John S. Oghalai
Colin L.W. Driscoll

Atlas of Neurotologic and Lateral Skull Base Surgery

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ISBN 978-3-662-46693-3 ISBN 978-3-662-46694-0 (eBook)
DOI 10.1007/978-3-662-46694-0

Library of Congress Control Number: 2015946111

Springer Heidelberg New York Dordrecht London

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Printed on acid-free paper

Springer-Verlag GmbH Berlin Heidelberg is part of Springer Science+Business Media (www.springer.com)

To my wife, Tracy, and my children, Kevin and Tom, for their support.

To my trainees for their inspiration. To my patients for their faith.
John S. Oghalai, MD

To my patients for their trust.

To my family, Sheri, Abigail and Avery for their support.
Colin L.W. Driscoll, MD

Acknowledgements

No one learns surgery in a vacuum. Most of the techniques we describe within this text are based upon techniques we learned during training. Since both of us were clinical fellows at the University of California, San Francisco, we certainly must acknowledge our fellowship director and mentor, Robert Jackler, MD. His training, leadership, and enthusiasm for scholarship helped build the foundation for our careers in academic medicine. Dr. Jackler's textbooks, lectures, and writings are wonderful models of educational materials. We hope this text will serve to honor and enhance his legacy.

Additional acknowledgments must go out to the other neurotologists that also trained us. This list is extensive, but includes Bobby Alford, MD, Herman Jenkins, MD, Newton Coker, MD, Anil Lalwani, MD, Steve Cheung, MD, and Steve Harner, MD. Of course, we have also learned from the neurosurgeons we have worked with, including Larry Pitts, MD, Mike McDermott, MD, Mitch Berger, MD, Dan Yoshor, MD, Youssef Comair, MD, David Baskin, MD, Gordon Li, MD, Larry Shuer, MD, Robert Dodd, MD, Gary Steinberg, MD, PhD, Mike Ebersold, MD, and Mike Link, MD.

Of course, we are indebted to Scott Weldon. His skill as a medical illustrator is of the highest level. Besides his incredible talent as an artist, Scott is an easy-going person and a great collaborator. We feel lucky to have been able to work with him on this large project.

Finally, we must express gratitude to the multitude of faculty, fellows, residents, medical students, and visitors that we have had the opportunity to work with, train, and learn from over the years. We find it is this spirit of collegiality, teamwork, learning, and optimism, all while striving to care for our patients with empathy, that makes us feel lucky to have careers as academic skull base surgeons.

John S. Oghalai, MD
Colin L.W. Driscoll, MD

Contents

Introduction

1

Neurotology and skull base surgery is a wonderful career path. We highly recommend it! Patients range in age from the very young to the elderly and range in health from being completely normal to having multiple severe comorbidities. The pathologies are variable, spanning the spectrum from uncomplicated benign lesions to highly complex life-threatening lesions. Operating in and around the skull base is complex because of the detailed anatomy, large vascular structures, and the presence of cranial nerves. As you become an expert in this anatomy, you will be able to resect formidable-appearing tumors with superb survival rates and limited morbidity. Most patients will return to active and productive lives.

The importance of having a dedicated skull base surgical team cannot be overstated. There is a synergistic effect when the group works as a coordinated team in the management of these complex tumors and pathologies. A dedicated neurotologist, neurosurgeon, neuroradiologist, radiation oncologist, intraoperative monitoring technician, proficient surgical scrub, and experienced ICU staff are all critical to success. A high case volume is required to generate the necessary expertise.

The increasing use of stereotactic radiotherapy and observation strategies to treat vestibular schwannoma has led to a decline in surgical volume. However, these strategies have added options that increase patient choice and have improved outcomes for many patients. Since benign skull base tumors often have minimal presenting symptoms, surgical treatment and associated cranial neuropathies may make a patient feel worse after treatment than before treatment. Involving the patient in the selection of treatment planning, in our opinion, makes them much more satisfied when living with side effects after the chosen treatment strategy. Thus, you should embrace the consideration of these and any other future treatment strategies and always discuss these options.

This atlas contains both illustrations and case examples. The illustrations show the anatomy and the key steps in the surgical approaches. The case examples highlight unique features relevant to the approach. For example, pre- and postoperative radiographic images are included to demonstrate representative pathologies and the expected results. Similarly, intraoperative photos demonstrate specific features of the procedure that are often quite subtle but, when followed, can help to achieve ideal results. Most importantly, we have found that the careful review of case examples is an excellent way to teach residents and fellows the process of surgical decision-making. When you have a challenging case, we hope that by scanning the cases in this book, you will be able to find a similar case that can help guide your treatment planning.

Each chapter in this atlas covers approaches to different regions of the skull base. However, the head and neck are not easily divided up as many structures involve multiple regions. Also, many tumors involve more than one region. Thus, many of the approaches overlap. For example, a temporal bone tumor invading into the parotid gland and posterior fossa may be best treated with a transcochlear approach (Chap. 4) combined with a temporal bone resection (Chap. 8). Do not feel limited by the nomenclature of each approach, which is based upon CPT coding. Instead, treat each patient as an individual by considering the physical exam and radiographic imaging findings when deciding what structures need to be removed and what can be preserved. This thought process will help you to figure out which approach or combination of approaches will best allow you to perform the procedure you wish to perform. Many tumors call for creativity, an exciting aspect of the specialty.

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General Principles

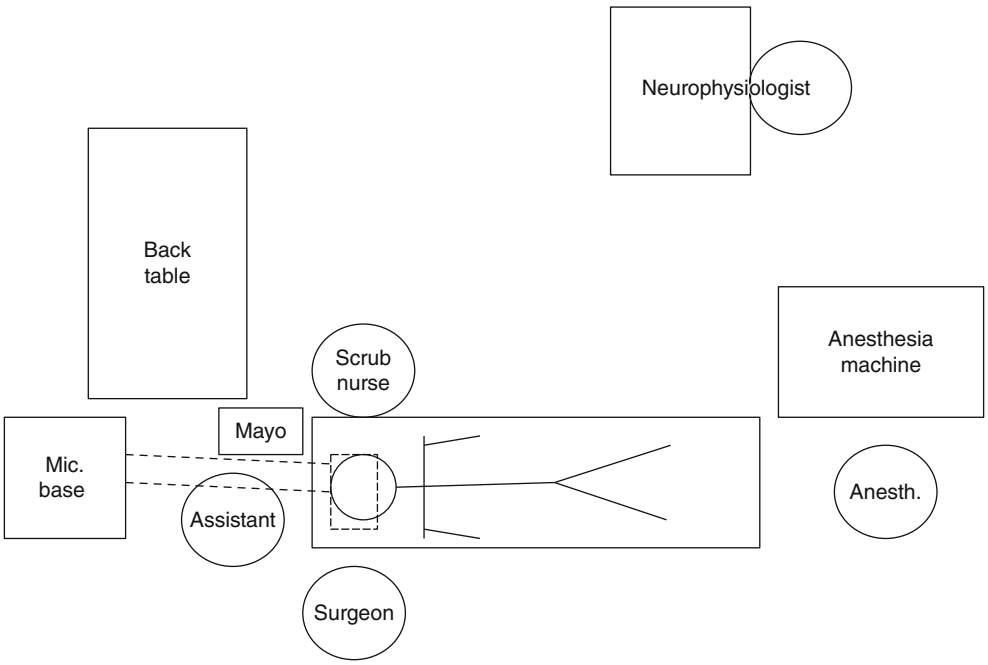
2

Room Layout

1. Room layout for an approach on the right side. The bed should be turned 180° from the anesthesiologist to allow maximum room around the patient's head. Having the microscope base at the head of the bed allows the assistant to sit under the boom arm and observe through the side arm. The scrub nurse sits across the patient from the surgeon to facilitate the handing of instruments. He/she can have a Mayo stand near the patient's head to hold the commonly used instruments, cottonoid patties, Surgicel, and Gelfoam. All of the rest of the less frequently used instruments can be kept on the back table.

The neurophysiologist can realistically be placed anywhere in the room. However, he/she should be close enough so that the surgeon can communicate with the neurophysiologist and be able to hear the speaker from their machine.

Your anesthesia colleagues may initially not be enthusiastic about being away from the head of the bed but will adapt. The sooner after induction of anesthesia that the table can be turned, the sooner the case can be started. An experienced team should be ready to make an incision 45 min after the patient enters the OR. Once the OR table is turned, multiple people can work simultaneously to place an arterial line, Foley catheter, or EMG monitoring electrodes and to work on patient positioning.



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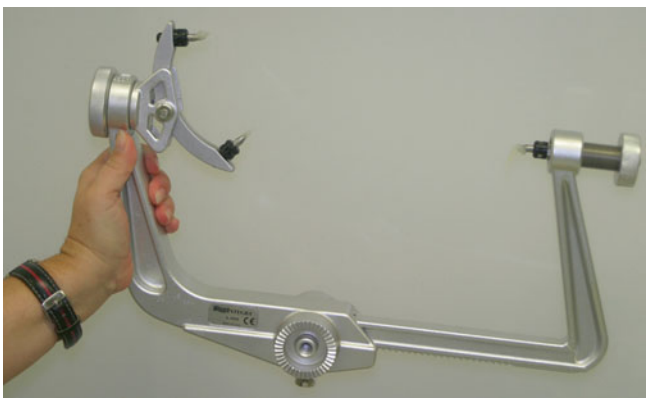
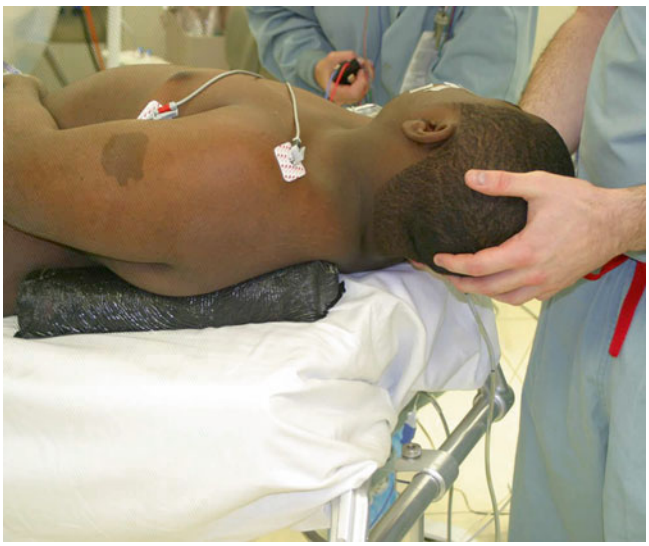
Use of the Mayfield Head Holder

2. A Mayfield head holder serves two important purposes. First, it rigidly fixates the head so it will not move relative to the operating table. Second, it allows for the attachment of adjustable retractors. We typically use the Greenberg retractor system or the Budde Halo system. By rigidly connecting the table, the head, and the retractor, there is less opportunity for unexpected movements to occur during the surgery. While not every skull base surgery needs the use of the Mayfield, it is often helpful in long cases or those where careful brain retraction is expected.

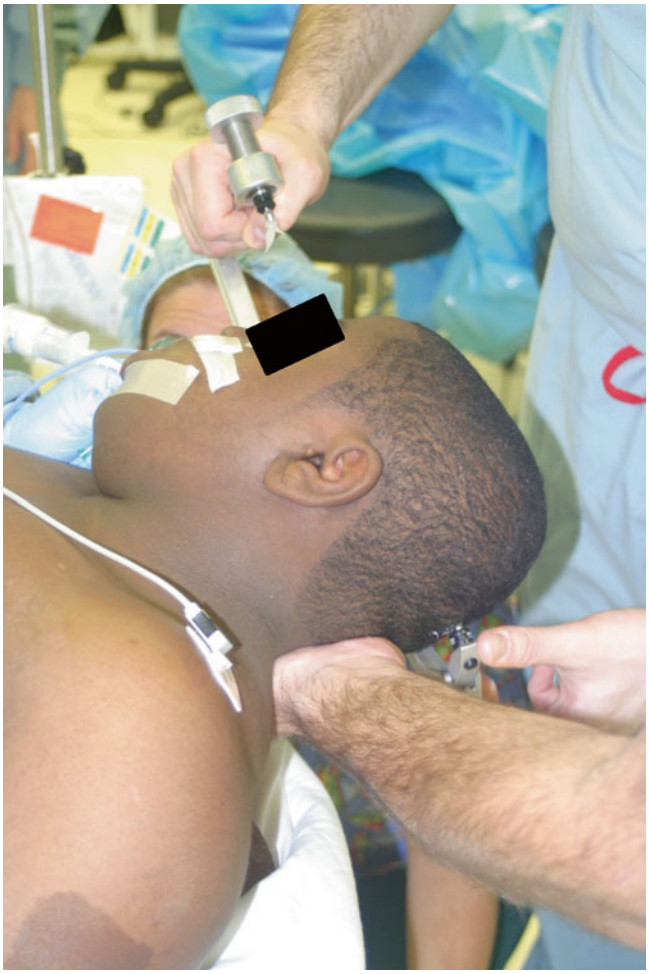
   The Mayfield has three pins. To securely clamp the head, the two pins are typically placed near the back of the head and must be seated above the nuchal line (the horizontal ridge of bone in the back of the head where the posterior paraspinal muscles attach). Ideally, pinning is performed so that one of these two pins is placed under the head to reduce the risk of gravity pulling the patient's head out of the pins during the long surgery. After first making sure the two pins are firmly in contact with the head, the side with the single pin is then clamped down near the front of the head. Before pinning the patient, bacitracin ointment is applied to the three pins. Also, the anesthesiologist should be warned. The stimulation associated with pinning can often require additional sedation.

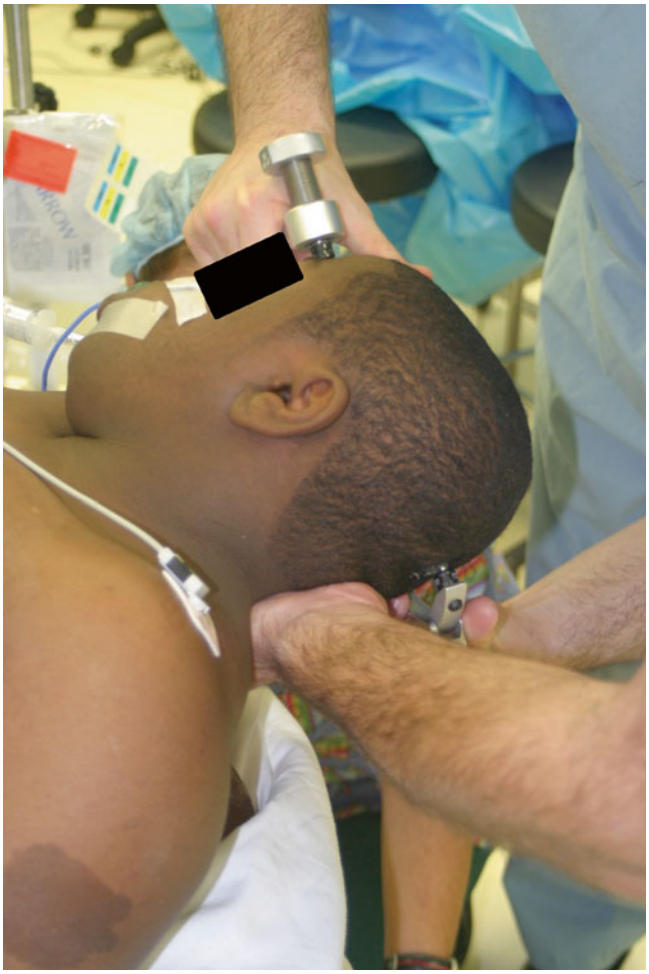


3. Pinning must be performed carefully so as not to traumatize the patient's neck or brachial plexus with overstretching. In this example, the patient was pinned for a retrosigmoid approach for vestibular schwannoma resection. Note the large café au lait spot consistent with this patient's diagnosis of neurofibromatosis type II. A shoulder bump was placed to help rotate the torso slightly.

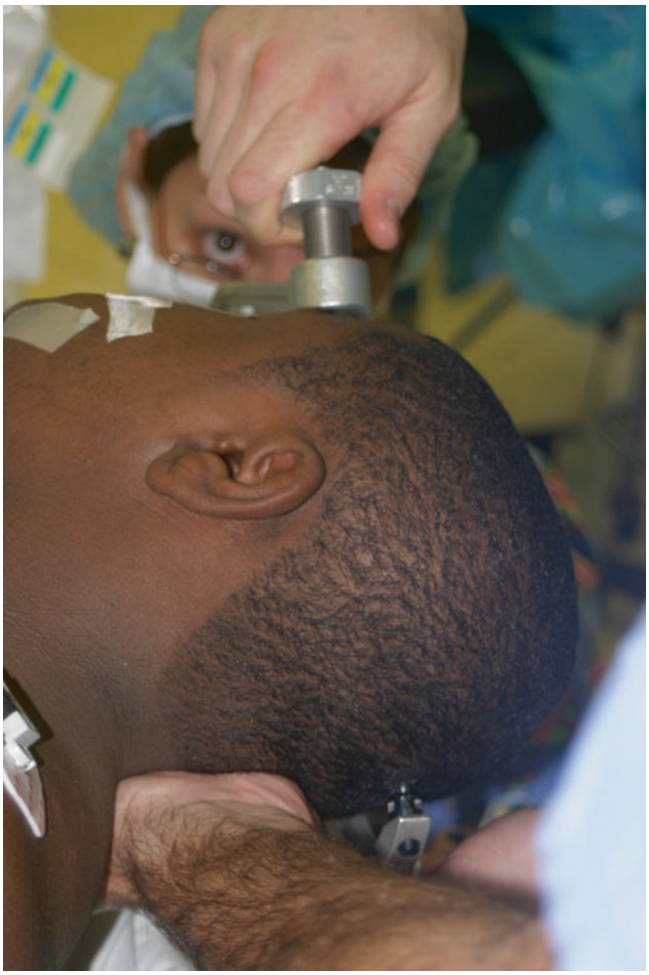


4. The posterior two pins are seated first to ensure that they both make firm contact with the skull above the nuchal line. During this process, the person applying the pins must be sure not to accidentally poke the hand of the person holding the patient's head. Note the glob of bacitracin ointment on the anterior pin.
5. Next, the single pin is brought in. With lateral skull base surgery, this pin often needs to be placed in the forehead. While this is not ideal because of the postoperative pigmentation that can occur in that spot, it is not worth the risk of trying to move the pin to a hair-bearing area. It will not hold the head tightly, and the head may slide out of the pins during the long surgery.





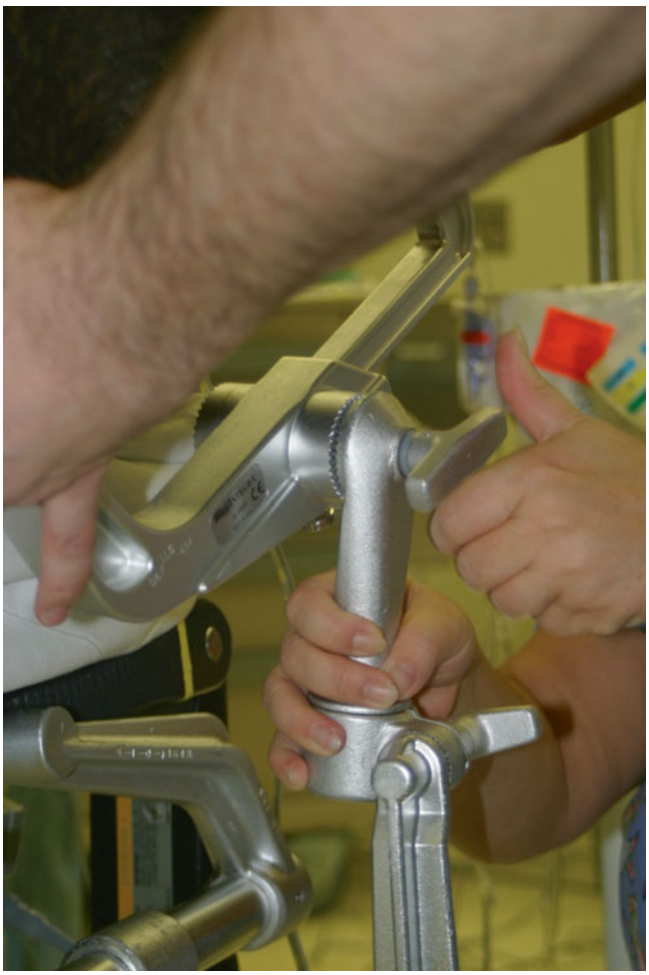
6. The screw is turned to tighten the pins.



7. For adults, the screw should be tightened until the third line is reached (60 lbs pressure). When pinning children, shorter pins are used, and the pressure is lowered to prevent a skull fracture.

8. Finally, the head is placed in the proper position. The surgeon must think about what view he/she wants during surgery before finalizing the head position. Typically, we like to have the head flat and tilted forward slightly to keep the operative field as far away from the shoulder as possible. However, care should be taken to make sure that a hand can fit between the patient's chin and shoulder. If space is not left here, a brachial plexus stretch injury can occur. Head and neck positioning is important when using the Mayfield head frame. Although the OR table can be tilted, every effort should be made to properly position the patient to minimize the need to tilt the bed. There is increased risk of a compressive neuropathy or of falling off the bed when it is tilted, particularly for prolonged procedures.

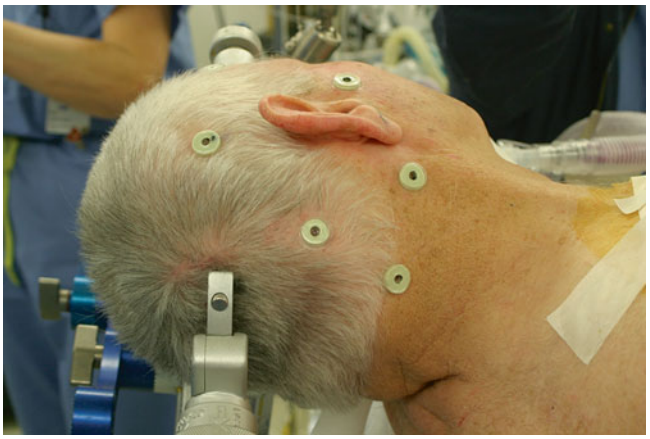
   The screws are tightened at each joint, working from the top down. Before releasing the head, verify the integrity of the Mayfield head holder by trying to jiggle the head slightly. It should not move at all.



9. The final view of the patient after placing the Mayfield head holder.

Computer-Guided Stereotactic Navigation

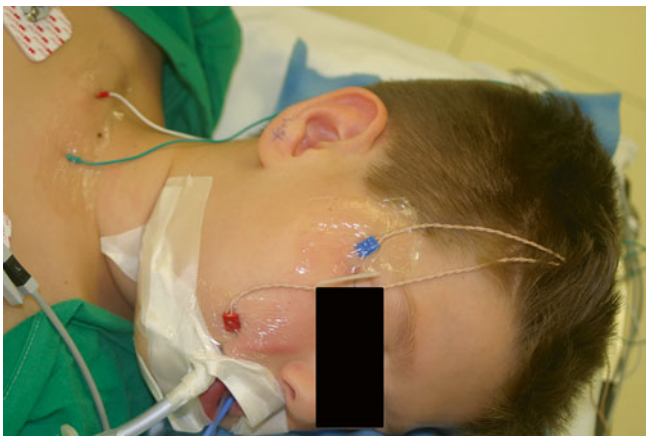
10. A typical setup for a Stealth navigation system is shown here. The patient has already had an MRI and/or CT scan with the fiducials in place. The Mayfield head holder is placed. Then, each fiducial is located using the computer software. After this has been done, the fiducials can be removed.



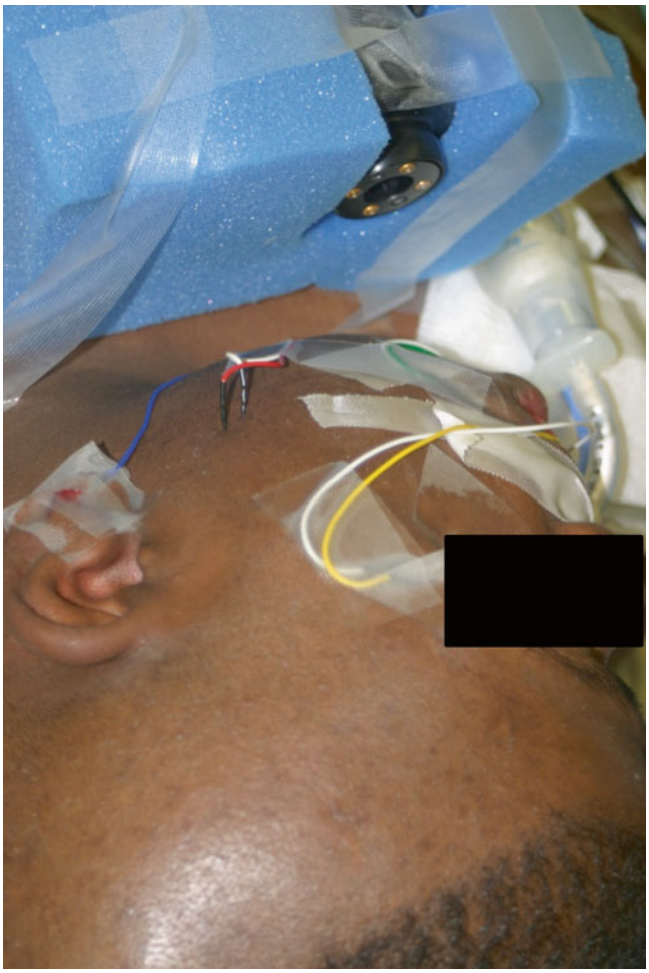
11. During surgery, the Stealth probe is used to identify the anatomic position of structures noted intraoperatively. This is particularly helpful when assessing structures fixed to the skull as they do not shift position as do structures within or attached to the brain. One minor problem with the Stealth system is that the microscope must sometimes be moved out of the way to fit the probe into the wound. Finding an appropriate position for the viewing screen and other stereotactic navigation equipment can be challenging in smaller ORs.

Cranial Nerve Monitoring

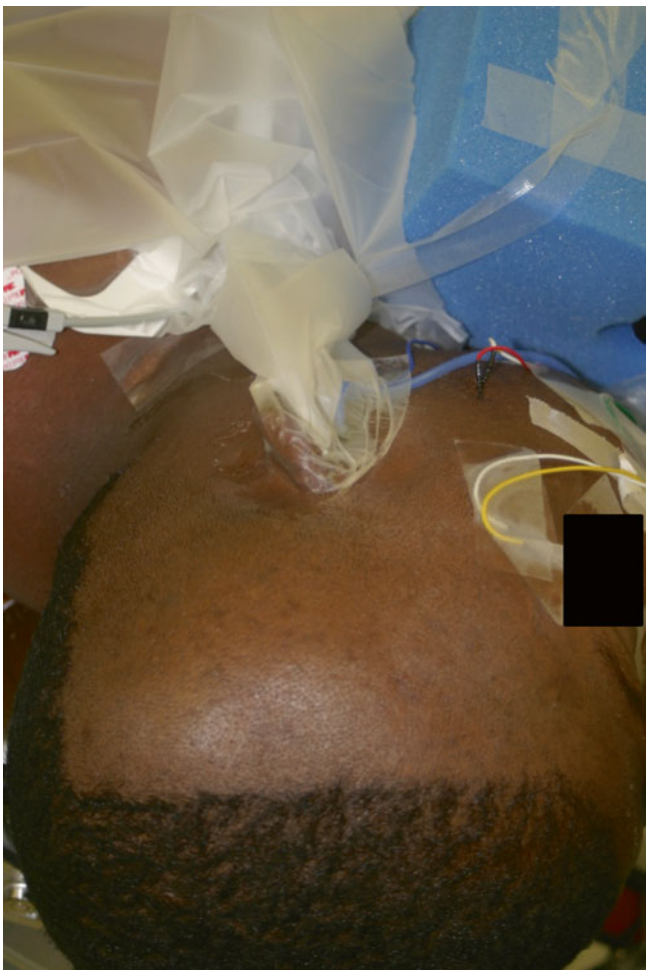
12. A typical setup for facial nerve monitoring is shown here. This is what we use for routine ear surgery and cochlear implant. The automated facial nerve monitoring machine is used instead of a dedicated neurophysiologist. The paired electrodes (red and blue) are placed at the corner of the eye and mouth. They are placed in a subdermal position, meaning that they do not penetrate deep, just parallel to the skin. There is no significance to whether the red or blue paired electrode is placed at either the corner of the eyes or the corner of the mouth. In either case, activation of the orbicularis oculus and orbicularis oris muscles will be detected. The ground for the recording electrode (green) and the ground for the stimulating electrode (white) are placed anywhere on the chest.



13. When skull base surgery is to be performed, we always use a neurophysiologist. At a minimum, we measure cranial nerves V, VII, and XI. In this example, where we were doing a hearing preservation middle fossa approach, we also measured ABRs. The facial nerve electrodes were placed at the corner of the eye and mouth. Also, the electrodes for the masseter muscle (CN V) are visible in the midcheek region. Lastly, the electrode for the ABR was placed in the earlobe.

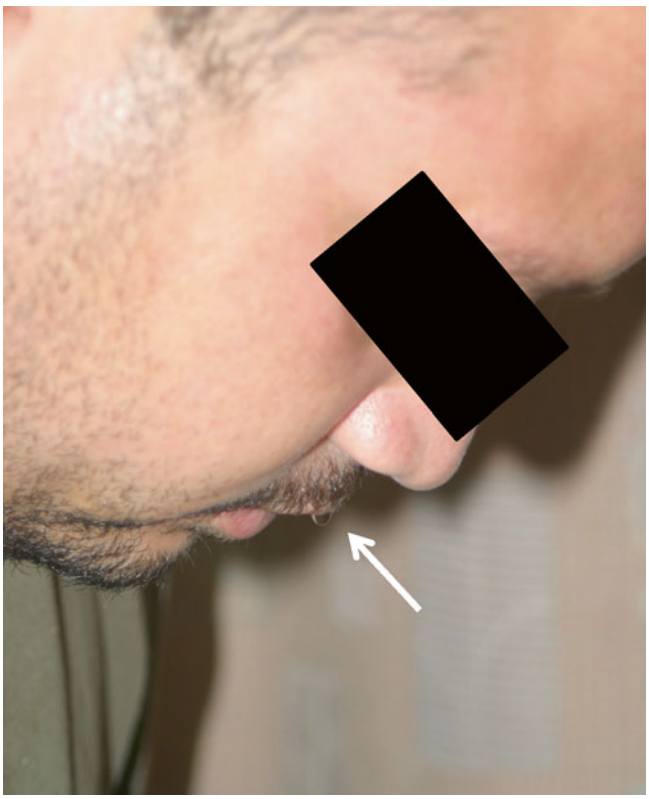


14. Next, the earphone was placed in the ear canal. Sound travels through the blue tube, and care needs to be taken that the tubing will not become kinked during the case. After applying Mastisol, a sticky drape was applied around the ear to keep the ear canal dry. This is important because if blood or fluid gets into the ear canal, it can cause a conductive hearing loss and abolish the ABR tracing.



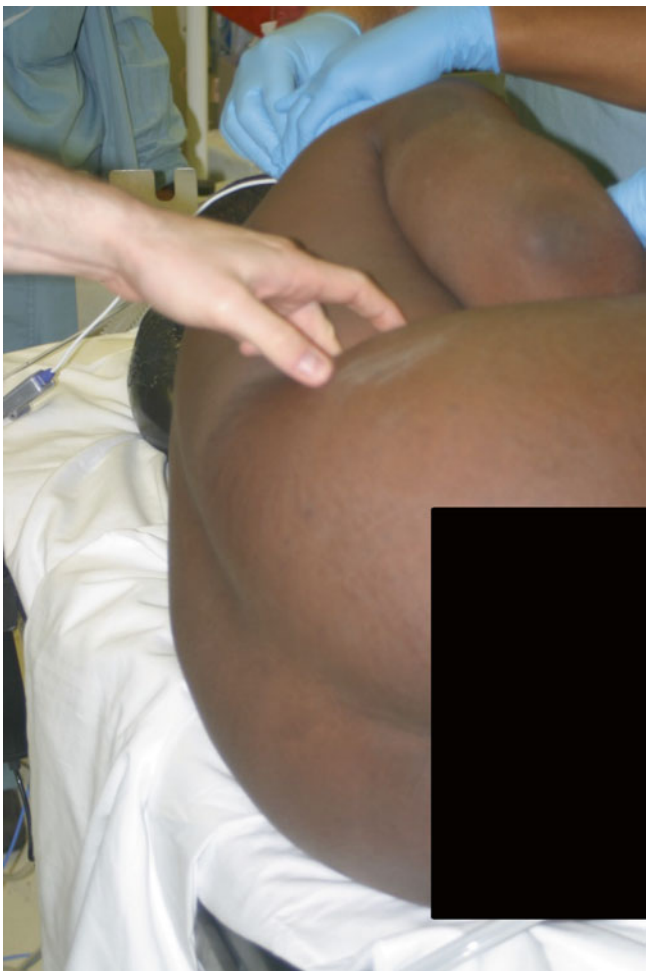
CSF Management

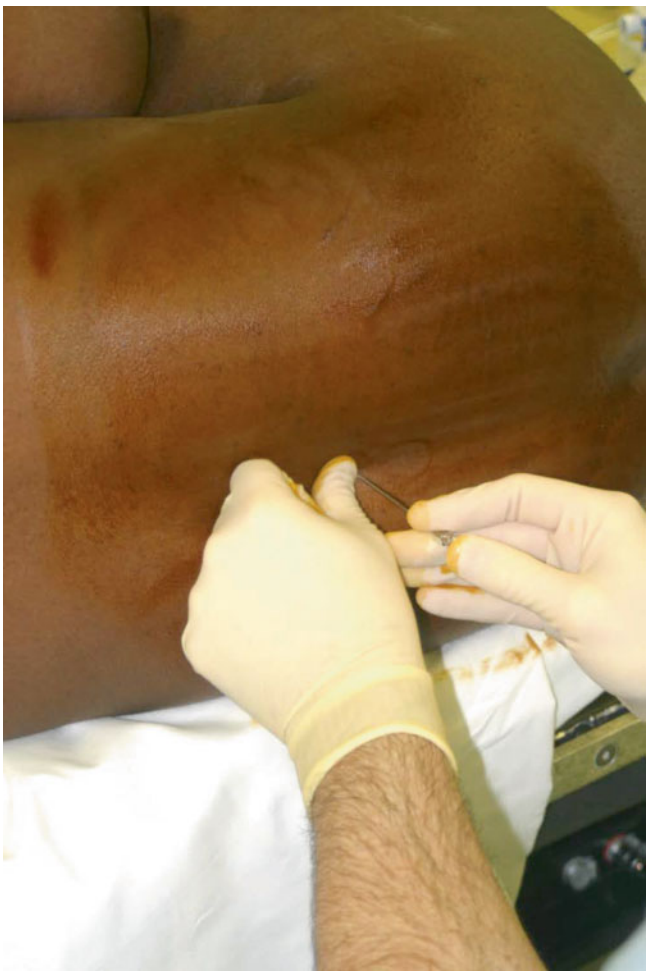
15. After skull base surgery, patients can have CSF rhinorrhea. This occurs when the dura is not closed in a watertight fashion (as is common after skull base procedures). CSF can percolate through the air cell tracts in the temporal bone and reach the middle ear space. It will then drain down the Eustachian tube and enter the nasopharynx. When the patient is lying back in bed, he/she may notice a salty-tasting drainage, but most often, they won't appreciate this. By having them lean forward, the presence of CSF rhinorrhea can be diagnosed by visually seeing the CSF drip out of the nose. In this representative patient, the CSF trickled down his mustache (*arrow*) before dropping to the floor. To treat this, a lumbar subarachnoid drain (LSAD) can be placed.



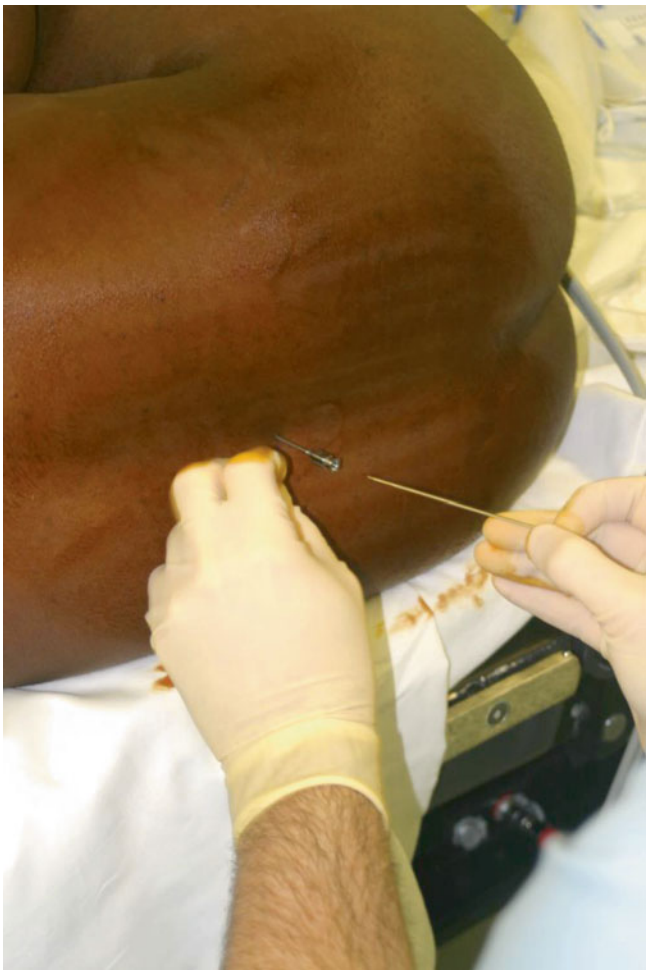
16. In this example, a postoperative CSF leak was expected because the patient had a very large tumor, and so a LSAD was placed in the operating room before the surgery was started. It was used during the postoperative period to help prevent a CSF leak from developing. First, the patient is turned on his side, and the iliac crest is palpated as a landmark.

17. The area is prepped in a sterile fashion, and the space between L3 and L4 is found. The trocar from the LSAD kit is inserted into the interspace at a slight superior angle of approach. The bevel of the trocar is oriented vertically to minimize trauma to the dura when it is penetrated.

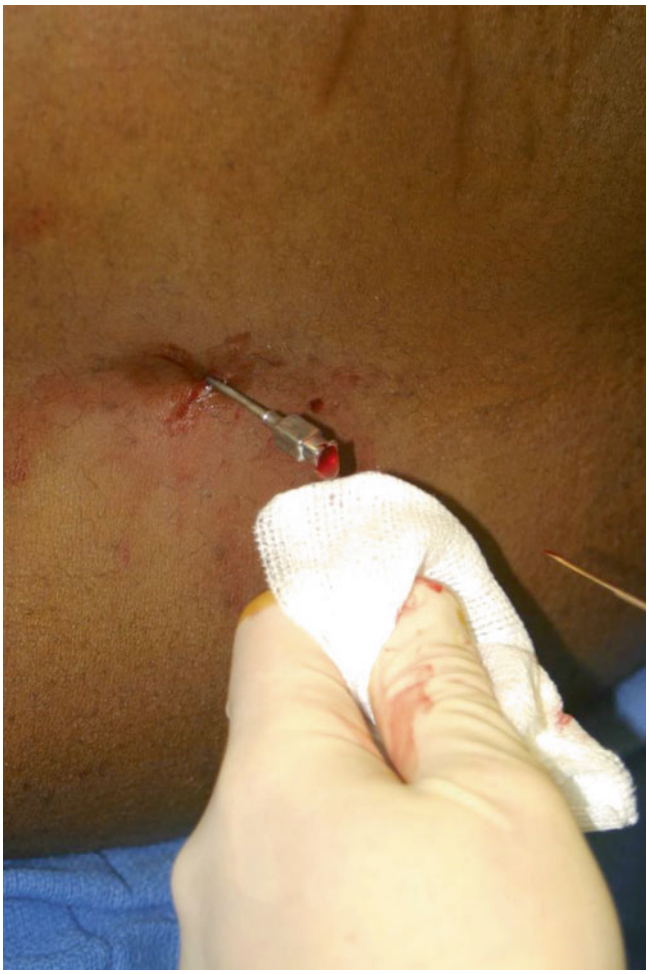




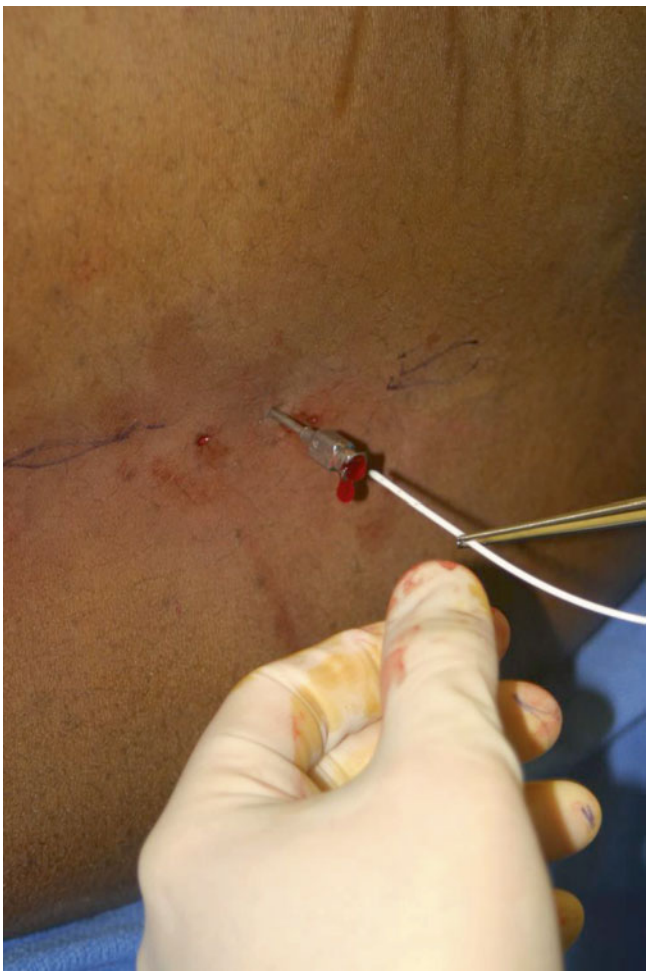
18. Periodically, the inner cannula is removed to see if CSF is flowing. If it is not, the cannula is reinserted, and the trocar is advanced further. Sometimes but not always, a very slight "give" is felt when entering the intradural space.



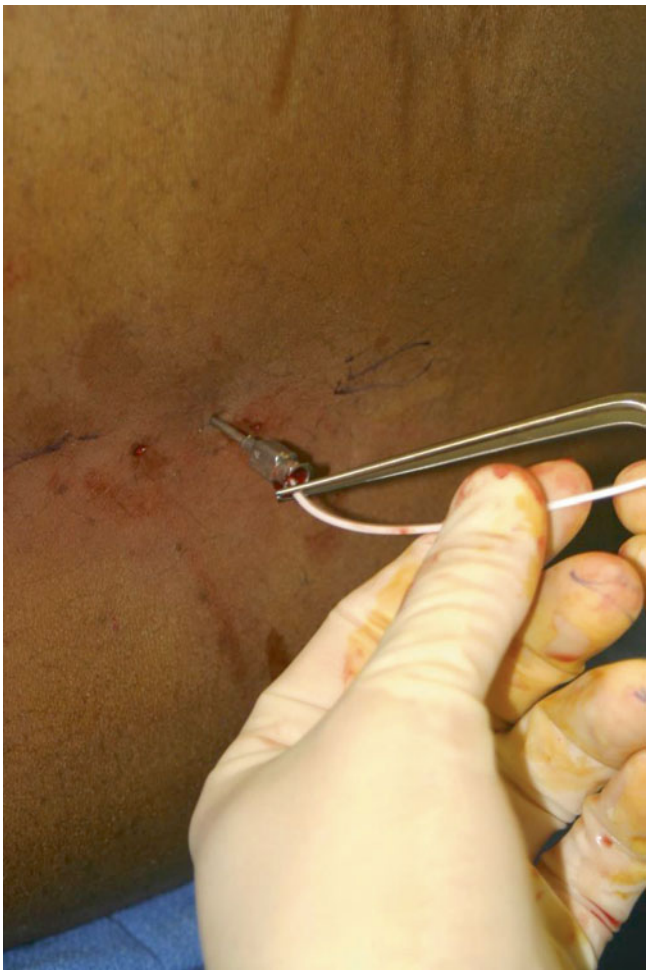
19. When CSF flows, the trocar is turned 90° so that its bevel is oriented superiorly (cephalad).



20. The catheter is then gently inserted and advanced at least 10 cm beyond the tip of the trocar.

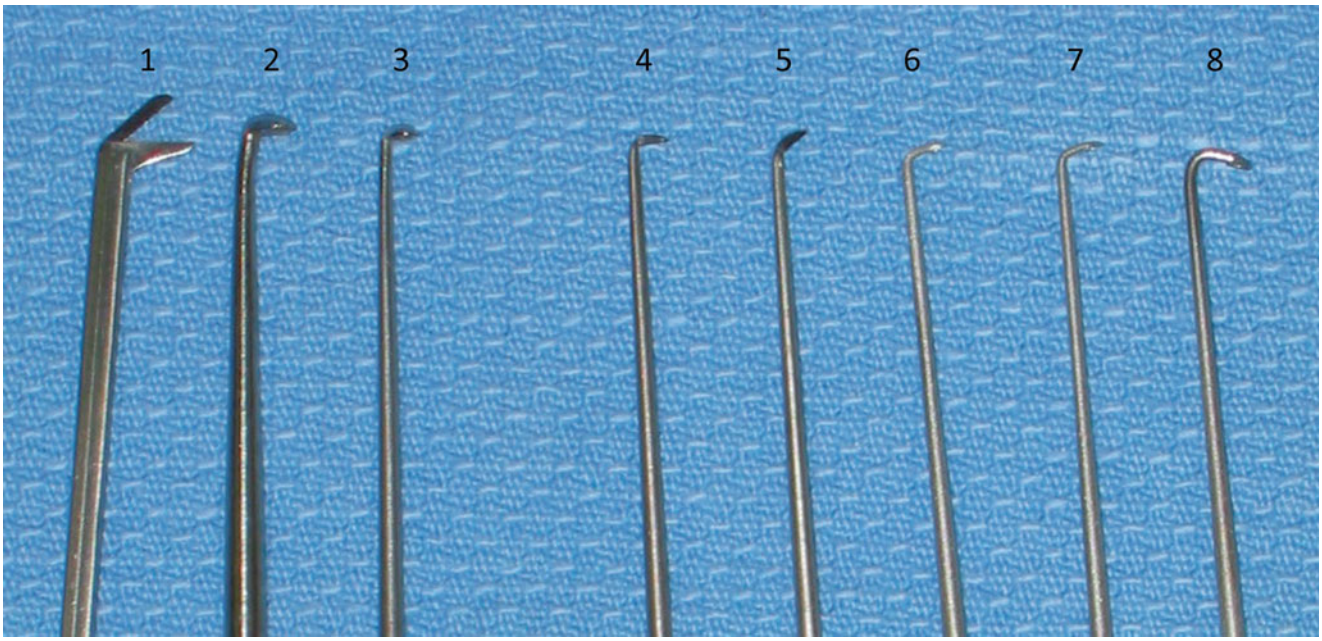


21. The trocar is then carefully removed, and flow of CSF through the catheter is verified. If it is working, the catheter is sutured to the back in two different locations. A sterile dressing is applied. For extra safety, the catheter is also coiled twice and secured to the skin next to the entry point with a large Tegaderm.

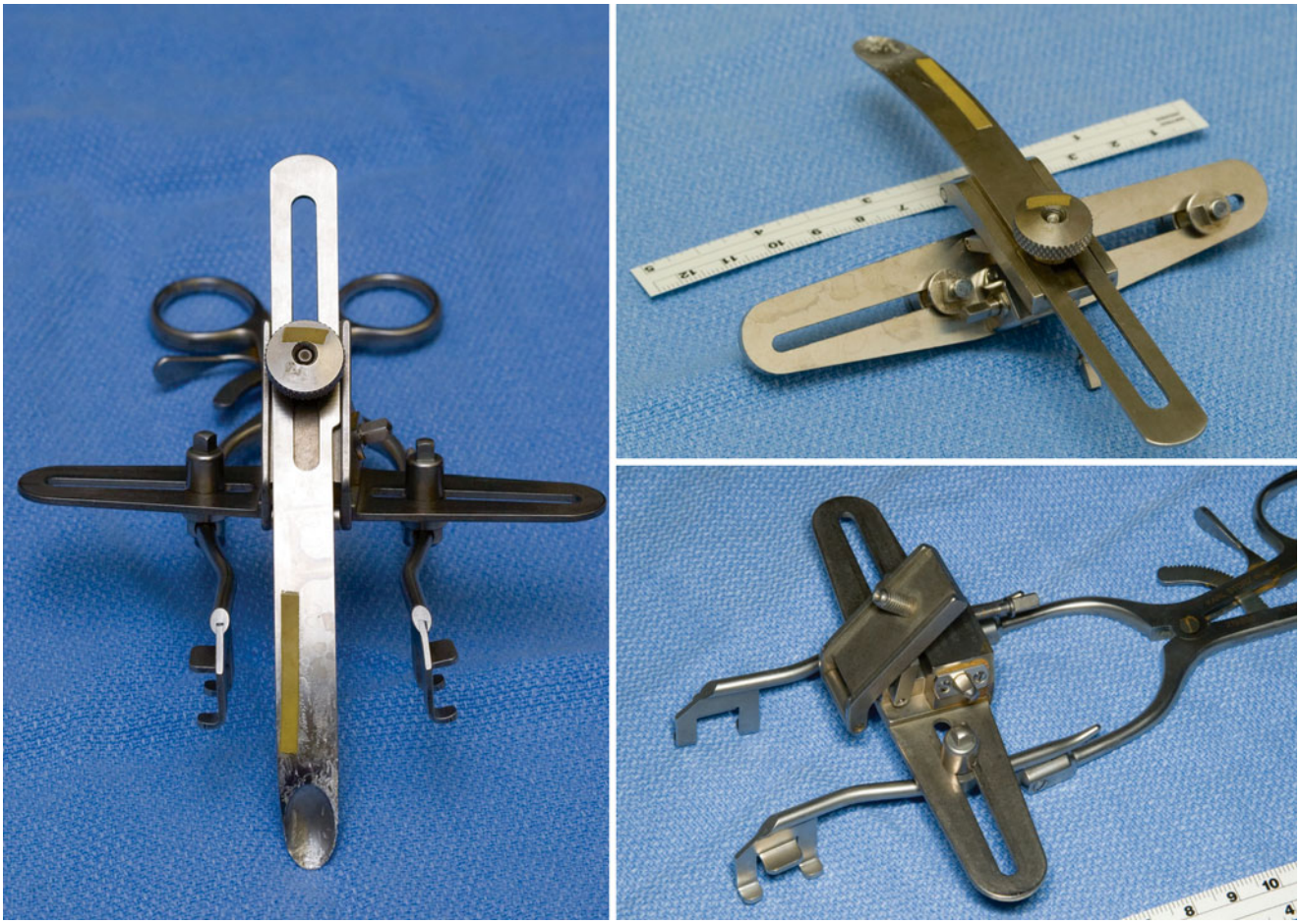


Instrumentation

22. Skull base surgery requires a standard craniotomy set, a neurotology set, and a fat graft set. Some of the specialized microdissectors in the neurotology set are shown in the picture. The purpose of the microdissectors is mainly to allow careful dissection of tumors off the cranial nerves and out of the internal auditory canal. (1) Angled scissors. (2–3) Microcurettes allow removal of residual tumor that rests under a lip of bone, typically the lateral aspect of the internal auditory canal. (4–5) Angled knives allow the dura of the internal auditory canal to be opened in a careful and precise manner without disturbing the tumor or nerves that may lie directly underneath. (6–8) Smaller microcurettes at various angles allow probing of the fundus of the internal auditory canal to verify that all the tumor has been removed.



23. Three views of a custom-modified version of the House-Urban and Fisch retractors. Such a device can be used instead of malleable retractors and the Greenberg retractor set for middle fossa approaches if desired.



A list of the contents of our instrument sets are given below in the following tables:

Craniotomy set

Manuf	Prod Num	Inst/Cmt	Qty
Codman	50-1194	Retractor Weitlaner Small Sharp 3×4 5 1/8″	2
Codman	50-1020	Retractor Vein Large 13 mm	2
Vmueller	NL1020	Retractor Cushing	1
Vmueller	NL1302	Spatula Brain Silver 3/4″×7″	1
Integra	NL8700208	Spatula Brain Teflon 5/8″×8″	1
Integra	NL8700210	Spatula Brain Teflon 1/2″×8″	1
Codman	59-1085	Spatula Brain 1″×7″	1
Codman	59-1082	Spatula Brain 1/2″×8″	1
Codman	50-1181	Retractor Adson Cerebellar	2
Pilling	34-3550	Ruler 6″	1
Weck	588200	Adson Rongeur	1
MedtrSof	9560565	Micropituitary 2 mm	1
Vmueller	AU6780	Rongeur Ruskin Double Action 5 mm Jaws	1
Codman	65-1116	Elevator Langenbeck	1
Codman	53-1224	Wilde Takahashi Medium	1
Codman	23-1042	Curette Straight #00	1
Vmueller	SU1403-001	Handle Knife #3	1
Pilling	35-2957	Handle Knife #7	1
Codman	53-4005	Forceps Alligator Micro Cup Straight	1
Vmueller	NL4251-81 T	Kerrison 1 mm UpBiting 40°	1
Vmueller	NL4251-82 T	Kerrison 40° Upbiting 2 mm (Gold & Black Handle)	1
Vmueller	NL4251-83 T	Kerrison 40° Upbiting 3 mm (Gold & Black Handle)	1
Codman	36-2016	Needleholder Mayo Hegar Diamond Jaw 6″	4
Codman	36-3014	Needleholder Ryder 6″	2
Codman	36-5051	Scissors Mayo Classic Plus Straight 6 3/4″	1
Codman	36-5016	Scissors Metzenbaum 7″ Curved	1
Codman	54-5566	Scissors Metzenbaum 5″	1
Weck	520130	Scissors Wire	1
Codman	32-4001	Clamp Mosquito Curved 5″	10
Codman	32-4021	Clamp Kelly Curved 5.5″	2
Codman	32-7000	Clamp Allis 6″	12
Vmueller	SU2800	Clamp Kocher Straight 6″	2
Codman	30-4291	Clamp Schnidt 8″ Curved	2
Codman	20-5115	Applier Raney Clip	3
EthicEnd	LX107	Applier Clip Short Small Blue Handled 7.25″	2
Codman	32-5015	Clamp Edna Towel	4
Codman	32-5000	Clip Towel Small	2
Codman	80-2901	Forceps Bipolar Irrigating Insulated Bayonette-Blue Coated 7.75	1
Vmueller	SU-2332	Forceps Tissue 5 3/4″	1
Codman	30-1172	Forceps Dura Fine Toothed	1
Weck	468220	Forceps Cushing 7″ w/ Teeth	2
Vmueller	NL3138	Forceps Gerald Bayonet	2
Codman	65-1015	Dissector Penfield Broad Curved #1	2
Codman	65-1016	Dissector Penfield Curved #2	2
Codman	65-1017	Dissector Penfield Full Curved #3	2
Codman	65-1018	Dissector Penfield Slight Curved #4	2
Vmueller	NL1902	Suction Tip Frazier 10fr #3 w/ Stylet	1
Vmueller	NL1903	Suction Tip Frazier 12fr w/ Stylet	1
Storz	SP7-57488	Suction Tip Brackmann Short #5	2
Storz	SP7-35326	Suction Tip Brackmann Medium #5	2
Storz	SP7-57780	Suction Tip Brackmann Short #7	2
Storz	SP7-35326A	Suction Tip Brackmann Medium #7	2

Manuf	Prod Num	Inst/Cmt	Qty
Storz	N4725	Skin Hook Double Prong Medium Wide	2
Jarit	277-241	Hook Nerve Sharp Small	1
Jarit	277-235	Hook Krayenbuehl Nerve Fine Dull 7 1/4″	1
Codman	38-1042	Hook Dura	1
Codman	54-1041	Scissors Dandy	1
Codman	30-1186	Forceps Adson w/ Teeth 4″	2
Fukash		Hook Scalp	4

Neurotology set

Manuf	Prod Num	Inst/Cmt	Qty
		Rongeurs	
Codman	53-4000	Rongeur Decker Alligator Action Straight 2 mm×6 mm	1
Codman	53-4002	Rongeur Decker Alligator Action Curved Left 2 mm×6 mm	1
Codman	53-1235	Love Gruenwald Straight 3 mm×10 mm	1
		Scissors	
Vmueller	NL3799	Scissors Kurze Dissecting straight	1
Vmueller	NL3800	Scissors Kurze Dissection Curved left	1
Vmueller	NL3801	Scissors Kurze Dissecting Curved right	1
Vmueller	NL4003	Scissors Yasargil bayonet shaped straight 12.5 mm	1
Vmueller	NL4004	Scissors Yasargil bayonet shaped Curved up 12 mm	1
Instrume	s.50.411.13	Scissors Special Sinus 130 mm Long Shaft Straight	1
Instrume	s.50.420.13	Scissors Special Sinus 130 mm Long Shaft Left	1
Instrume	s.50.421.13	Scissors Special Sinus 130 mm Long Shaft Right	1
Vmueller	RH1680	Scissors Foman Upper Lateral Fully Curved 5 1/4″	1
Codman	80-1524	Scissors Bayonet Titanium Straight Fine Tip	1
Codman	80-1525	Scissors Bayonet Titanium Curved	1
		Forceps	
Codman	53-4006	Forceps Rhoton Micro Cup Curved Right 1 mm×6″	1
Codman	53-4007	Forceps Rhoton Micro Cup Curved Left 1 mm×6″	1
Codman	53-4005	Forceps Alligator Micro Cup Straight	1
		Bipolar forceps	
Kirwan	10-1603NS	Cautery Irrigating Bipolar regular 1.5 mm	1
Kirwan	12-1600NS	Cautery Irrigating Bipolar Micro 0.7 mm	1
		Suctions	
Storz	SP7-57718	Suction Brackmann 5fr Long (Custom – fenestrated)	2
Storz	SP7-57607	Suction Brackmann 7fr. Long (Custom – fenestrated)	2
Storz	SP7-54918	Suction Brackmann 9 Fr.	1
Storz	N0607-5	Suction Brackmann Irrigating 4×5fr	2
Storz	N0607-7A	Suction Brackmann Irrigating 5×7fr	2
Storz	N1705-76A5	Suction Irrigating House 5×7fr	2
Storz	N1705-77A	Suction Irrigator House 7×10fr	2
Storz	N1705-77B	Suciton Irrigator House 8×12Fr.	2
Vmueller	58-6313	Rhoton atraumatic suction, straight tip, angled tube, 4” 3 Fr	2
Vmueller	58-6315	Rhoton atraumatic suction, straight tip, angled tube, 4” 5 Fr	2
Vmueller	58-6317	Rhoton atraumatic suction, straight tip, angled tube, 4” 7 Fr	2
		Retractors and elevators	
Codman	50-1520	Retractor Cerebellar w/ 9.5 cm Flexible Arm (2 Pieces Each)	2
Codman	50-1511	Retractor Greenberg 6.5 cm flexible secondary arm	1
Codman	0308 N	Retractor Malleable Blades Right/Left/Midline 2 Each	6
Codman	SP01031	Retractor Blade Old Style 1/2″×4″	2
Codman	SPO1031-3	Retractor Blade Old Style 5/8″×4″	2
Storz	N1705-71	Retractor Middle Fossa Dura Custom	1
Codman	50-1186	1 Curved Weitlaner Custom Made	1
W Lorenz	26-0028	Retactor Adson Cerebellar	1
Vmueller	NL1305-3	Retractor Davis Malleable 1/2″	2

Manuf	Prod Num	Inst/Cmt	Qty
Aesculap	OL153R	Elevator Cottle	1
Storz	N1124	Elevator Lempert 7 mm	1
Storz	N4610	Elevator Joseph 4 mm	1
Codman	65-1075	Elevator Cushing Periosteal sharp 16 mm	1
		Rhoton Rack	
Boss	71-5101	Dissector Round 1 mm Angled Blade	1
Boss	71-5101	Dissector Round 1 mm Custom Straight Blade	1
Boss	71-5102	Dissector Round 2 mm Angled Blade	1
Boss	71-5102	Dissector Round 2 mm Custom Straight Blade	1
Boss	71-5103	Dissector Round 3 mm Angled Blade	1
Boss	71-5103	Dissector Round 3 mm Custom Straight Blade	1
Codman	80-1683	Elevator General Purpose Small #4	1
Codman	80-1684	Elevator General Purpose Large #5	1
Codman	80-1685	Dissector/Spatula Rhoton Small #6	1
Codman	80-1688	Hook Nerve Fine Semi Sharp 90° #9 Blue	1
Codman	80-1689	Hook Nerve Blunt 90° #10	1
Codman	80-1690	Hook Semi Sharp 45° #11	1
Codman	80-1692	Curette Micro Straight #13	1
Codman	80-1693	Curette Micro Angled #14	1
Codman	80-1696	Dissector Rhoton Teardrop 90° 3 mm #16	1
		Rack #2	
Mizuho	07-821-12	Knife McEleen 90′	1
Storz	N1690-7	Knife Rosen Canal Large	1
GyrusACM	13-0562	Knife Lancet #2 2 mm	1
Mizuho	07-821-01	CP-1 Sickle Style Knife	1
Mizuho	07-821-02	Knife 2.5 mm Tumor Microbayonet	1
Mizuho	07-821-03	CP-3 Tumor Knife Blunt Tip	1
Mizuho	07-821-04	Knife 2.5 mm Tumor sharp tip 80′ angled up Microbayonet	1
Mizuho	07-821-08	CP-8 1.2 mm Tumor Ring Curr. 60°	1
Mizuho	07-821-09	CP-9 1.55 m Tumor Ring Curr. 45°	1
Mizuho	07-821-10	Curette Cup 1×1.5 mm angled up Microbayonet	1
Mizuho	07-821-11	Curette Cup 1.5×2.0 mm angled up Microbayonet	1
Vmueller	NL2400	Hook Adson Dural 5 mm tip	1
Storz	NI705-HM	Knife Sickle	1

Fat graft set

Manuf	Prod Num	Inst/Cmt	Qty
Vmueller	SU1403-001	Handle Knife #3	1
Codman	36-5032	Scissor Metzembaun 7″	1
Jarit	099-210	Scissors Mayo 6 – 3/4″ Straight	1
Jarit	130-265	Forceps Brown 6″	1
Jarit	129-234	Forceps Adson W/Teeth	1
Jarit	107-102	Clamp Mosquito Curved	4
Jarit	136-100	Clamp Allis 6″ 4×5 Teeth	4
Jarit	120-135	Needle Holder Mayo-Hegar 6″	1
Codman	50-1197	Retractor Weitlaner Dull Medium 6 1/2″	1
Codman	70-6560	Suction Tip Andrews Pynchon (Andrews)	1

Special cochlear implant instruments

Manuf	Prod Num	Inst/Cmt	Qty
Cochlear Corp	Z60770	AOS Forceps – to insert the electrode	1
Richards	13-0577	House Pick 90°, 0.5 mm– to open the round window membrane	1

Middle Fossa Approaches

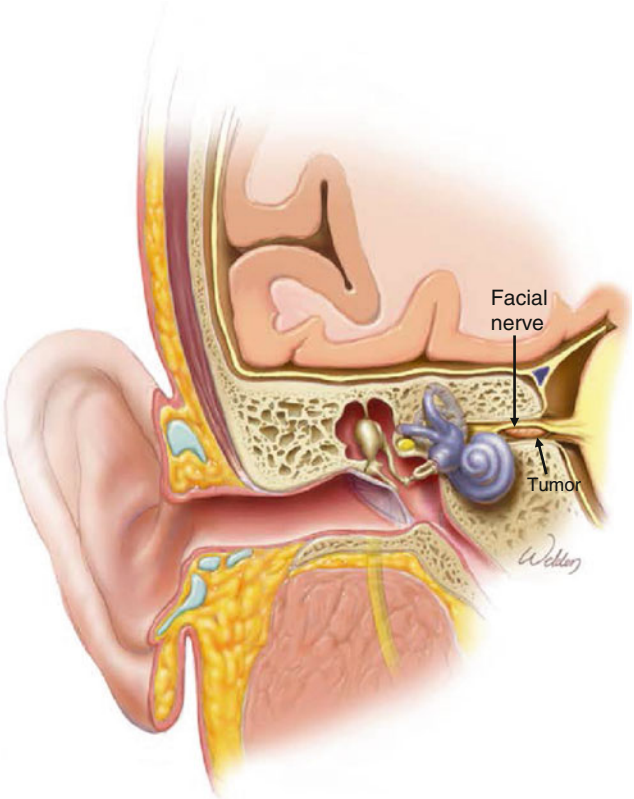
3

Approach to the Internal Auditory Canal

- *Concept*
  - Retract the temporal lobe in an extradural fashion, and drill through the petrous apex to reach the posterior cranial fossa and internal auditory canal
- *Conditions treated*
  - Small vestibular schwannoma (intracanalicular lesions and those with a diameter in the cerebellopontine angle <1.0 cm)
  - Facial nerve decompression or repair
- *Risks*
  - Retraction injuries to the temporal lobe can cause contusion, edema, or stroke.
  - Temporal lobe seizure.
  - Anomic aphasia.
  - Hearing loss if the labyrinth is violated or auditory nerve involved with the tumor.
  - Facial nerve injury, particularly if the geniculate ganglion is dehiscent and not recognized.
  - Carotid artery injury along the horizontal segment.
  - Dry eye if the GSPN is transected.
  - CSF leak.
- *Benefits*
  - Best approach for hearing preservation when removing a vestibular schwannoma that extends to the fundus
  - Only way to access the labyrinthine course of the facial nerve while preserving hearing

J.S. Oghalai, C.L.W. Driscoll, *Atlas of Neurotologic and Lateral Skull Base Surgery*,
DOI 10.1007/978-3-662-46694-0_3, © Springer-Verlag Berlin Heidelberg 2016

1. Coronal view of the temporal bone. An intracanalicular vestibular schwannoma is shown. The facial nerve lies superior to the tumor.



2. Theory of the middle fossa approach to the internal auditory canal. Elevation of the middle fossa dura is performed, followed by drilling out the petrous apex to expose the posterior fossa dura and the dura of the internal auditory canal. These are then opened to expose the tumor.