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Chapter 75 – Branchial Cleft Cysts and Sinuses

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Branchial cleft remnants are diagnosed frequently in both children and adults. The branchial apparatus is a transient structure that is present from weeks 4 to 7 of fetal development.[1] The general category of branchial cleft remnants can be subdivided into cyst, sinus, or fistula. Depending on the branchial arch origin, these anomalies can be manifested as a mass or draining tract anywhere from the preauricular region to the supraclavicular fossa, lateral to the anterior midline of the neck and medial to the sternocleidomastoid (SCM) muscle.

It is helpful to a surgeon managing branchial cleft remnants to understand the developmental anatomy of the branchial arch apparatus.[2,3] By understanding the ontogeny of the branchial apparatus, the surgeon can more accurately predict the course of the branchial cleft sinus and anticipate important anatomic relationships. Between the fourth and sixth weeks of gestation, five paired swellings (arches) appear along the ventrolateral aspect of the embryonic head. The five swellings are each associated with a corresponding internal pouch; externally, the arches are separated by four grooves. The internal pouches are lined by endoderm, the external grooves are lined by ectoderm, and the arches are composed of mesoderm. Each arch also has an associated cranial nerve, artery, and cartilaginous element. During development, these arch components mature into well-defined anatomic structures. Incomplete closure of branchial pouches or failure of obliteration of the branchial grooves explain these anomalies.

The presence of a fistula or draining sinus tract often simplifies the diagnosis. A branchial cleft remnant can also appear as a smooth, firm, nontender mass anywhere from the preauricular region to the supraclavicular fossa. The differential diagnosis of a mass in this location includes the following conditions:

- Benign inflammatory cervical lymphadenopathy
- Mycobacterial infection (scrofula)
- Lymphangioma (cystic hygroma)
- Hemangioma
- Dermoid cyst
- Neurofibroma
- Lipoma
- Lymphoma
- Salivary neoplasm (benign or malignant)
- Vascular malformations
- Carotid body tumor
- Metastatic carcinoma

Branchial cleft anomalies can occur at any age with an equal male-to-female ratio and predilection regarding the site of involvement. A 5-year retrospective review of a series of 71 patients undergoing surgery for branchial cleft anomalies demonstrated an age range of birth to 16 years (mean, 4.1 years). Patients with a branchial cleft fistula were initially seen the earliest, at a mean age of 3 months. The male-to-female distribution in this pediatric series was 1:1.[4] In a review of our experience consisting of 59 adult patients with a branchial cleft cyst, there was a mean age of 40 years with a range of 18 to 83 years and a male-to-female ratio of 1:1.5.[5]

FIRST BRANCHIAL CLEFT ANOMALIES

The first branchial groove gives rise to the external auditory canal and lateral tympanic membrane, whereas the first pharyngeal pouch (tubotympanic recess) gives rise to the middle ear, mastoid air cells, and eustachian tube. The derivatives of the mesodermal components of the first branchial arch include the mandible, the head of the malleus and incus, and the muscles of mastication.[6] Periauricular cysts, sinuses, and fistulas occur commonly in the pediatric population. They arise from developmental defects of the first branchial cleft and first branchial arch.[7]

Anomalies of first branchial cleft/arch structures can be classified into aplasia, stenosis, and reduplication types. Surgical treatment of aplasia/stenosis of the external auditory canal or ossicular deformities requires reconstruction of the sound-conducting mechanism and is discussed in Chapter 111. Our discussion is limited to surgical

treatment of anomalies of the first branchial arch.

Congenital preauricular sinuses and tags result from faulty resorption of the first arch hillocks. In the sixth week of fetal life, six hillocks, three arising from each of the first and second arch mesoderm, develop around the opening of the first branchial cleft.[8] The first arch derivatives give rise to the tragus only, whereas the rest of the auricle arises from the second arch. Preauricular sinuses usually occur anterior to the tragus or the ascending rim of the helix.[9]

Preauricular sinuses usually have a history of drainage, the site of which is highly suggestive of the diagnosis (Fig. 75-1). The timing of surgery is dependent on the age of the patient and the presence of infection. Excision should be performed after the infection has been satisfactorily treated. Indications for excision are recurrent infection and cosmesis because the majority of these sinuses are asymptomatic and do not require treatment.

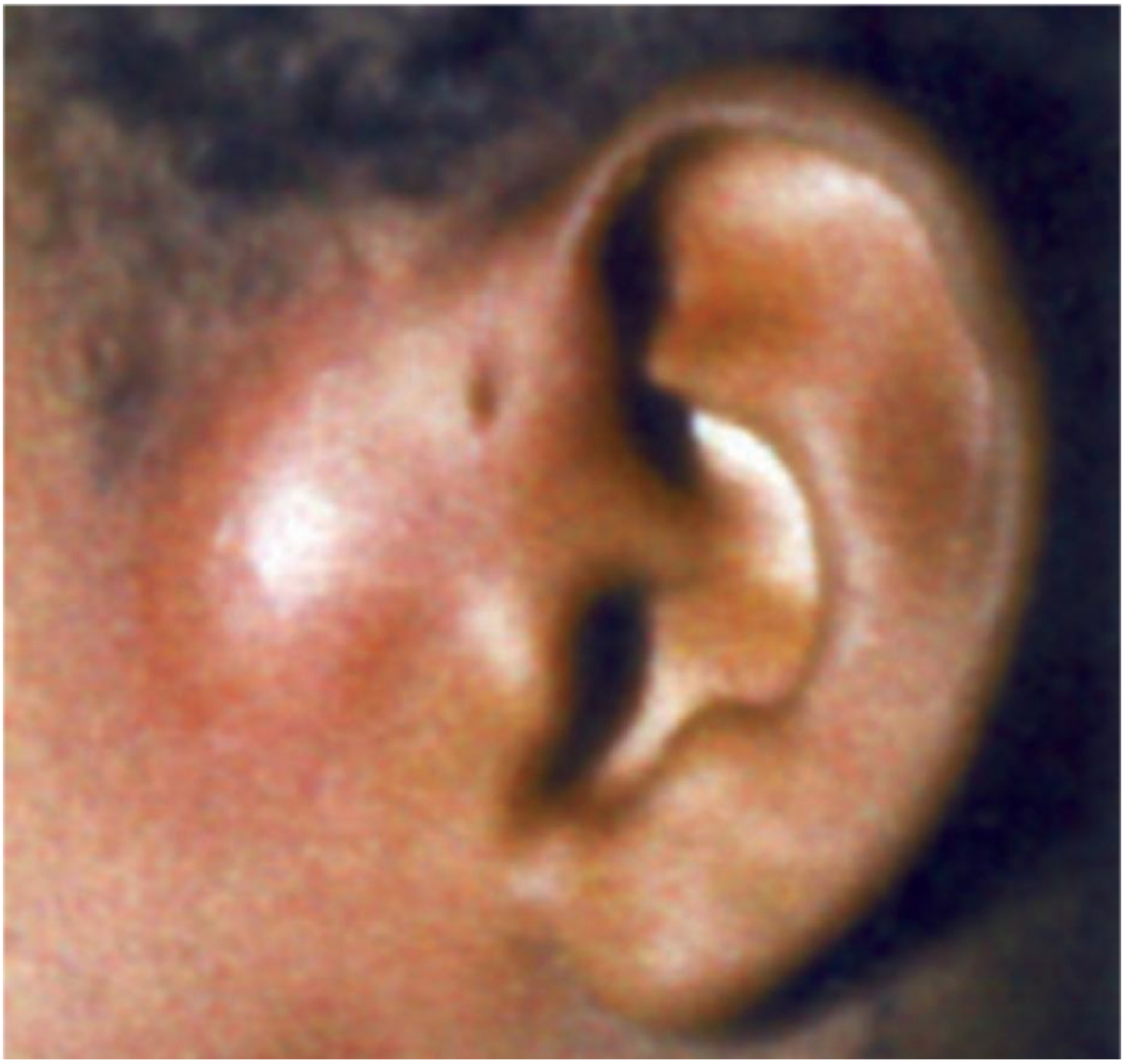

Figure 75-1 A preauricular sinus that had previously been inadequately excised. It is now manifested as an abscess anterior to the sinus tract.

First branchial arch anomalies are rare and account for less than 10% of all branchial anomalies.[10,11] The external component (mass or sinus) is always located superior to the hyoid bone. The tract courses through the parotid gland and has a variable relationship to the facial nerve; it lies either superficial or deep to the main trunk or travels between nerve branches.[12] If present, the internal communication opens into the external auditory canal or middle ear, but association with the ossicles has also been described.[13] Blevins and coauthors[14] reported four patients with both aural atresia and duplication anomalies of the external auditory meatus. Three had nonsyndromic unilateral aural atresia and periauricular lesions originating from the first branchial cleft. The other patient had a variant of Treacher Collins syndrome and was evaluated for a draining infra-auricular fistula. Yalçin and colleagues[15] reported a case of first branchial cleft sinus with cholesteatoma and atresia of the external auditory canal.

First branchial cleft remnants may be manifested as a recurrent inflammatory mass in the periauricular and cervical region. They frequently rupture spontaneously and result in a draining sinus. Because of misdiagnosis, management may be inadequate, recurrence is common, and iatrogenic injury to the facial nerve may occur. First branchial cleft anomalies are often located close to the parotid gland (Fig. 75-2 and see Fig. 75-8B later). Many lesions diagnosed as intraparotid cysts may be derived from the first branchial cleft.[16] Alternatively, the presence of purulent drainage in the external auditory meatus in the absence of active middle ear disease raises suspicion of an infected first branchial cleft remnant. If the cyst had previously been excised, it may be present in another site or may continue to drain or become recurrently infected. Computed tomography (CT) can be helpful in localizing the cyst. Daniel and coworkers[17] reviewed 15 patients from the experience of Montreal Children's Hospital who had a nonmalignant mass in the parotid area. They reported that the most common cause of such masses was first branchial arch anomalies, followed by lymphangioma and dermoid cyst.

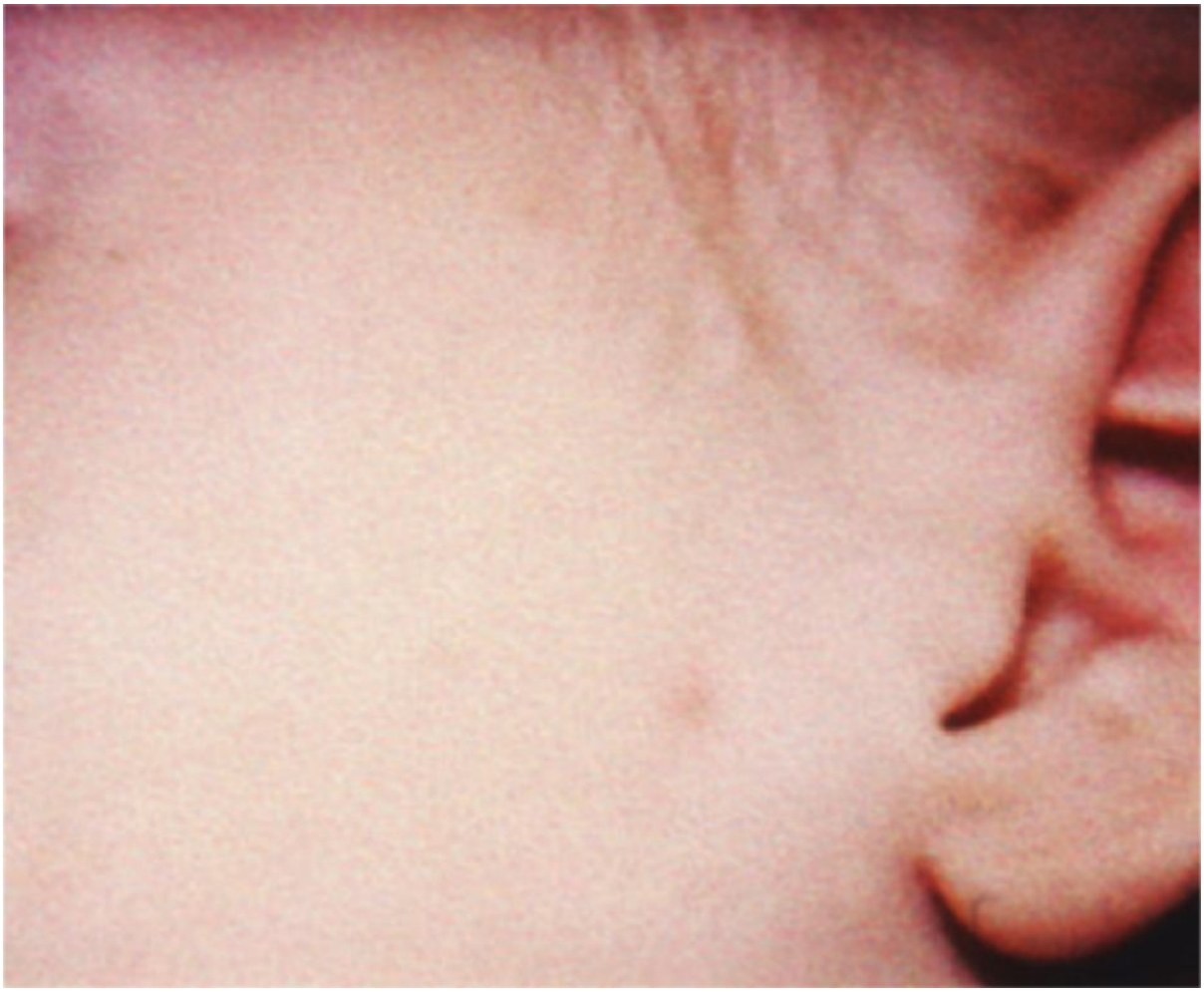

Figure 75-2 First branchial cleft sinus with a history of continuous drainage.

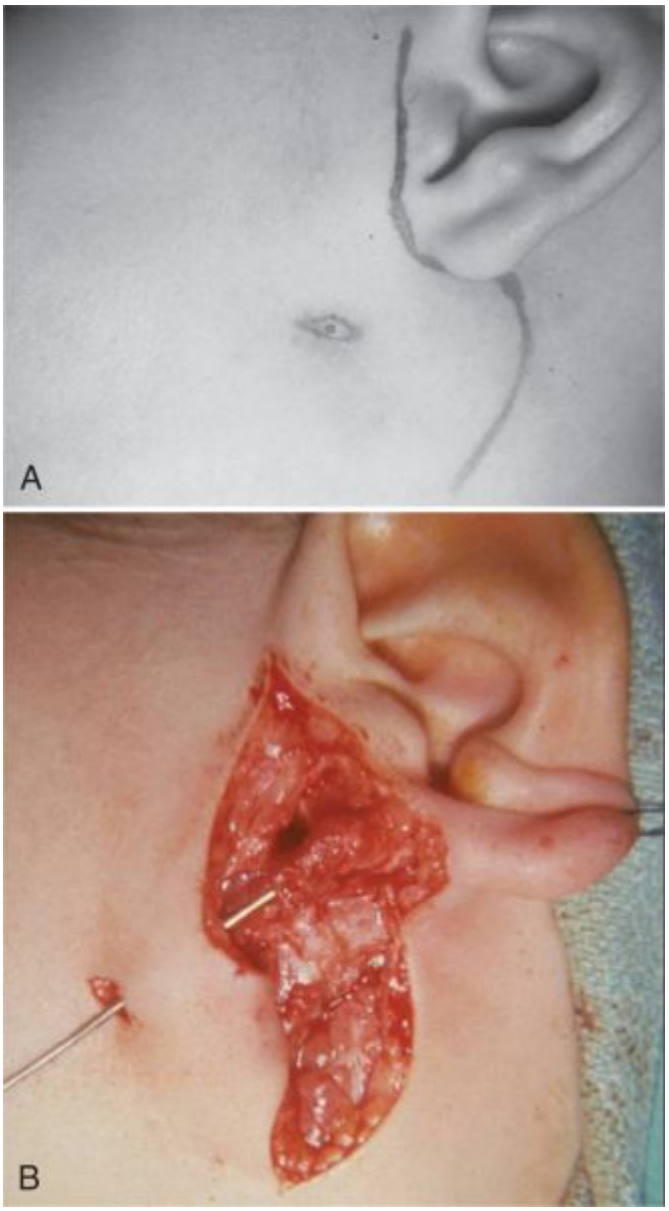

Figure 75-8 Two-year-old child with a first branchial groove remnant. **A,** Excision of the skin around the opening of the sinus tract. **B,** Dissection exposes the facial nerve back to the cartilaginous external auditory meatus.

Several authors have attempted to classify first branchial cleft anomalies. Work suggested that branchial cleft anomalies could be divided according to their embryologic derivative.[18] Type I anomalies consisted of ectoderm only, whereas type II anomalies consisted of ectoderm and mesoderm. Several authors have proposed revisions of Work's classification. Belenky and Medina base their classification on anatomy rather than histology.[19] The Belenky-Medina classification suggests that a type I anomaly is a cyst or sinus in the preauricular area. The sinus tract is lateral or superior to the facial nerve, parallel to the external auditory canal, and terminates without an opening in the external auditory canal. A type II anomaly is a cyst, sinus tract, or fistulous tract beginning below the angle of the mandible and running in an anterosuperior direction. The tract terminates at the junction of the bony and cartilaginous external auditory meatus, either with or without a direct communication with the meatus. The tract of type II anomalies generally lies lateral to the facial nerve, although some may pass medial to it or actually split and go on either side of the nerve. Belenky and Medina report that both type I and type II anomalies contain ectoderm and mesoderm.[19]

Belmont and Grundfast evaluated data from 14 patients treated for first branchial cleft anomalies.[20] They suggest a unifying concept in which some anomalies are proposed to result from imperfect closure of the ventral portion of the first branchial cleft and others from defective canalization of the dorsal portion of the first branchial cleft. Patients with these latter anomalies actually have a duplication of the external auditory meatus. The Belmont-Grundfast model may provide insight into the derivation of first branchial cleft anomalies. Nevertheless, the clinical issue remains unresolved. Some first branchial cleft anomalies clearly have a sinus tract or fistula. Cysts are encountered twice as frequently as either sinuses or fistulas.[10]

There does not currently exist an accurate and effective way for the clinician to determine the relationship of the sinus tract or fistula to the facial nerve before surgery. In their series of 10 patients operated on for first branchial cleft anomalies, Solares and associates[21] reported that seven of the tracts were found deep to the facial nerve (Fig. 75-3), two were lateral to the facial nerve, and one was found between branches of the facial nerve. D'Souza and colleagues[22] analyzed a series of 158 patients and found that fistulas were more likely than sinus tracts to be deep to the facial nerve. Lesions with openings in the external auditory meatus are associated with a tract superficial to the facial nerve. Accordingly, all patients with first branchial cleft anomalies should be counseled about the need for dissection of the facial nerve during removal of these cysts. Only surgeons expert in facial nerve dissection should undertake removal of first branchial cleft anomalies.

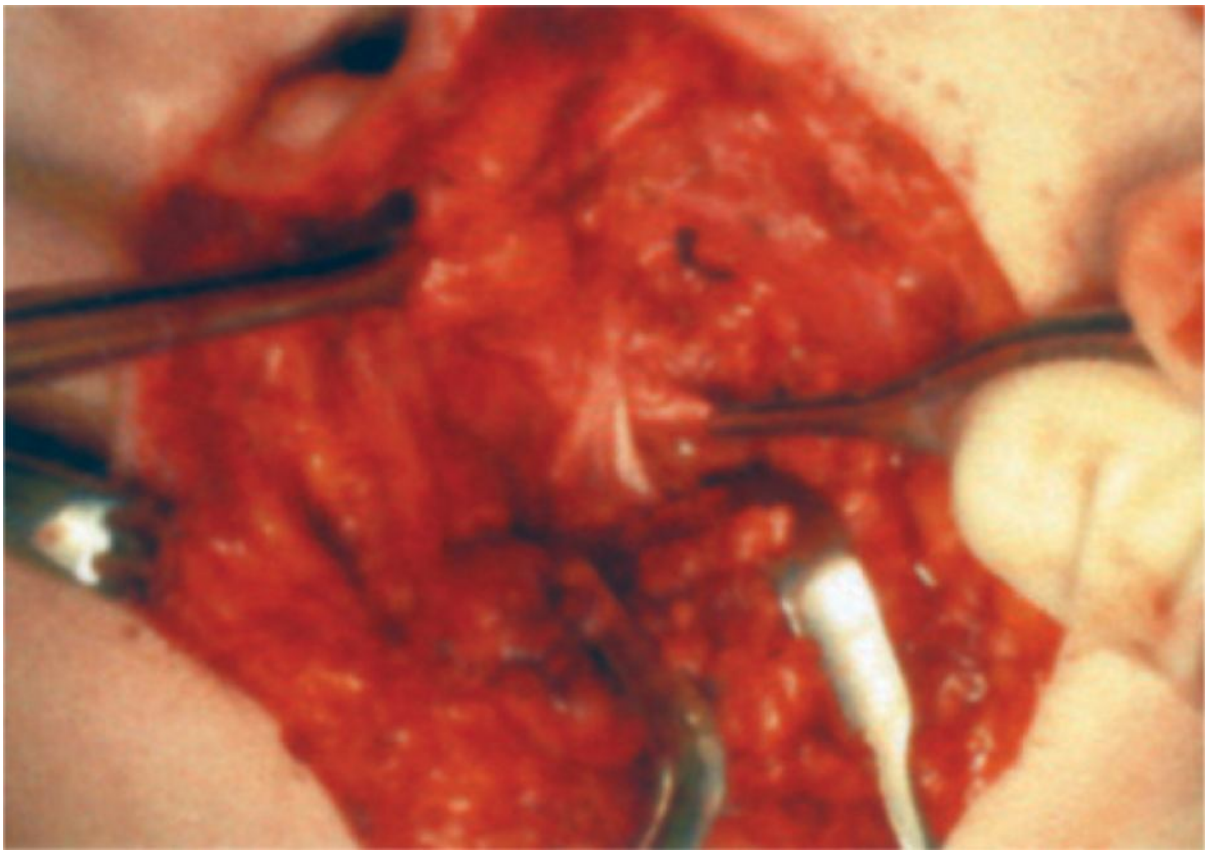

Figure 75-3 A first branchial cleft cyst with the tract going deep to the main trunk of the facial nerve and connecting with the external auditory meatus.

SECOND AND THIRD BRANCHIAL CLEFT ANOMALIES

The vast majority (>90%) of branchial cleft anomalies originate from the second branchial arch apparatus. Clinically, the rarely encountered remnant of the third branchial arch apparatus behaves like the remnant of the second branchial arch apparatus. There are differences in their internal openings and anatomic course, however. The second arch tract originates in the tonsil fossa, travels superior and lateral to both the glossopharyngeal and hypoglossal nerves, courses between the internal and external carotid arteries, and terminates in the upper part of the neck. Third arch sinuses originate in the apex of the piriform sinus, pierce the thyrohyoid membrane, travel inferior and posterior to the glossopharyngeal nerve and superior to the hypoglossal nerve, and course posterior to the internal carotid artery to terminate in the neck. This anomaly is also closely related to the thyroid gland, which when inflamed, may cause thyroiditis. Cysts of both the second and the third arches are usually located at the anterior border of the SCM muscle at the junction of the middle and anterior aspect. Occasionally, a second branchial cleft cyst is found in the posterior triangle (Fig. 75-4).

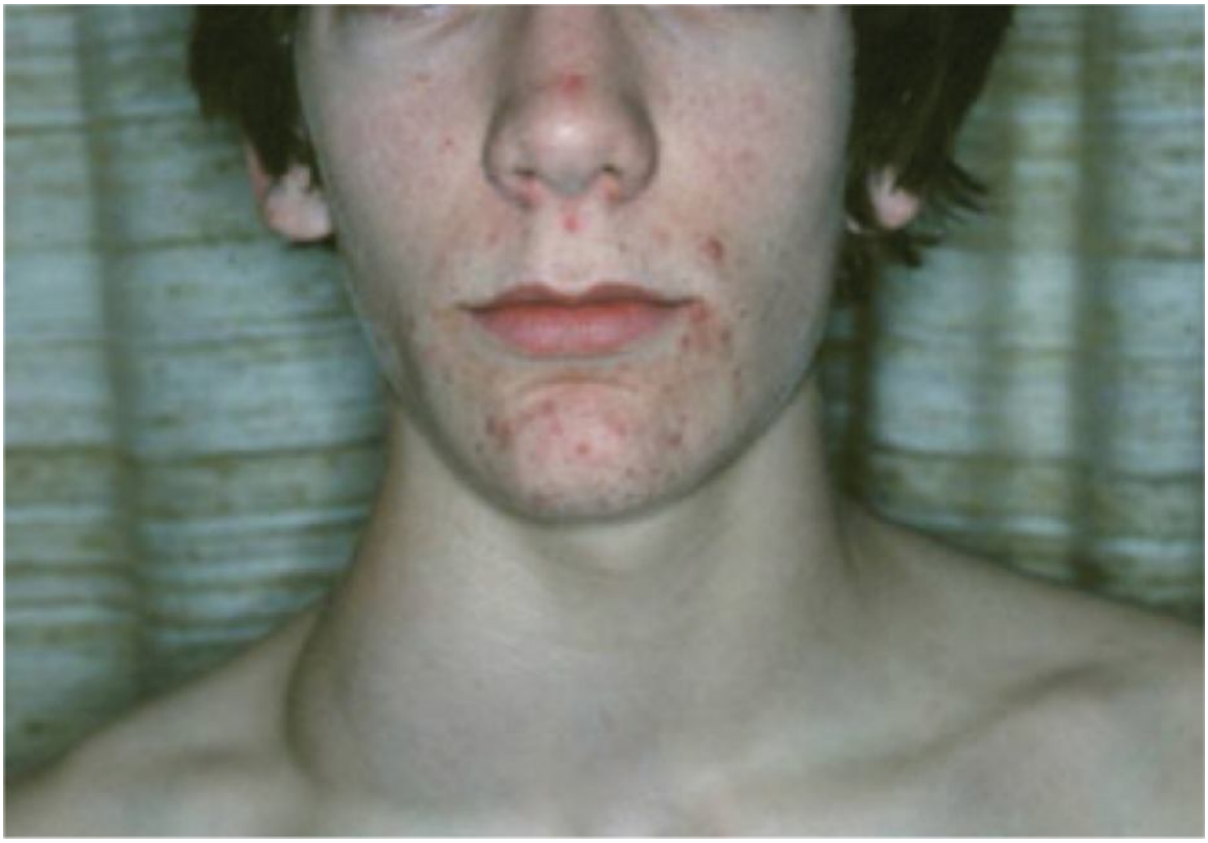

Figure 75-4 A 15-year-old boy with an atypical manifestation of a second branchial cleft cyst in the posterior triangle.

We recommend complete surgical excision of second or third branchial cleft remnants when the cyst is not inflamed. Preoperative antibiotics, high-resolution CT, fine-needle aspiration, barium swallow esophagography, and contrast fistulography, alone or in combination, can be used for the preoperative evaluation of patients with second and third branchial cleft remnants. An abscess in the neck located within or surrounding the thyroid gland should alert the physician to the possibility of acute suppurative thyroiditis or a piriform sinus fistula with a third or fourth branchial cleft anomaly.[23] A neck abscess is typical of infection of a third branchial arch cyst, probably via the piriform fistula. If this tract is not recognized and removed, recurrence of the abscess can be expected. The authors describe the technique of a non–contrast-enhanced CT with barium swallow. They emphasize that this was not done as a diagnostic modality but as a tool to better delineate the tract and its relationship to surrounding structures, which will aid the surgeon in complete extirpation of the tract.

In the setting of a recurrent fistula or infection in the neck, contrast esophagography and endoscopy can be used to more carefully examine the hypopharynx to look for an internal opening. A third arch remnant is diagnosed when an internal opening is identified in the apex of the piriform sinus. Direct laryngoscopy should be carried out, and a probe or Fogarty catheter should be inserted to facilitate dissection of this tract. Kim and associates[24] reported successful use of sclerotherapy for the treatment of third and fourth branchial cleft cysts. Trichloroacetic acid was injected into the fistula via suspension microlaryngoscopy. No serious complications were encountered.

Histologic evaluation of branchial cleft remnants reveals some differences between first and second/third branchial cleft remnants. First branchial cleft cysts contain both ectodermal and mesodermal derivatives. The cysts are lined by keratinized stratified squamous epithelium with adrenal structures (sweat glands, salivary glands, hair follicles). Mesodermal components, such as cartilage, may also be identified. Second branchial cleft cysts are lined by stratified squamous epithelium. Within the cyst wall are lymphoid aggregates, which often contain germinal centers (Fig. 75-5). Previous attempts at excision may lead to the finding of giant cell foreign body reaction, cholesterol clefts, and chronic inflammation with fibrosis.

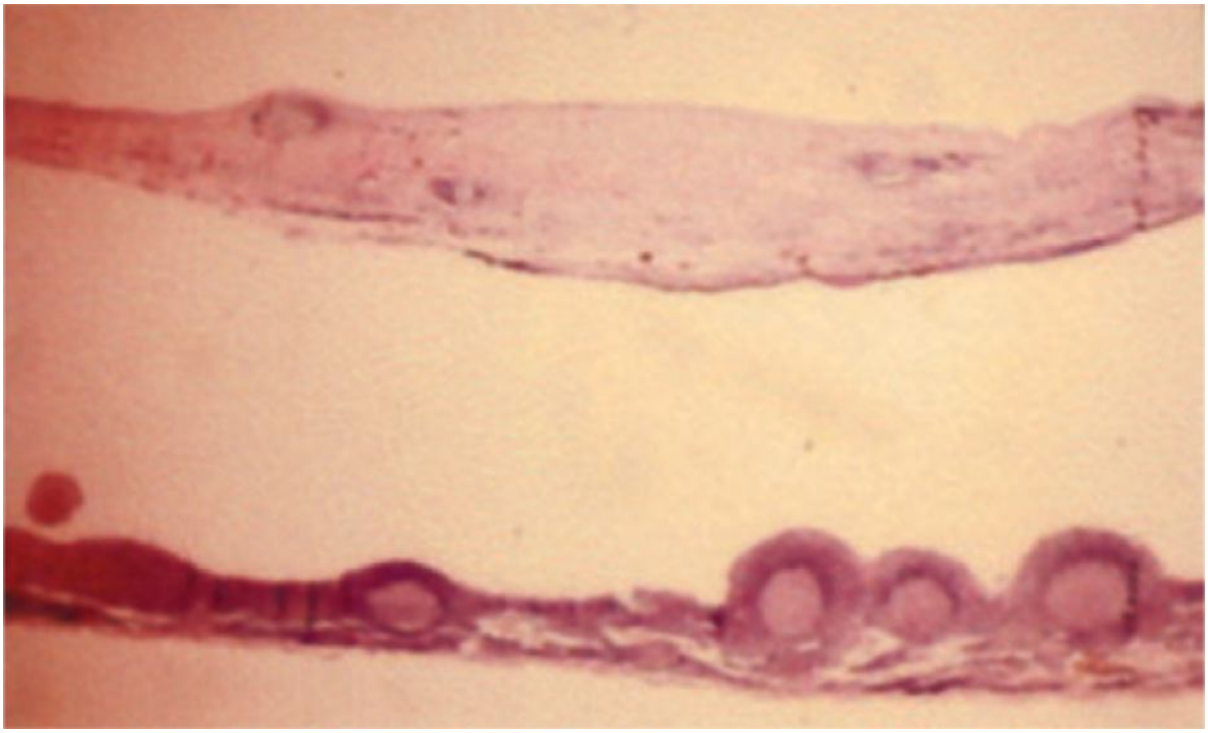

Figure 75-5 Lymphoid follicles in the wall of a branchial cleft cyst.

PATIENT SELECTION

Surgical excision of masses in the preauricular, postauricular, or lateral cervical region is performed for diagnostic and therapeutic purposes. Indications for removing presumed branchial cleft remnants include (1) symptomatic recurrent infections, (2) improved cosmesis, (3) recent increase in size, and (4) obtaining material for histopathologic evaluation. Preauricular sinuses are excised only for recurrent infection because most of them are asymptomatic. The size and location of a branchial cleft cyst at initial evaluation can vary (Fig. 75-6; also see Fig. 75-4). Many patients give a history of an increase in the size of a neck mass associated with an upper respiratory or sinonasal tract infection. Occasionally, patients will be seen after unsuccessful attempts at treatment with antibiotics and incision and drainage (Fig. 75-7). Excision after adequate treatment includes complete excision of the entire cyst and tract to prevent recurrence. This may be difficult in the setting of recent active infection or in a patient who has previously undergone incomplete surgery in which the epithelium-lined branchial remnant may be “multifocal” because of prior intervention.

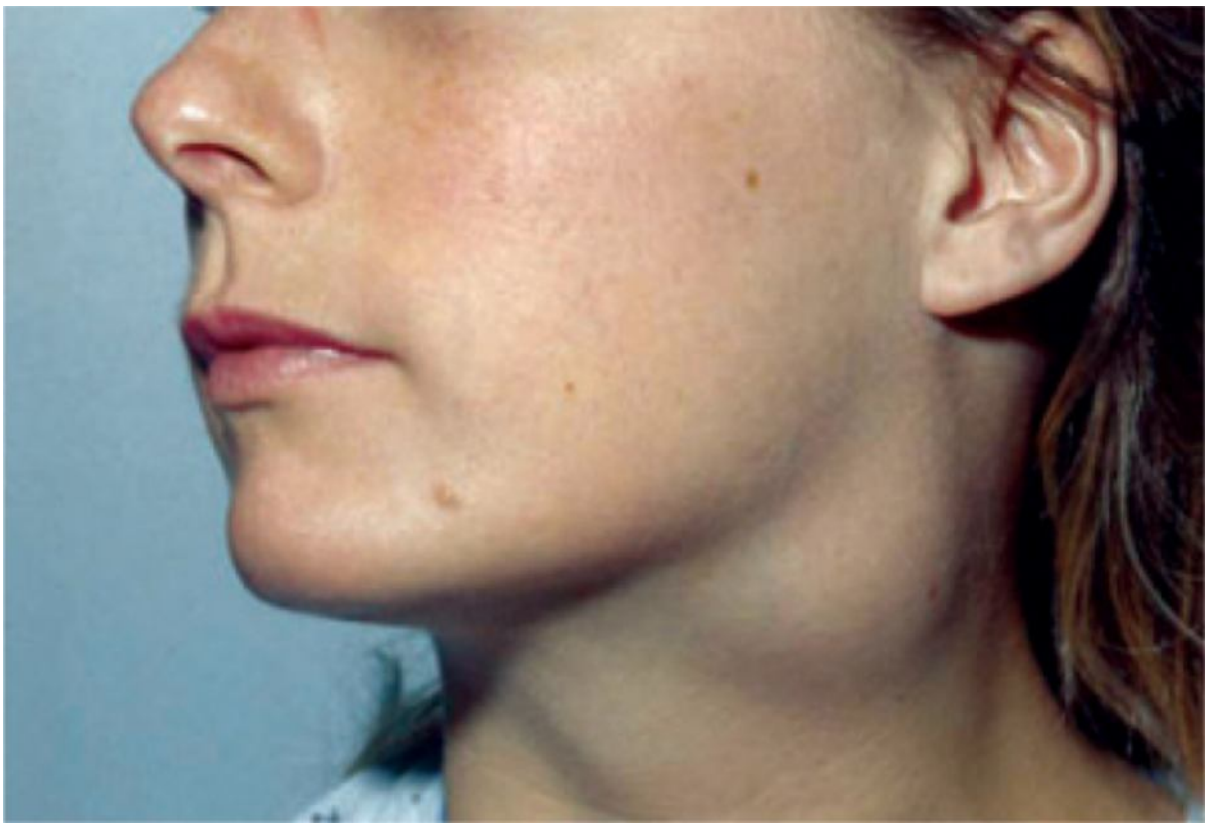

Figure 75-6 Typical manifestation of a type II branchial cleft cyst in the anterior cervical triangle.

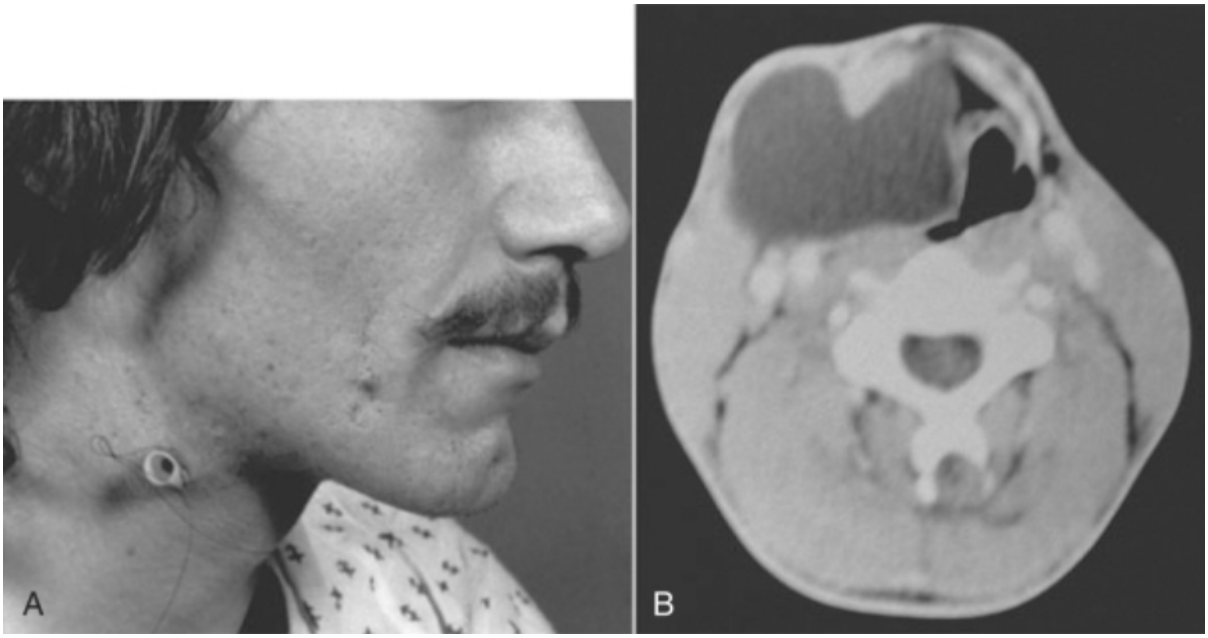

Figure 75-7 **A,** Patient with an infected second branchial cleft cyst treated by incision and drainage and insertion of a Penrose drain. **B,** Computed tomography scan of the patient in **A.**

Controversy still surrounds the entity of “branchiogenic carcinoma,” or carcinoma arising in a branchial cleft remnant.[25] None of the 56 adult patients in our series who underwent excision of branchial cleft remnants had a carcinoma.[5]

Cystic metastases to cervical lymph nodes are often mistaken for second branchial cleft cysts. Thompson and Heffner[26] studied the pathology of 136 cases of cystic metastasis of squamous cell carcinoma. Sixty-four percent of the primary cancers were found in the faucial tonsil or base of the tongue. Many of these primaries in the tonsil are not apparent because they are small and may be found deep in the tonsil crypts. Correct diagnosis in these

cases is achieved with the use of fine-needle aspiration biopsy, direct laryngoscopy, and tonsillectomy rather than random biopsy of the tonsil.

Singh and coauthors[25] reviewed the controversy surrounding branchial cleft carcinoma and the criteria for this diagnosis and added two cases that fit the criteria. However, our critical view of this article indicates that tonsillectomy was not performed and therefore metastasis was not actually ruled out. We believe that squamous cell carcinoma manifested as a cystic mass in the lateral aspect of the neck represents metastasis to a lymph node from an occult primary cancer arising in the tonsil or the base of the tongue, not a primary cancer arising in a branchial cleft cyst.[27] Careful and complete head and neck examination is required in the preoperative evaluation of all patients to avoid the pitfall of removing a “branchial cleft cyst” only to find squamous cell carcinoma.

The presence of an internal connection, the site of origin, and the size of the cyst determine the magnitude of the associated symptoms. A fistula or a sinus tract may have intermittent external drainage, such as a first cleft anomaly extending from the external auditory meatus down along the anterior border of the SCM and manifested as purulent drainage from the tract or cervical skin. Most patients have a firm, nontender mass, usually in the anterior cervical triangle anywhere from the preauricular region to the supraclavicular fossa. Larger cysts can produce dysphagia, dyspnea, and stridor. Infection can lead to an increase in size, severe pain, or abscess formation with spontaneous rupture or airway obstruction.

PREOPERATIVE PLANNING

A branchial cleft remnant can generally be diagnosed by history and physical examination. When carefully obtained, the history will almost always reveal the presence of a mass in the neck with fluctuation in size and level of discomfort. Activation of lymphoid aggregates (see Fig. 75-5) in the cyst wall by concurrent upper respiratory tract infection is the probable mechanism of recurrent pain, erythema, and swelling.

Tsai and coworkers[28] recently reported the prenatal diagnosis of a branchial cleft cyst. Because such a cyst could presumably cause upper airway obstruction at delivery, early surgical excision is recommended. This mass was visualized prenatally by three-dimensional ultrasound, a technique that had not been reported previously. Tracheal deviation was noted 3 days after delivery, and a 3-cm mass was excised.

Adults with a lateral cervical mass must be questioned about risk factors for head and neck squamous cell carcinoma (e.g., tobacco and alcohol use). In such patients, careful and complete examination of the upper aerodigestive tract, including the nasopharynx, must be performed to identify suspicious mucosal lesions. Metastases from squamous cell carcinoma, usually from the tonsil, may mimic branchial cleft cysts in adults, and thus diligence is necessary in establishing a diagnosis without removing the metastatic cancer.[29]

Congenital lesions in the neck are uncommon causes of deep neck infection but appear clinically in the same manner as other types of deep neck infection.[30] The authors noted that when the underlying cause is a congenital lesion, recurrence is more common. These recurrences are generally attributed to initial lack of awareness of the underlying pathology. The major value of this article is that the authors state emphatically that the addition of CT scanning to the initial workup provided early evidence of the true underlying pathology. This information directs management of the case.

High-resolution CT may be helpful in determining the size, depth, and precise location of the surrounding structures in the neck, particularly the facial nerve. Positron emission tomography (PET) or PET/CT scanning is an important diagnostic study that can play a key role in making the distinction between cystic metastasis to a cervical lymph node and a second branchial arch cyst in an adult. If fine-needle aspiration biopsy is performed, a branchial cleft cyst may be definitively diagnosed with the finding of epithelial cells and debris in the cyst fluid; however, complete evacuation of the contents of the cyst can make dissection at the time of surgery much more difficult and lead to complications. Ultrasonography may also be helpful because of the typical superficial nature of cysts.[31] Sonomorphologic findings usually demonstrate a rounded mass that has uniform low echogenicity and lacks internal septation, with no acoustic enhancement or enlargement.[31,32]

Surgical excision of an acutely infected branchial cleft cyst is technically difficult because of edema and local inflammation obscuring tissue planes. Fine-needle aspiration of infected material is helpful in determining appropriate antimicrobial sensitivities. In more severe cases, patients are treated with a 7-day course of appropriate high-dose intravenous antibiotics, followed by 4 weeks of oral antibiotics before surgical excision of an infected branchial cleft remnant. This treatment program may avoid the need for incision and drainage, which makes definitive surgical excision more complex. These neck masses may be large enough to cause asymmetry of the neck, dyspnea, or dysphagia or dysphonia.

SURGICAL TECHNIQUE

The fundamental surgical principle in treating all branchial cleft remnants is complete surgical excision of the cyst,

sinus tract, and when present, previously dissected tissues, which may harbor epithelial rests. The critical concept in operations for removal of a first branchial groove remnant is identification and preservation of the facial nerve (Fig. 75-8).

Preauricular Cysts/Sinuses

Excision of preauricular cysts/sinuses is usually carried out under general anesthesia with the patient supine. In adults, it would be possible to excise them under local anesthesia with intravenous sedation. A vertical elliptical incision (Fig. 75-9) is made and incorporated into the preauricular skin crease if possible. If there is a scar from previous surgery, it should be excised with the sinus tract.

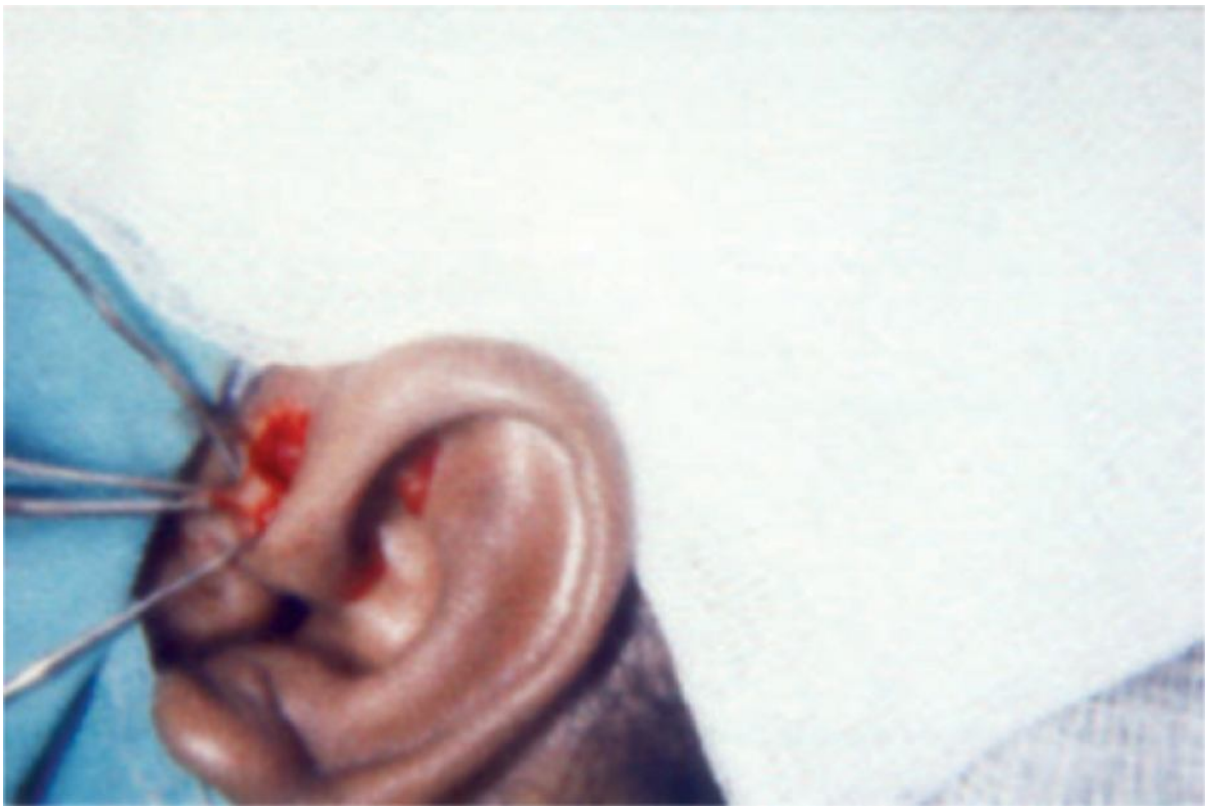

Figure 75-9 A vertical elliptical incision is incorporated in the preauricular skin crease. Dissection is carried deep along the cartilage of the auricle down to the temporalis muscle, and the cyst is then excised and the wound closed primarily.

Dissection is carried out along the cartilage of the helix, and if scarring is present from previous surgery, a margin of cartilage may be removed. Dissection around the entire sinus tract is carried deep and includes the cyst. Dissection should be as deep as the temporalis fascia to be certain of complete removal.

Concern about injury to the facial nerve may limit the surgeon's dissection and thereby lead to inadequate excision and recurrence. The surface landmark for the main trunk of the facial nerve is the tragus, so dissection will be well away from the nerve.

First Branchial Arch Remnants

First branchial cleft remnants are excised under general anesthesia with the patient supine. The surgeon should inform the anesthesia team that muscle relaxant medications are not to be administered. Electrophysiologic monitoring should be used in patients in whom previous surgery has been performed or infection has been present. A parotidectomy incision is outlined in anticipation of exposing the facial nerve. The incision begins in a pretragal skinfold and extends inferiorly around the lobule posterior to the angle of the mandible and anteriorly 2 cm below the inferior aspect of the body of the mandible. If the cyst or sinus has previously been incised, it may be adherent to the overlying skin. An ellipse of skin should be incorporated into the incision to remove the sinus tract or the scar from previous surgery along with the specimen (Fig. 75-10A). The skin flap is elevated superficial to the platysma muscle over the face just anterior to the anterior margin of the parotid gland. Inferiorly, the anterior border of the SCM, mastoid tip, and posterior belly of the digastric muscle are identified. The greater auricular nerve is identified and transected. In some cases it may be possible to save the nerve.

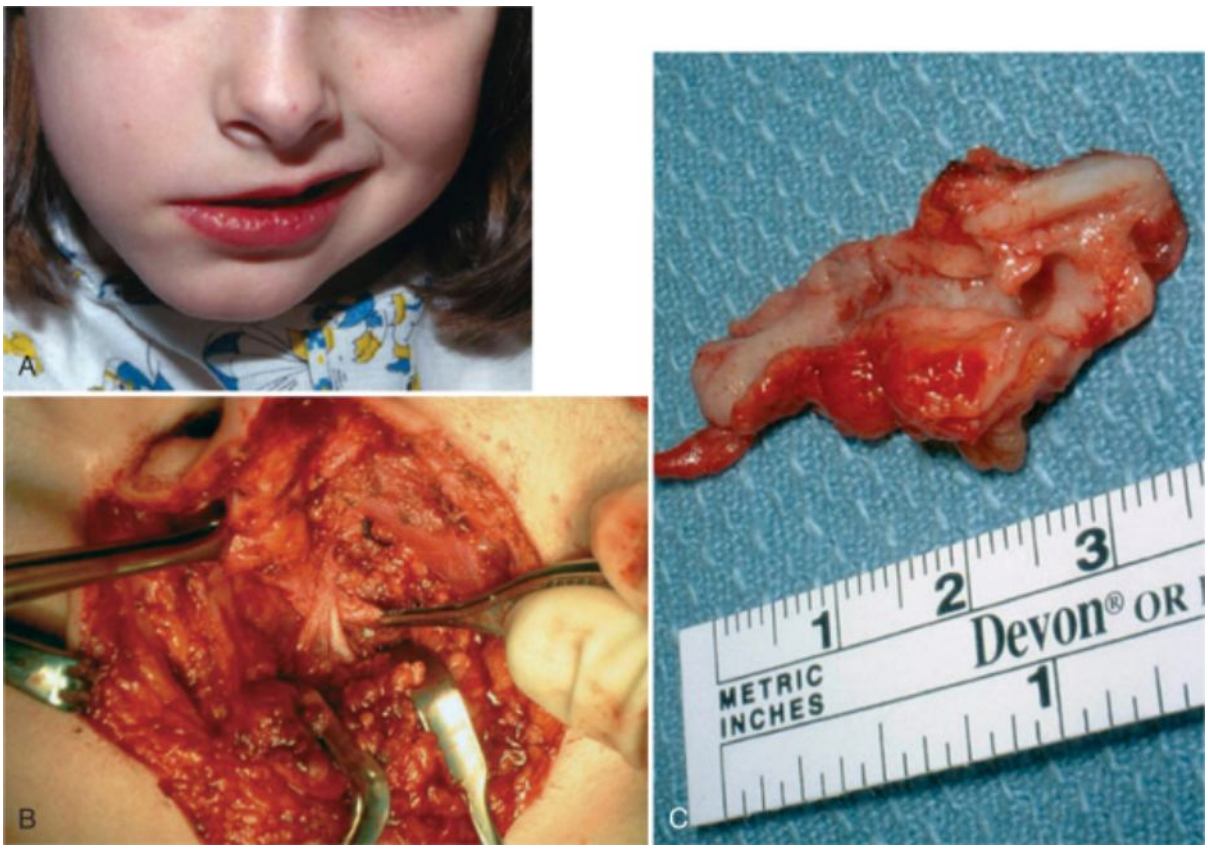

Figure 75-10 **A,** Patient with a recurrent first arch cyst. Injury to the facial nerve occurred during previous incision and drainage of a postauricular abscess. **B,** The facial nerve must be identified so that when the tract is found deep to the facial nerve, it can be excised. **C,** Gross specimen of the branchial cleft cyst and the external auditory meatus.

The tail of the parotid gland is elevated off the SCM muscle up to the mastoid tip, and the avascular plane between the parotid gland and the external auditory canal is dissected. The posterior belly of the digastric muscle is then identified deep to the mastoid attachments of the SCM. The cartilaginous external auditory meatus (pointer) is identified. The facial nerve exits the temporal bone through the stylomastoid foramen, which is lateral to the styloid and medial to the mastoid process, along the tympanomastoid suture. The main trunk is located 10 mm deep and 6 to 8 mm anterior/inferior to the cartilaginous pointer. Depending on the course and location of the first branchial cleft remnant, partial parotidectomy may be required.

Once the main trunk of the facial nerve is identified, dissection is carried anteriorly as far as the bifurcation. Attention can now be turned to the distal portion of the cyst/sinus. Via sharp dissection, the tract is dissected proximally with a narrow cuff of surrounding normal tissue. The relationship of the tract to the facial nerve can then be identified. Previous infection or open drainage makes dissection in this region difficult and potentially dangerous to the facial nerve. In such cases, physiologic nerve monitoring should be instituted. Lacrimal probes and dilators can be used to facilitate identification of a first branchial cleft fistula during dissection. Frequently, the nerve must be mobilized and retracted to fully expose and remove the tract (see Fig. 75-10B), which is often encountered deep to the main trunk of the facial nerve.

The tract is dissected proximal to the external auditory canal. A segment of the external canal cartilage may need to be resected to encompass the sinus tract completely (see Fig. 75-10C). If external canal cartilage or skin is resected, the meatus should be allowed to heal by secondary intention. Should the tract pass medial to the tympanic annulus and involve the tympanic membrane, tympanoplasty may be required. The wound is closed in two layers over ⅛-inch closed suction drains. Deep tissues are closed with 4-0 or 3-0 chromic suture, and the skin is closed with a running 6-0 mild chromic gut stitch and reinforced with Steri-Strips.

Isaacson and Martin[33] described a modification of this technique in which a smaller surgical approach was used than generally advocated. The facial nerve was localized by electrophysiologic means rather than superficial lobe parotidectomy and identification of the main trunk of the facial nerve and branches.

Second and Third Branchial Remnants

Second and third cleft remnants are excised under general anesthesia without neuromuscular blockade to facilitate identification of motor nerves encountered along the course of the dissection. The patient is placed in the supine

position with the head extended and rotated to accentuate the cervical cyst. The line for incision should be drawn with the patient in the anatomic position before extension and rotation to avoid distortion. A skin incision is made in the natural major skin crease near the cyst (Fig. 75-11). If a sinus tract or a previous incision is present, it is incorporated into the incision and an ellipse of skin is included and left on the specimen. The skin, subcutaneous tissue, and platysma muscle layers are incised. Flaps are elevated superiorly and inferiorly to protect the marginal mandibular branch of the facial nerve. The external jugular vein may be ligated, and the greater auricular nerve should be identified and spared.

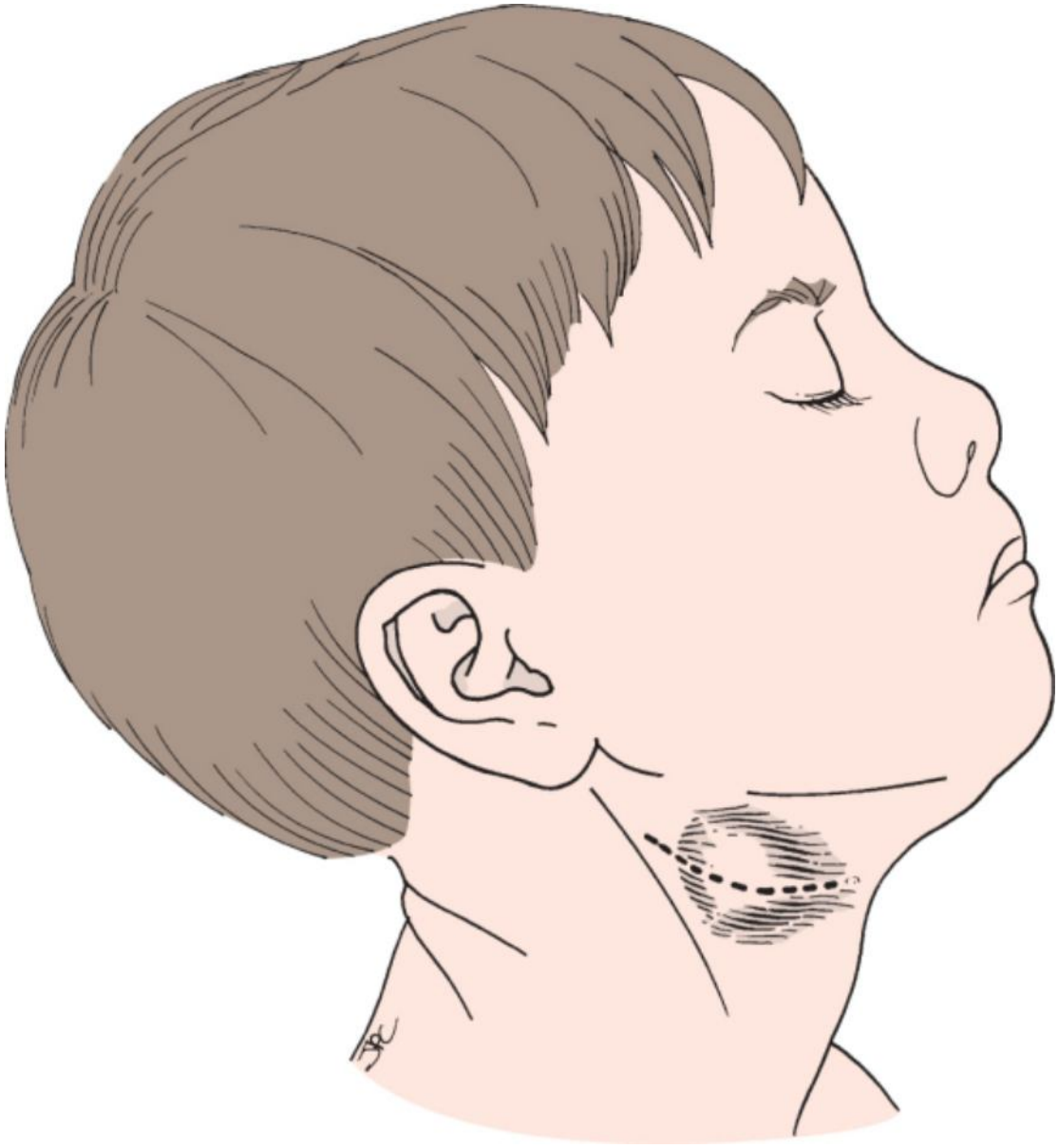

Figure 75-11 The incision is placed in a skin crease.

The cyst is separated from the superficial layer of the deep cervical fascia investing the SCM by sharp and blunt dissection (Fig. 75-12). As the SCM muscle is retracted laterally, the spinal accessory nerve may be exposed and preserved. The cyst should be gently retracted to prevent rupture of the cyst and contamination of the wound.

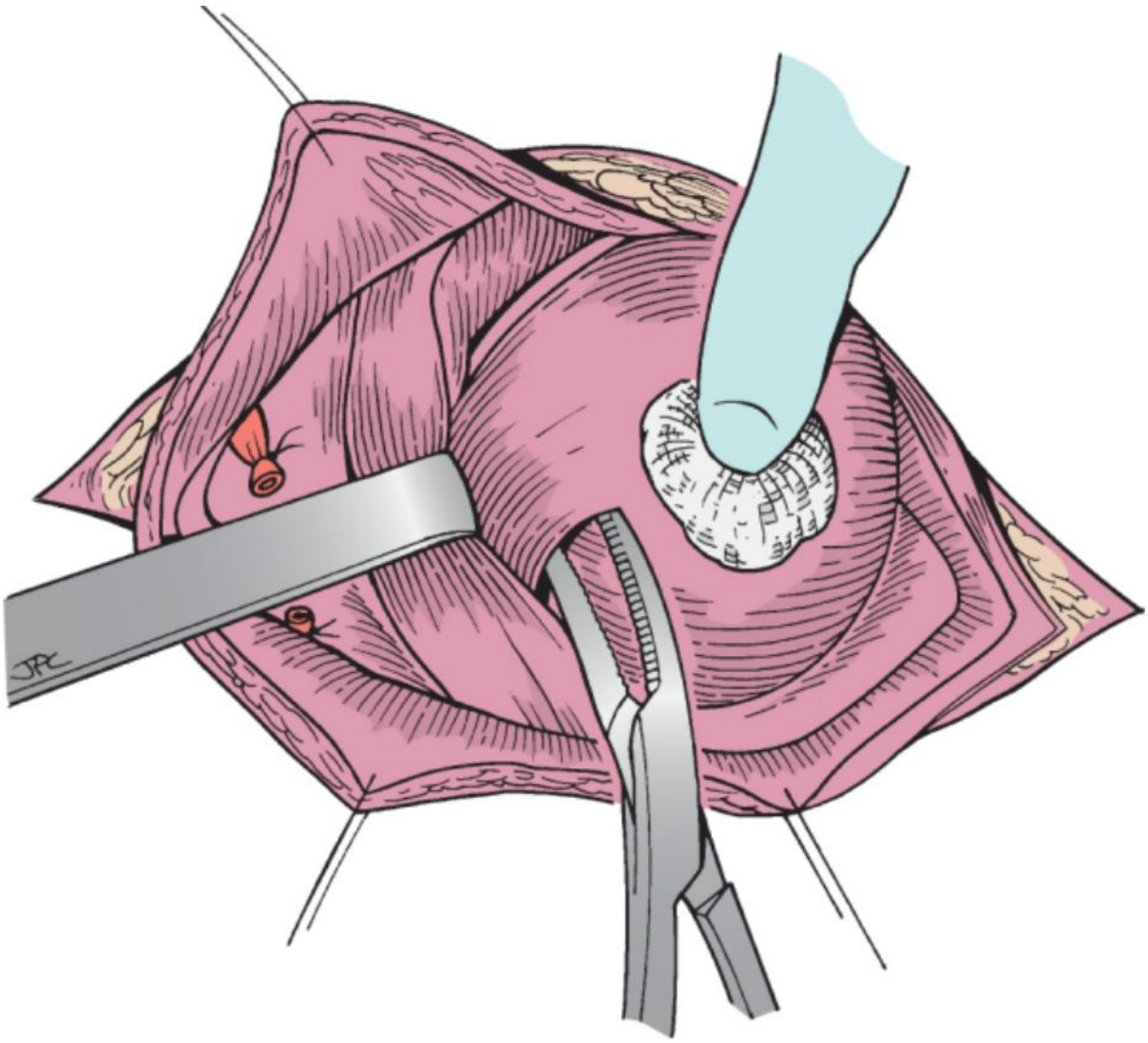

Figure 75-12 The cyst is separated from the cervical fascia, and the sternocleidomastoid muscle is retracted laterally.

Sharp scissors dissection is used to take down fascial attachments and adhesions from the posterior and medial aspects of the cyst. Blunt dissection with a hemostat or a Kitner (peanut) sponge can be used to separate the cyst from the carotid sheath and hypoglossal nerve, which are located deep to the cyst (Fig. 75-13). Partial decompression by needle aspiration or insertion of a trocar into the cyst may facilitate removal when the cyst is large and tense and obscures the view of underlying components of the carotid sheath.

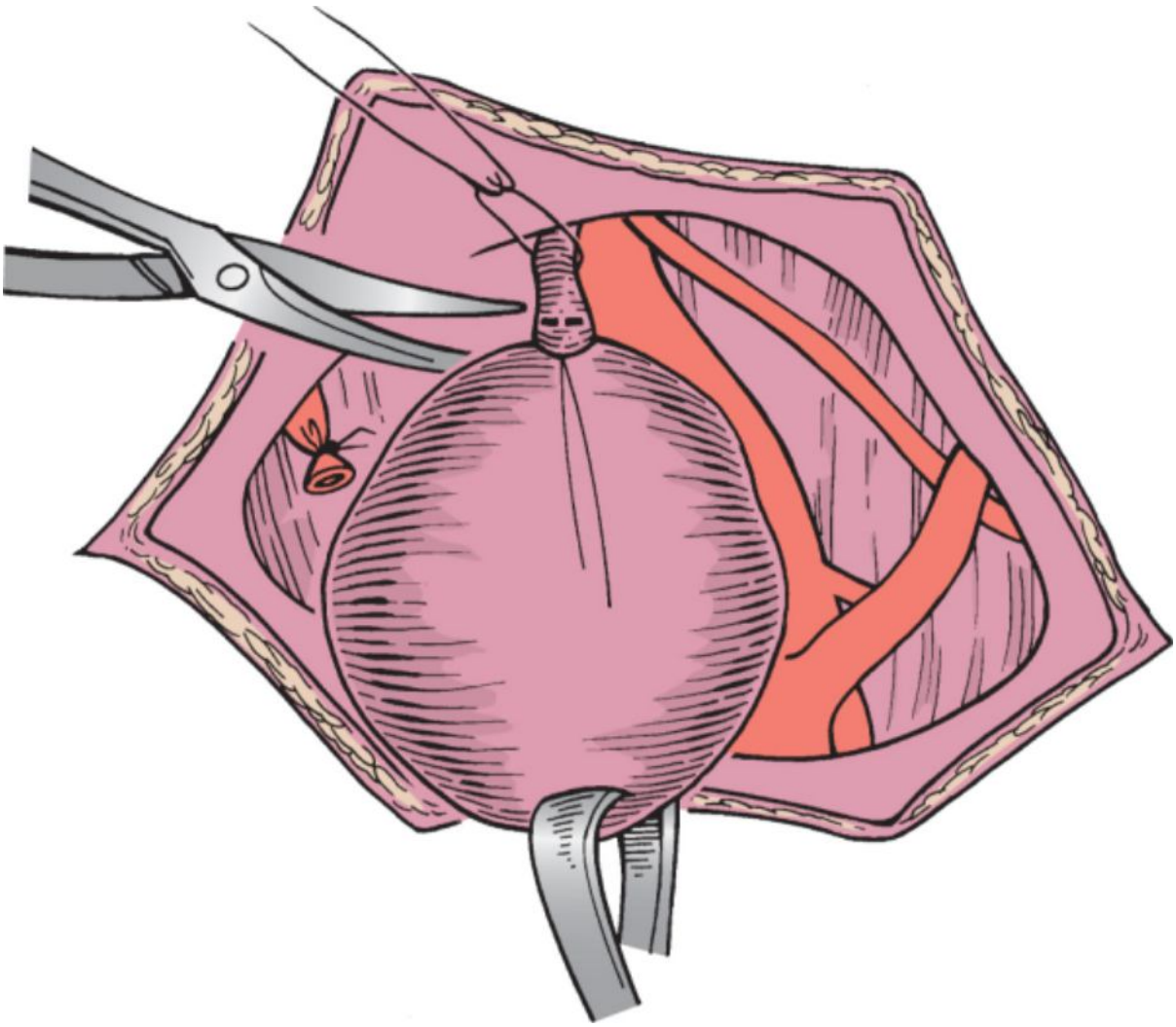

Figure 75-13 Separation of the cyst from the carotid sheath and dissection of the tract to the tonsil.

With the inferior aspect of the cyst mobilized, the dissection proceeds superiorly along the tract. As dissection of the tract ascends over the hypoglossal nerve, bleeding may be encountered from the lingual venous plexus. Care must be exercised because indiscriminate clamping can lead to injury of the hypoglossal or superior laryngeal nerve at this level. The tract is followed superiorly as it courses between the internal and external carotid arteries either anterior (second arch) or posterior to the internal carotid artery (third arch) (Fig. 75-13) and passes deep to the posterior belly of the digastric to enter the pharynx. If no internal connection is identified, the tract can be ligated and transected at this level from the external approach. Talaat has described a pull-through technique for transcervical exposure and transoral removal of complete second branchial cleft fistulas.[34]

There may be only a sinus rather than an actual cyst. The tract may be long and thereby prevent complete exposure and delivery of the cyst through a low cervical incision. In such cases we have found it necessary to make a second incision higher in the neck, in a skin crease at the level of the hyoid bone. The superior extent of the fistula can more easily be dissected through the superior incision; once it has been transected superiorly, the entire specimen can be delivered via the inferior incision. This stepladder technique allows complete exposure of the entire branchial cleft remnant without excessive traction on the skin flaps (Fig. 75-14).

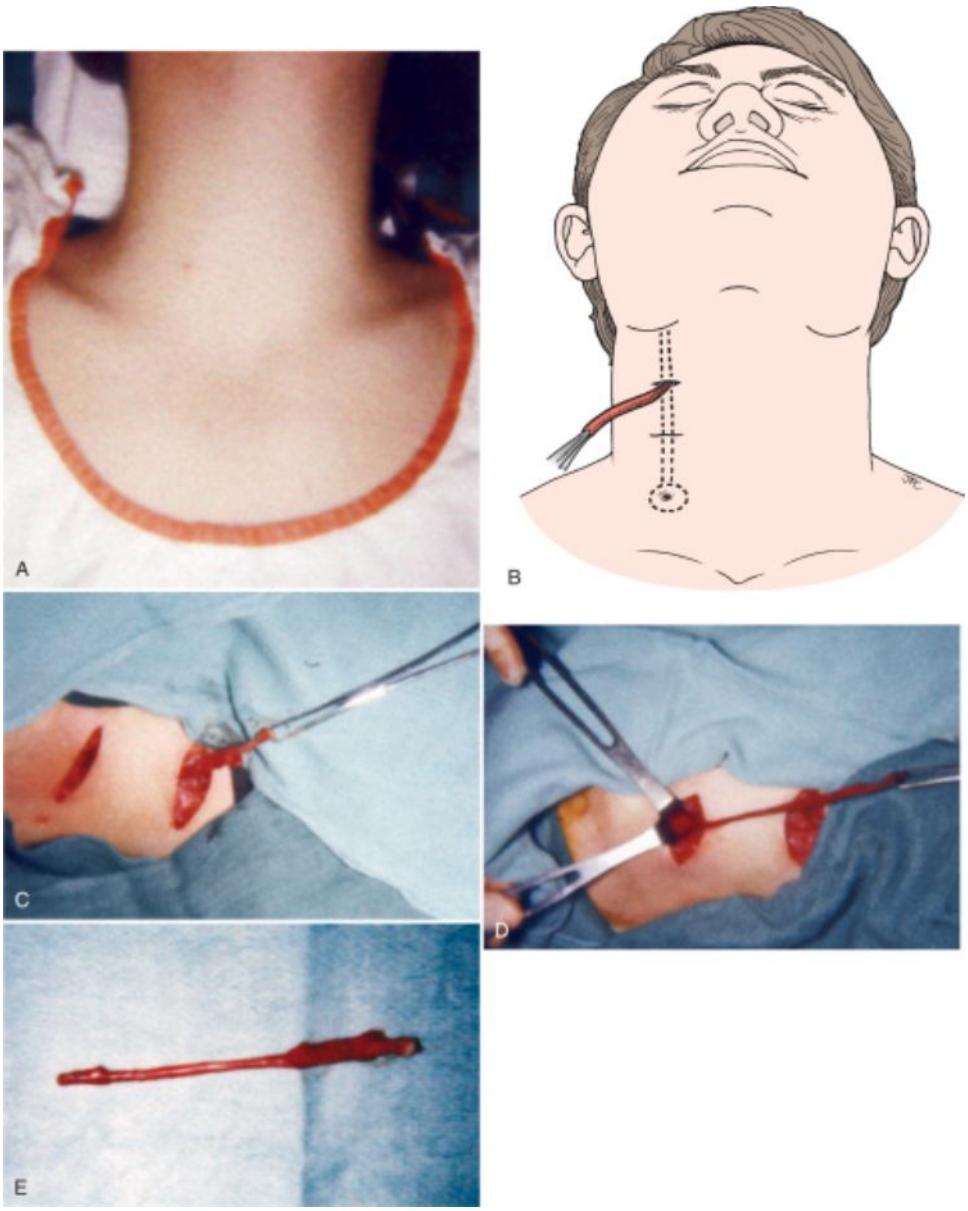

Figure 75-14 **A,** A 15-year-old patient with a lifelong history of drainage from a sinus tract in the right side of the neck. **B** to **D,** Stepladder incisions are necessary for removal of the branchial cleft sinus exiting in the inferior aspect of the neck. **E,** The specimen includes the complete sinus tract and an ellipse of skin around the opening of the sinus tract in the neck.

When faced with a patient who has a history of a recurrent abscess in the neck, especially if surgery has previously been performed, the surgeon should consider the presence of a third arch remnant with a piriform sinus fistula. A piriform fistula can be associated with either the third or the fourth branchial arch, and the distinction must be made at surgical exploration.[35] Huang and colleagues[36] described a 5-week-old patient with an infected third branchial cleft cyst that progressed to a retropharyngeal abscess. The lack of response to high-dose antibiotics and incision and drainage of the abscess led the surgeon to suspect a piriform fistula, which was confirmed at direct laryngoscopy. This rare combination of a retropharyngeal abscess associated with a third branchial remnant has been reported only twice previously. Diagnosis of a piriform sinus fistula may be made by barium swallow, CT scan, and direct hypopharyngoscopy. Endoscopic placement of a Fogarty vascular catheter into the sinus tract helps locate this sinus tract during dissection (Fig. 75-15).[37,38]

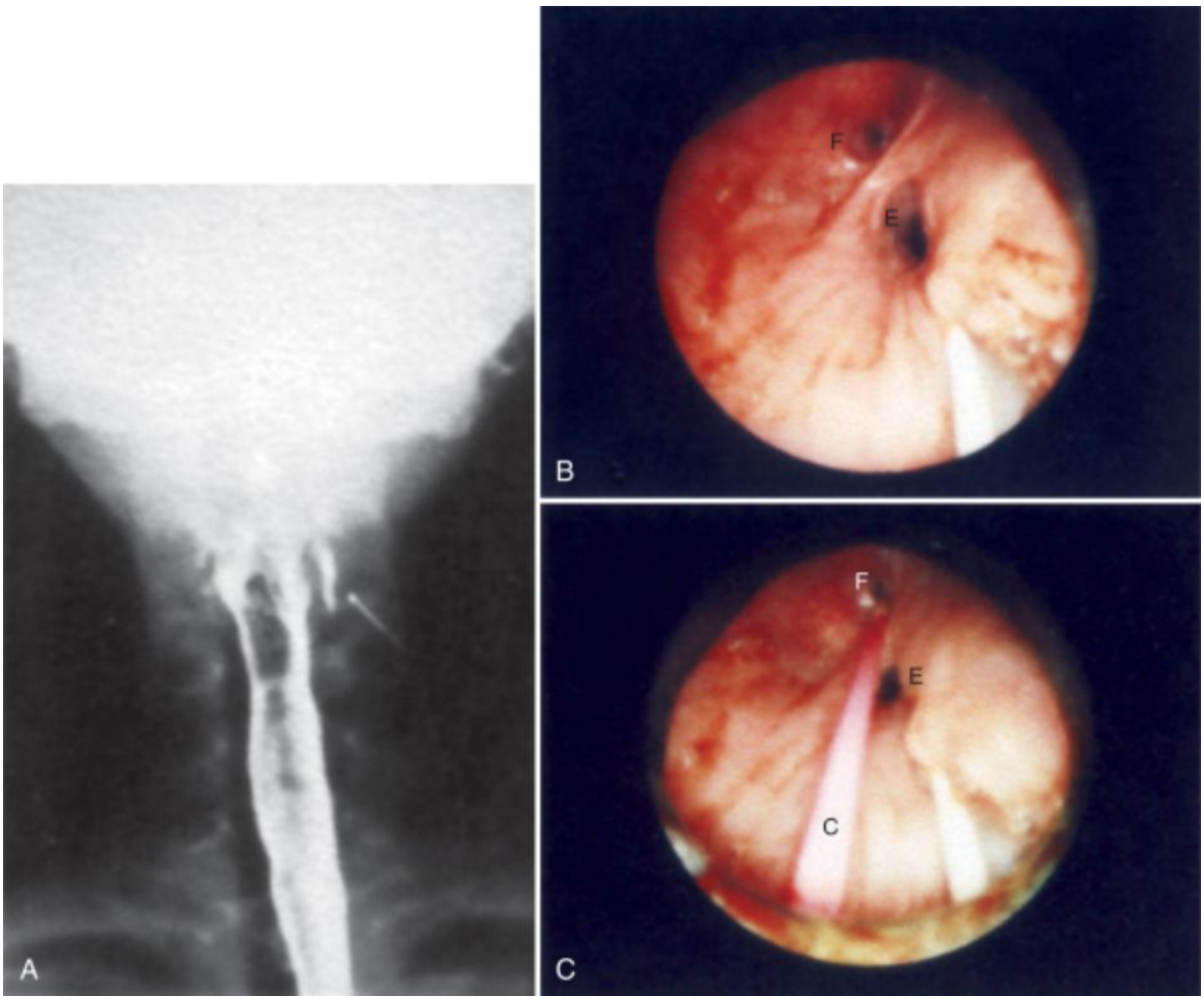

Figure 75-15 **A,** A piriform sinus fistula is noted on a barium swallow esophagogram *(arrow)*. **B,** Laryngoscopy is carried out to identify the fistula. E, esophagus; F, piriform sinus fistula. **C,** Through the laryngoscope, a Fogarty catheter is placed in the piriform sinus fistula (F) to aid in dissection of the fistulous tract. C, Fogarty catheter.

The need for complete excision of these lesions cannot be overemphasized. Because the history of most patients with third arch remnants includes a recurrent abscess in the neck and multiple attempts at extirpation, recurrence is usually the result of failure to recognize or adequately excise the tract connecting with the piriform sinus. Scarring and disruption of fascial planes are other important surgical features. When a third arch remnant is treated by complete excision, identification and preservation of the recurrent laryngeal nerve is necessary to prevent vocal cord paralysis. Thyroid lobectomy should also be carried out to preserve the recurrent laryngeal nerve and completely excise the cyst, particularly if there is infection or previous surgery has been performed. An attempt should be made to preserve the parathyroid glands. After identification of the recurrent laryngeal nerve, the fistula tract is excised and the sinus tract from the piriform sinus is closed with a pursestring suture and inverted to prevent recurrence.[35,38]

If the pharynx has been entered, the wound is copiously irrigated with antibiotics, and intravenous perioperative antibiotics are administered. A Hemovac suction drain is placed in the wound via a separate stab incision, and the wound is closed in layers. The platysma layer is closed with inverted interrupted 3-0 chromic suture, and the skin is closed with a running 6-0 fast-absorbing mild chromic stitch. The skin closure is reinforced with Steri-Strips, and a dressing is applied.

Edmonds and coworkers[39] also concluded that complete excision of the cyst, tract, and fistula is necessary to avoid recurrence. Direct laryngoscopy with examination of the piriform sinus is advocated before excision of this suspected branchial cleft anomaly. A combined lateral approach with simultaneous telescopic illumination of the piriform sinus tract aids in complete extirpation, especially in recurrent cases.

Cote and Gianoli[40] made a valiant effort to explain that there is actually a fourth branchial arch remnant with the tract extending into the chest, passing posterior to the aorta on the left and the subclavian artery on the right, looping back up superior to the hypoglossal nerve, and then descending to an external opening low in the neck. There are two troubling aspects of their article that actually further obfuscate the issue. The first is that their diagram of a fourth arch anomaly does not really show the tract traversing the area described. There is also no

mention of treatment of this lesion, which sounds as though it would be necessary to combine the cervical approach with opening of the mediastinum and chest to completely excise this lesion.

Jordan and coauthors[41] reported the technique of endoscopic cauterization of the piriform fistula for the treatment of a fourth branchial cleft sinus. They successfully treated seven patients with this technique, thereby avoiding external surgical extirpation. They point out the actual distinction between third and fourth branchial arch anomalies and discuss the theoretical basis of the embryology to justify the title of the paper.

POSTOPERATIVE MANAGEMENT

Closed suction drainage is continued until the output is less than 10 mL per 24 hours, which usually occurs within the first 48 hours. The pressure dressing is removed before discharge. The Steri-Strip wound covering is left in place and removed during the first postoperative visit in 1 week.

COMPLICATIONS

Wound complications are rare but may include hematoma, seroma, and infection. Adequate suction drain age allows coaptation of the skin flaps and obliteration of dead space, thereby preventing seroma or fluid collections from forming. Hematoma is due to technical error and usually requires a return to the operating room for re-exploration of the wound, evacuation of the hematoma, and achievement of complete hemostasis.

Complications associated with first branchial cleft remnants include hematoma, infection, transient facial paralysis, facial nerve injury, and recurrence of the remnant. Every attempt should be made to completely excise the cyst at the first attempt because the potential morbidity associated with reoperation in this area is significant. Untoward events can be prevented by meticulous surgical technique, correct identification of the facial nerve, and careful attention to hemostasis.

Second/third branchial cleft cysts are closely related to the carotid sheath and the 9th, 10th, 11th, and 12th cranial nerves. Fibrosis from previous infection or surgery can cause the cyst to become adherent to these structures, thus making dissection more difficult and increasing the chance of injury. Failure to recognize entry into the pharynx can lead to wound infection and recurrent fistulization.

PEARLS

- Intricate knowledge of the embryology of the branchial cleft system is fundamental for success in the management of these problems.
- The use of CT scanning and ultrasonography has improved the accuracy of diagnosis and management of these problems.
- Direct laryngoscopy, barium swallow esophagography, and CT should be used for the diagnosis of patients with a history of recurrent infection of the neck, particularly on the left side. Such imaging will help make the diagnosis of third branchial arch remnants with a piriform fistula.
- Recurrent infection in the periauricular area, especially in children, accompanied in some cases by otorrhea with an intact tympanic membrane suggests a first branchial arch anomaly.
- CT scanning, intraoperative facial nerve monitoring, and experience in parotid surgery are necessary in the management of first branchial arch cysts.

PITFALLS

- Lack of understanding of the embryology of the branchial cleft system will result in misdiagnosis and mismanagement of patients with such lesions.
- Not using CT scanning or ultrasound will delay accurate diagnosis and localization of these lesions.
- Excision of first arch anomalies by a surgeon inexperienced in parotid surgery puts the facial nerve at risk.
- First arch anomalies that have previously been infected or operated on are technically difficult surgical cases. Facial nerve electrophysiologic monitoring is essential in avoiding injury to multiple structures in the head and neck.
- The use of CT, PET, and fine-needle aspiration biopsy is advisable to make the distinction between a second branchial arch anomaly and cystic metastasis to the cervical lymph nodes.

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