 2006;116(9):1710-1712. https://doi.org/10.1097/01.mlg.0000231743.74993.0b.
4. Spielman DB, Kim M, Overdevest J, Gudis DA. Zero-degree endoscopic visualization of the frontal sinus predicts improved topical irrigation delivery. *Laryngoscope*. 2021;131(2):250-254. https://doi.org/10.1002/lary.28654.
5. Chin D, Snidvongs K, Kalish L, Sacks R, Harvey RJ. The outside-in approach to the modified endoscopic Lothrop procedure. *Laryngoscope*. 2012;122(8):1661-1669. https://doi.org/10.1002/lary.23319.