



Suboccipital Surgery for Acoustic Neuroma

Overview

A suboccipital craniotomy is a surgery performed to remove an acoustic neuroma growing from the nerve responsible for balance and hearing. During surgery, a section of the skull is removed behind the ear to access the tumor and nerves. Acoustic neuromas cause hearing loss, ringing in the ears, and dizziness. The goals of surgery are: first, maintaining facial nerve function; second, preserving socially useful hearing in the affected ear; and third, removing the tumor.

What is suboccipital acoustic neuroma surgery?

A craniotomy is any bony opening cut into the skull. The section of skull, called a bone flap, is removed to access the brain underneath. After the tumor is removed, the bone flap is placed back in its original position and secured with plates and screws.

An acoustic neuroma may be surgically removed by one of three different craniotomies: suboccipital, translabrynthine, or middle fossa. The choice of a particular craniotomy depends on the tumor size, tumor position, and hearing status. The suboccipital craniotomy (also called retrosigmoid) involves removing a portion of the occipital bone behind the ear to remove the tumor (Fig. 1).

Who is a candidate?

You may be a candidate for suboccipital acoustic neuroma surgery if you have:

- A medium or large acoustic neuroma that is causing symptoms, especially balance problems caused by brainstem compression
- Serviceable hearing in the affected ear
- Neurofibromatosis type 2 (NF-2)

Who performs the surgery?

A neurosurgeon or neuro-otologist can remove acoustic neuromas. The suboccipital approach is performed by a neurosurgeon. Because each patient and each acoustic neuroma is unique, it is important to seek treatment at a center that offers the full range of options, including surgery, radiation, and hearing rehabilitation. Preventing or treating deafness in both ears for people with NF-2 requires a team approach. Studies show that tumor size and the surgeon's experience are the most significant factors influencing facial nerve function and hearing outcome after removal [1].

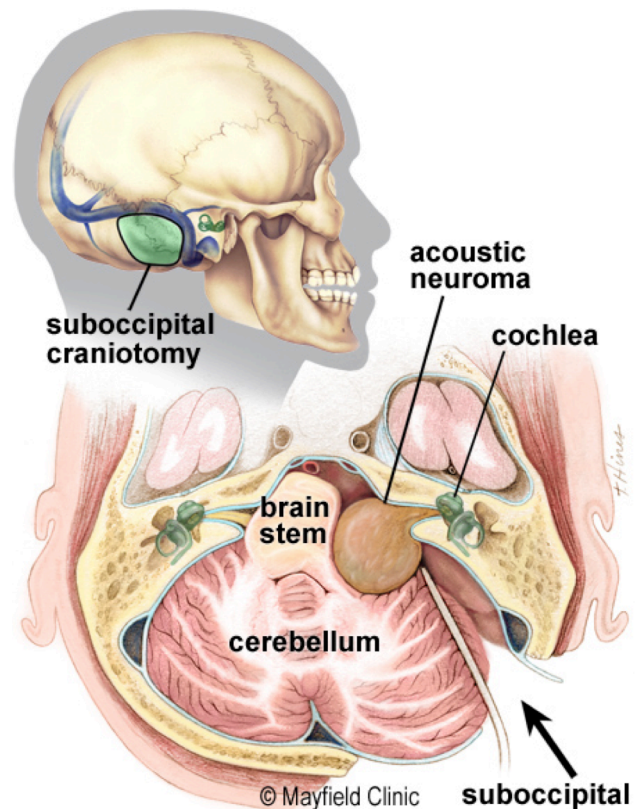


Figure 1. The suboccipital approach involves removing a portion of the bone behind the ear. The cerebellum is gently held back to remove the acoustic neuroma.

What happens before surgery?

You will have an office visit with a neurosurgeon, otologic surgeon, and an audiologist before surgery. An audiologist will perform a hearing test and a presurgical assessment of cranial nerve function. During the office visit, the surgeon will explain the procedure, its risks and benefits, and answer any questions. Next, you will sign consent forms and complete paperwork to inform the surgeon about your medical history (i.e., allergies, medicines, vitamins, bleeding history, anesthesia reactions, prior surgeries). Discuss all medications (prescription, over-the-counter, and herbal supplements) you are taking with your healthcare provider. Some medications will need to be continued or stopped the day of surgery. You will be scheduled for presurgical tests (e.g., a blood test, electrocardiogram, chest X-ray, and CT scan) several days before surgery.

Stop taking all non-steroidal anti-inflammatory medicines (Naprosyn, Advil, Motrin, Nuprin, Aleve) and blood thinners (coumadin, Plavix, aspirin) 1 week before surgery. Additionally, stop smoking and chewing tobacco 1 week before and 2 weeks after surgery, as these activities can cause bleeding problems. Wash your hair with Hibiclens® (chlorhexidine) antiseptic soap for 3 consecutive days prior to surgery. No food or drink is permitted past midnight the night before surgery.

Morning of surgery

- Shower using antibacterial soap. Dress in freshly washed, loose-fitting clothing.
- Wear flat-heeled shoes with closed backs.
- If you have instructions to take regular medication the morning of surgery, do so with small sips of water.
- Remove make-up, hairpins, contacts, body piercings, nail polish, etc.
- Leave all valuables and jewelry at home (including wedding bands).
- Bring a list of medications (prescriptions, over-the-counter, and herbal supplements) with dosages and the times of day usually taken.
- Bring a list of allergies to medication or foods.

Arrive at the hospital 2 hours before your scheduled surgery time to complete the necessary paperwork and pre-procedure work-ups. You will meet with a nurse who will ask your name, date of birth, and what procedure you are having. The nurse will explain the preoperative process and discuss any questions you may have. An anesthesiologist will talk with you to explain the effects of anesthesia and its risks. An intravenous (IV) line will be placed in your arm before transport to the operating room.

What happens during surgery?

There are 6 steps to the procedure, which generally takes 4-6 hours, depending on the tumor size.

Step 1: prepare the patient

You will lie on the operating table and be given anesthesia. Once you are asleep, your head will be placed in a 3-pin skull-fixation device, which attaches to the table and holds your head in position during surgery. The hair near the incision area will be shaved and the scalp prepped with an antiseptic. The audiologist will attach electrodes to your face and ear to monitor the facial nerve, hearing, and brainstem functions during surgery.

Step 2: make a skin incision

The lesser and greater occipital nerves innervate the skin on the back of the scalp. These nerves can be cut, stretched or trapped in scar tissue from the incision. Chronic headache and occipital neuralgia (electric-shock pain) may be related to damage of these nerves. A high-arching skin incision crosses the nerves at their end branches and is less likely to cause damage (Fig. 2). The skin and muscles are lifted off the bone and folded back.

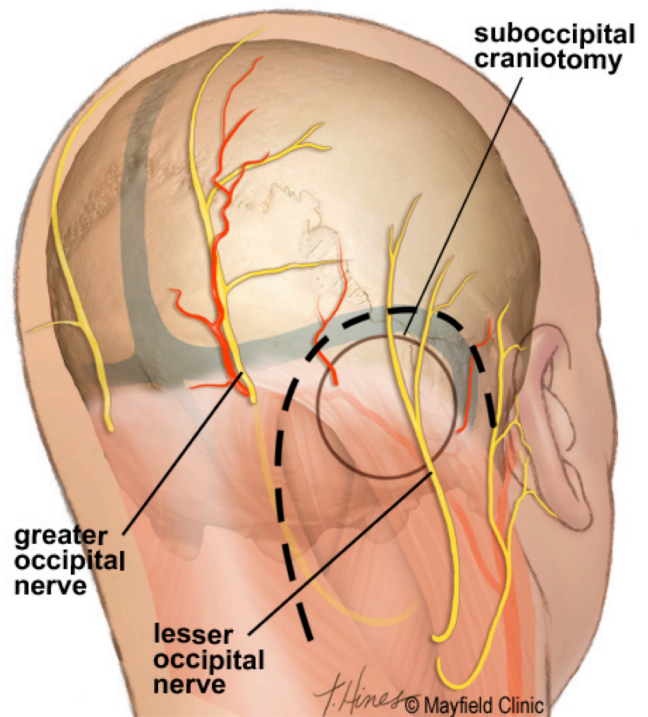


Figure 2. A high-arching skin incision is made behind the ear (dashed line) that crosses the occipital nerves at the end branches. This incision also avoids deep dissection of the neck muscles and is less likely to cause postoperative headache compared to a straight incision.

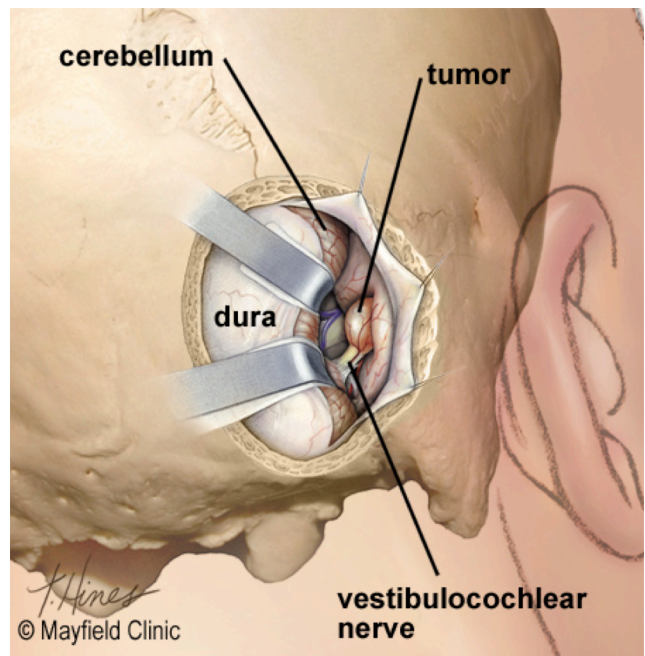


Figure 3. A 1.5 inch-wide craniotomy is made in the occipital bone and the bone flap is removed. The cerebellum is gently held back to expose a small tumor and its attachments to the nerve.

Step 3: perform a craniotomy

A 1.5 inch-wide craniotomy is made in the occipital bone with a drill. The bone flap is removed to expose the protective covering of the brain called the dura. The dura is opened and folded back to expose the brain. Retractors are used to gently hold back the cerebellum, allowing the surgeon to see the acoustic neuroma and the nerves (Fig. 3).

Step 4: debulk the tumor

Depending on the size, acoustic neuromas can be attached to the facial nerve, trigeminal nerve, brainstem, and blood vessels. If the tumor is large, its size must be reduced so that the surgeon has enough room to see its attachments to nerves. An incision is made in the tumor capsule and the center is hollowed out (debulked). A drill is used to open the bony internal auditory canal to expose the origin of the tumor (Fig. 4).

Step 5: remove the tumor

The tumor origin at the vestibular nerve is cut, and attachments to the facial nerve are carefully dissected. Damage to the facial nerve may result in facial weakness or paralysis. Every effort is made to remove the tumor without damaging hearing, the facial nerve, and vital brainstem functions. Throughout tumor removal, an evoked potential monitoring probe is used to stimulate and monitor the nerves and brainstem. A decrease in nerve waveform signals the surgeon to stop dissecting. In some cases it may be best to leave remnants of tumor capsule attached to critical structures (Fig. 5 and 6). This is called a near-total removal. Because these tumors grow slowly, the risk of regrowth is far less than the risk of damaging the nerves.

Step 6: close the craniotomy

After the tumor is removed, the internal auditory canal is sealed with bone wax, and a small piece of muscle is glued over the opening. This prevents cerebrospinal fluid (CSF) from leaking into the middle ear. The dura is closed in watertight fashion and biologic glue is applied to prevent CSF leakage. The bone flap is replaced and secured with titanium plates and screws. The muscles and skin incisions are then rejoined and sutured together.

What happens after surgery?

After surgery, you are taken to the recovery room where vital signs are monitored as you awake from anesthesia. You may have a sore throat from the tube used to assist your breathing. After you awaken, you'll be moved to the neuroscience intensive care unit (NSICU) for close monitoring. Your blood pressure, heart rate, and respiration will be monitored. You may experience nausea, unsteadiness, and headache after surgery. Medication can control these symptoms. When your condition stabilizes, you will be transferred to a regular room, where you will begin to increase your activity level.

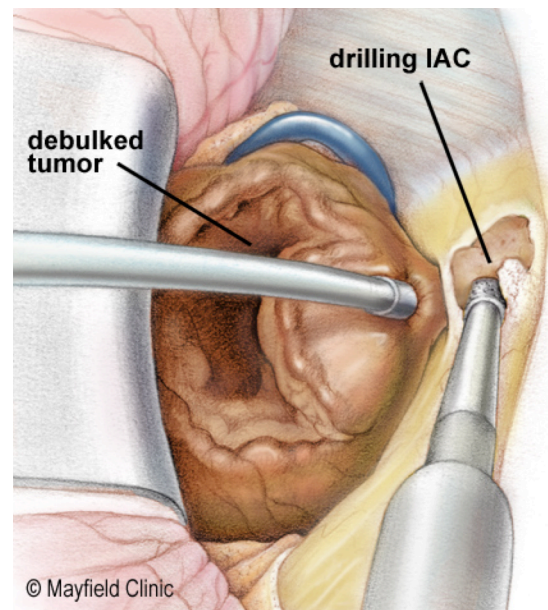


Figure 4. A drill is used to open the internal auditory canal (IAC) to expose the tumor origin.

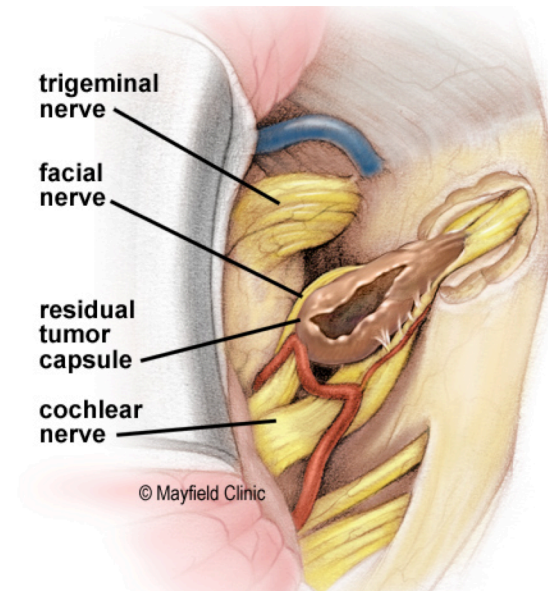


Figure 5. In large tumors, the bulk of the tumor is hollowed out and cut away. The tumor capsule adherent to the delicate facial nerve is not removed.

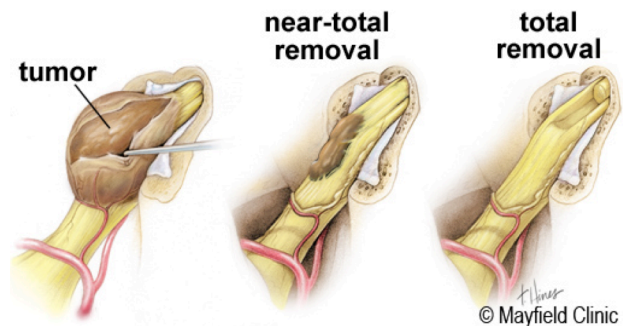


Figure 6. In small tumors, a near-total or total removal may be accomplished. The amount of tumor removal is guided by evoked potential monitoring during dissection.

The length of the hospital stay varies but is usually 2 to 3 days. When you are released from the hospital, you will be given discharge instructions.

Discharge instructions

Discomfort

1. After surgery, headache and incision pain may be managed with narcotic medication. Because narcotics are addictive, they are used for a limited period of 2 to 4 weeks. Their regular use may also cause constipation, so drink lots of water and eat high-fiber foods. Stool softeners (e.g., Colace, Docusate) and laxatives (e.g., Dulcolax, Senokot, Milk of Magnesia) can be bought without a prescription. Thereafter, pain is managed with acetaminophen (e.g., Tylenol).
2. Ask your surgeon before taking nonsteroidal anti-inflammatory drugs (NSAIDs) (e.g., ibuprofen, Advil, Motrin, Nuprin; naproxen sodium, Aleve). NSAIDs may cause bleeding and interfere with bone healing.

Restrictions

1. Do not drive after surgery until you are cleared to do so by your surgeon and avoid sitting for long periods of time.
2. Do not lift anything heavier than 5 pounds (e.g., a 2-liter bottle of soda), including children.
3. Housework and yard work are limited until the first follow-up office visit. This includes gardening, mowing, vacuuming, ironing, and loading/unloading the dishwasher, washer, or dryer.
4. Do not drink alcohol or operate a vehicle while using pain medication.

Activity

5. Fatigue is common. You may feel that you do not have your normal energy level for 1 to 2 weeks after surgery. Gradually return to your normal activities.
6. Walking is encouraged; start with short walks and gradually increase the distance. Wait to participate in other forms of exercise until discussed with your surgeon.
7. Gentle stretches for the neck may be advised.

Bathing/Incision Care

8. You may shower and get your incision or sutures wet. Use mild baby shampoo with no harsh fragrances. Be careful not to let the water directly hit your incision. Gently clean any old dried blood from the incision area.
9. Do not submerge your head in a bath.
10. Inspect your incision daily and check for signs of infection, such as swelling, redness, yellow or green discharge, warm to the touch. Minimal swelling around your incision is expected.

Face / Eye care

- Do not rub your eyes. Use eye drops 3 to 4 times a day in the affected eye.
- Inspect your eye daily for signs of redness, irritation, or blurring of vision. If any of these conditions occur, notify your surgeon.
- Eat slowly and avoid tough foods. You may find it helpful to chew and swallow on the opposite side of your mouth until facial weakness improves.

When to Call Your Doctor

- A temperature that exceeds 101.5° F.
- An incision that shows signs of infection, such as redness, swelling, pain, or drainage.
- Increased headache with nausea or vomiting, along with increased swelling at the incision site. Leaking cerebrospinal fluid may accumulate under the skin incision.
- Drowsiness, balance problems, or rashes.
- Decreased alertness, increased drowsiness, weakness of arms or legs, increased headaches, vomiting, or severe neck pain that prevents lowering your chin toward the chest.

Recovery and prevention

A follow-up appointment with the neurosurgeon will be scheduled 10 to 14 days after surgery. Recovery time varies from 4 to 6 weeks, depending on the tumor size and your general health. Patients typically return to work in 6 weeks, provided their balance is recovering, but be sure to check with your surgeon.

What are the risks?

No surgery is without risk. General complications of any surgery include bleeding, infection, blood clots, and reactions to anesthesia. Specific complications related to a craniotomy may include stroke, seizures, venous sinus occlusion, swelling of the brain, and CSF leakage. Risks related to acoustic neuroma surgery may include:

Facial weakness is the loss of muscle control on one side of the face caused by nerve swelling or damage; it may be temporary or permanent. Temporary facial paralysis or weakness is common after surgery and may persist for 6 to 12 months. Those with facial weakness will need to take extra care of their eye with artificial tears and lubricant until facial nerve function improves. Facial nerve function is directly related to the size of the tumor. The House-Brackmann Scale is used to evaluate facial nerve function before and after surgery (Fig. 7). Massage and facial exercises are recommended to improve facial nerve function [2]. It is possible for facial weakness to improve, e.g., Grade 4 to a Grade 2. A high-grade weakness may not recover completely. A weakness of Grade 4 to 6 may need facial surgery to protect the eye and improve one's appearance.

Permanent facial paralysis (Grade 5 or 6) is less common, usually occurring with large tumors, and results in an inability to close the eye, loss of facial expression, and facial droop. If a patient still has facial paralysis 1 year after surgery, the chance of further recovery is reduced. Consultation with an ENT surgeon who specializes in facial reconstruction may be needed to restore facial tone and appearance at rest. Options include:

- Gold weight implant: places a small implant in the upper eyelid to improve eyelid closure.
- Lower eyelid tightening: pulls up a sagging lower eyelid.
- Brow lift: lifts sagging brows.
- Botulinum injection: reduces abnormal facial twitching (injection lasts 3 to 6 months).
- Temporalis muscle sling: borrows other muscles to increase facial movement.
- Static sling: uses materials to support sagging tissues.
- Nerve transfer: borrows other nerves to increase facial movement (facial-to-hypoglossal nerve anastomosis). This option is recommended as soon as there is no possibility of facial nerve recovery. After years of facial paralysis, the facial nerve may become scarred and unresponsive to reconstructive surgery.

Eye problems may occur as the result of facial weakness or paralysis that prevents the eye from closing completely. This allows the eye to become dry and unprotected. Artificial tears, eye lubricants, protective glasses, bandage contact lenses, and taping the eye shut are all options to protect the cornea. Care by an eye specialist may be indicated. Call the doctor if you have signs of a corneal abrasion, which include blurred vision, redness, and a sensation of something in your eye that doesn't improve after applying eye drops.

If prolonged facial nerve paralysis is expected, various procedures may be performed to protect the cornea and improve one's appearance. For example, to improve eyelid position and closure, acanthoplasty -- the bringing together of the tendons in the corners of the eye -- may be performed. To simulate blinking, a palpebral spring device may be inserted in the upper eyelid to provide a blink reflex synchronous with the other eye, or a silastic elastic prosthesis may be secured through and around the upper and lower eyelids. Alternatively, a gold weight may be implanted in the upper eyelid to enhance lid closure.

Hearing loss is the most common complication and may be permanent in the affected ear because the tumor is wrapped around the cochlear nerve. In small tumors it is possible to save hearing when removing the tumor. Larger tumors usually have already caused some hearing loss or deafness prior

House-Brackmann Facial Weakness Scale

- I: Normal symmetrical function in all areas.
- II: Slight weakness; complete eye closure with minimal effort; slight asymmetry of smile; synkinesis barely noticeable, contracture, or spasm absent.
- III: Obvious weakness, but not disfiguring; may not be able to lift eyebrow; complete eye closure and strong but asymmetrical mouth movement; obvious, but not disfiguring synkinesis, mass movement or spasm.
- IV: Obvious disfiguring weakness; inability to lift brow; incomplete eye closure and asymmetry of mouth; severe synkinesis, mass movement, spasm.
- V: Motion barely perceptible; incomplete eye closure, slight movement corner mouth; synkinesis, contracture, and spasm usually absent.
- VI: No movement, loss of tone, no synkinesis, contracture, or spasm.

Figure 7. The House-Brackmann facial weakness scale. Grades I and II are considered "socially acceptable" facial function by most physicians, although some patients cope well with a Grade III.

Exercises for Facial Weakness

Use a mirror to do these exercises 2 to 3 times daily. Begin with 8 to 10 repetitions and gradually increase.

1. Raise eyebrows, wrinkling the forehead as in surprise or fright.
2. Draw the eyebrows together, as in frowning.
3. Close eyelids firmly, forming wrinkles radiating from the outer angles.
4. Widen the nostrils of your nose.
5. Draw the point of the nose downward, narrowing the nostrils.
6. Raise the skin of chin and protrude the lower lip, as in pouting.
7. Draw the angle of the mouth backward, as in grinning.
8. Move the angles of the mouth upward and outward, as in smiling.
9. Raise and protrude the upper lip.
10. Close the lips and pucker them.
11. Pull down the angles of your mouth with your fingers.
12. Suck in sides of mouth, puff out cheeks. (Do not let air escape from behind the lips.)
13. Protrude the lower jaw on each side.
14. Bite firmly on each side.
15. Depress the lower jaw against resistance. Hold hand firmly under chin and try to open your mouth.

to surgery. Two to 3 months after surgery, a hearing test is performed to determine your degree of useful hearing (Fig. 8). An audiologist or speech therapist can help you learn tips for coping with one-sided hearing loss. Understanding speech in difficult listening situations may be helped with a CROS (contralateral routing of sound) aid. The CROS aid is an instrument that receives sound on the deaf side, amplifies it, and then routes it to the good hearing ear. A small aid is worn on each ear.

Sound may also be conducted from the tumor side to hearing side via the bone using a BAHA implant (bone-anchored hearing aid). This device has gained popularity in habilitating single-sided deafness related to acoustic neuromas because of the excellent sound quality and the need for only one device, which is worn behind, not in, the ear.

Balance problems are common and generally improve after surgery with head exercises, Pilates, or Tai Chi. Care should be taken when using stairs or escalators. Persistent balance or dizziness problems may need treatment with vestibular (balance) rehabilitation.

Cerebrospinal fluid (CSF) leakage is the escape of CSF that flows around the brain. This usually takes the form of a squishy pocket of fluid around the incision. Contact the surgeon immediately if leakage is suspected. A pressure dressing may be applied over the incision to stop the leak. Sometimes a lumbar drain is inserted in the lower back to reduce CSF pressure and close off the leak. If the leak continues, surgical repair may be necessary. New closure techniques and use of biologic glue greatly reduces CSF leakage.

Headache is common after acoustic neuroma surgery and usually subsides within several weeks. Persistent headache (>3 months) can occur after suboccipital craniotomy. The best way to prevent post-craniotomy headaches is to use a high-arching skin incision. Cutting of the nerve branches causes numbness of the scalp. Conversely, partial injury or entrapment of the nerves from instruments and muscle retraction can cause occipital neuralgia and headache pain. Typical postoperative headaches occur more than once daily (46%), last 1 to 4 hours in duration (43%), and are of moderate intensity (63%) [3]. Treatment with NSAIDs typically provides relief. For severe chronic headaches, non-narcotic medications may be prescribed (e.g., Neurontin, Lyrica). Shooting headache pain that has a specific trigger point can be treated with steroid injections into the painful area.

What are the results?

Outcomes of surgery depend on the size and adherence of the tumor, the use of cranial nerve monitoring, and the skill of the surgical team. Removing the tumor will usually restore balance,

Gardner-Robertson Hearing Scale

Grade	PTA (dB)	SD (%)
I: Good	0-30	70-100
II: Serviceable	31-50	50-69
III: Non-serviceable	51-90	5-49
IV: Poor	90-100	1-4
V: Deaf	0	0

PTA = pure tone average
SD = speech discrimination score

Figure 8. The Gardner-Robertson hearing scale. Grades I and II are considered "useful hearing" and can hear a phone conversation.

Exercises for Dizziness & Balance Problems

Exercises to be carried out for 15 minutes 2 times daily, increasing to 30 minutes. Dizziness is expected when first beginning the exercises.

Eye Exercises (do each 20 times):

- Look up, then down. At first slowly, then quickly.
- Look from one side to the other. At first slowly, then quickly.
- Focus on your finger at arm's length. Move finger one foot closer and back again.

Head Exercises (do each 20 times):

- With your eyes open, bend your head forward then backward. At first slowly, then quickly.
- Turn your head from one side to the other side. At first slowly, then quickly.
- As dizziness decreases, do these exercises with your eyes closed.

Sitting (do each 20 times):

- While sitting, shrug your shoulders.
- Turn your shoulders to the right, then left.
- Bend forward, pick up an object from the ground, and sit up.

Standing (do each 20 times):

- Change from sitting to standing and back again with your eyes open. Repeat with eyes closed.
- Throw a small rubber ball from hand to hand above eye level.
- Throw ball from hand to hand under one knee.

Moving About (do each 10 times):

- Walk across the room with your eyes open, then eyes closed.
- Walk up and down a slope with your eyes open, then eyes closed.
- Walk up and down steps with your eyes open, then eyes closed.

facial function and sensation, eyelid function, and tear production. Hearing loss is usually permanent because the tumor is wrapped around the eighth cranial nerve (the nerve responsible for hearing).

The medical literature reports vary, but overall, facial movement is preserved in 90% of patients, especially with small tumors, and useful hearing is preserved in 20 to 80% [4,5,6]. Delayed hearing loss may occur after surgery in 30 to 50% of patients who had useful hearing immediately after surgery. Partial-removal techniques have higher rates of hearing and facial function preservation; however, a recent long-term study revealed that subtotal resection had a three-fold higher rate of tumor regrowth and no long-term impact on facial nerve function or hearing [7]. Tumor recurrence is less than 5% after total surgical removal.

Sources & links

If you have questions, please contact Springfield Neurological and Spine Institute at 417-885-3888.

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Links

Acoustic Neuroma Association www.anausa.org
Vestibular Disorders Association www.vestibular.org
HearingLoss.org

Glossary

- BAHA** (bone-anchored hearing aid): a hearing device used for conductive hearing loss. It transmits sound through the bone of the skull to the inner ear, bypassing the middle ear.
- cerebrospinal fluid (CSF)**: a clear fluid produced by the choroid plexus in the ventricles of the brain that bathes the brain and spinal cord, giving them support and buoyancy to protect from injury.
- craniotomy**: the surgical opening of a portion of the skull, allowing access to the intracranial structures, and the replacement of the bone flap.
- CROS** (contralateral routing of sound): a hearing device used with one-sided deafness. It receives sound on the deaf side, amplifies it, and carries it to the good ear.
- dura**: the outer protective covering of the brain.
- facial nerve**: the seventh cranial nerve, responsible for movement of the face.
- facial palsy**: paralysis of the facial muscles on one side.
- facial synkinesis**: involuntary movement of facial muscles that accompanies purposeful movement of some other set of muscles; e.g., facial synkinesis may cause the mouth to involuntarily grimace when the eyes are purposefully closed.
- occipital neuralgia**: a persistent pain in the neck and back of the head that is caused by an injury or irritation of the greater or lesser occipital nerves.
- seizure**: uncontrollable convulsion, spasm, or series of jerking movements of the face, trunk, arms, or legs.
- tinnitus**: ringing or buzzing noise in the ear.
- vertigo**: a feeling of spinning, whirling or turning.



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