Neck Cysts, Sinuses, Thyroglossal Duct Cysts, and Branchial Cleft Anomalies

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Unlike benign masses in other locations where simple excision is often the preferred method of diagnosis, such an approach in the neck may result in chronic infection and draining tracts. The surgical approach to pediatric neck masses requires a thorough understanding of the diagnostic possibilities and the anatomic implications before making the incision. Sistrunk understood this dilemma after observing high recurrence rates with removal of thyroglossal duct cysts. His operation, published in 1928, was based on the anatomic and embryologic facts of thyroid descent through or around the hyoid bone. The combination of accurate preoperative diagnosis and specific anatomic knowledge remains the standard for neck surgery today. Fortunately, the preoperative diagnostic evaluation is straightforward, and when followed, operative outcomes are excellent.2

PREOPERATIVE EVALUATION

Pediatric neck masses are conveniently classified as midline or lateral (Table 1). Branchial cleft and thyroglossal duct anomalies are found with equal frequency in children and make up about half of all surgically excised neck masses.2 Occasionally, a cyst may appear on the border of the other's territory requiring additional differentiating features of the history and physical examination plus ultrasound.3 Indications for operation are increasing size, infection, diagnostic uncertainty, and prevention of infection or cancer.4

Midline Neck Masses

In the upper midline, thyroglossal duct cysts are the main concern, directing all investigations to its diagnosis. There is always a concern for the rare lingual thyroid; however, the typical cyst is an isolated anomaly residing close to the hyoid bone. Other masses close by include submental lymph nodes found higher in the neck just beneath the chin, and dermoid cysts that can be anywhere along the midline including below the thyroid cartilage where thyroglossal duct cysts are very rare.

Warning signs for unusual thyroglossal anomalies include a history of other congenital head and neck disorders, dysphagia, voice changes, or hypothyroidism. Any of these signs mandate further studies including direct laryngoscopy and thyroid scans.3 In the absence of such concerns physical examination of the head, neck, mouth, and pharynx is sufficient. Most children willingly tilt their heads back to display a prominent smooth round mass near the hyoid bone that moves with swallowing. Unless infected, it is usually not tender or erythematous. Parents may discover the cyst as their child begins to grow and the neck assumes a more school-age appearance at two or 3 years of age. Ultrasound evaluation is simple and straightforward, confirming the cystic nature of the mass and excluding more problematic issues such as ectopic thyroid tissue.3,5

Dermoid cysts in the upper midline may not be easily differentiated from thyroglossal duct anomalies. Most dermoids are found close to the deep cervical fascia and present as smooth round masses that move with swallowing. Movement with tongue protrusion may be a helpful differentiating finding. If all investigations fail to determine which is which, the surgical guidelines follow thyroglossal duct cyst excision. Although it may seem excessive, a Sistrunk procedure is recommended as the safest way to excise the cyst.3 At operation, dermoid cysts are usually yellow-orange, firm, disc-like masses that look much different than the typical thyroglossal duct cyst, but if infected or for other reasons not easily identified, they are removed in continuity with the hyoid bone.

Submental lymph nodes typically occur in groups and may be associated with an intercurrent illness. The nodes are

Table 1. Classification of Pediatric Neck Masses

<table>
<thead>
<tr>
<th>Midline</th>
<th>Lateral</th>
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<tbody>
<tr>
<td>Thyroglossal duct anomaly</td>
<td>Branchial cleft anomaly</td>
</tr>
<tr>
<td>Submental lymphadenopathy</td>
<td>Lymphatic/cleft malformation</td>
</tr>
<tr>
<td>Dermoid and epidermoid cysts</td>
<td>Lymphadenopathy</td>
</tr>
<tr>
<td>Cervical cleft</td>
<td>Thyroid nodule</td>
</tr>
<tr>
<td>Teratoma</td>
<td>Thymic cyst</td>
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<td></td>
<td>Laryngocele</td>
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<td></td>
<td>Benign soft tissue tumors</td>
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<td></td>
<td>Sialadenitis</td>
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located directly beneath the chin and do not move with swallowing. They are smooth, round, rubbery, mobile nodules that have a typical appearance on ultrasound imaging. Submental lymphadenitis comes and goes relatively quickly, making observation an excellent approach when the diagnosis is suspected. Persistent lymphadenopathy may lead to excisional biopsy especially if a chronic infection such as atypical mycobacteria is considered.

Lateral Neck Masses

The lymphatic system is responsible for the vast majority of normal and abnormal lateral neck masses. There is normal but sometimes alarming lymph node prominence in preschoolers whose necks have slimmer down with growth spurts. These nodes are not matted or fixed, but may be quite sizable nearing 2 cm in diameter on average. Cystic hygromas or other lymphoid malformations present during infancy in the lateral neck, most classically in the posterior cervical triangle. Infectious lymphadenopathy in childhood becomes problematic during the toddler years while malignant infiltration with lymphoma occurs later in childhood or adolescence. Metastatic disease with neuroblastoma and soft tissue sarcomas can occur early but there are usually other features that lead to the diagnosis. History and physical examination differentiate most lymphatic conditions, open biopsy is indicated for persistent enlarging, matted, fixed, or chronically infected lesions.

Branchial cleft anomalies, while much less common than lymphadenopathy, occur with about equal frequency to thyroglossal duct lesions and excite the most interest as lateral neck masses. The second branchial cleft is responsible for almost 90% of lesions, arising as a fistula in young children or as a cyst in the older child and adolescent. Parents point out a small punctate opening near the lower one-third of the neck. Other branchial cleft anomalies in the low neck are seen in the sternal notch and at the head of the clavicle. These are usually skin and cartilage remnants with small, short sinus tracts that disappear in the mediastinum without major connection to an epithelial-lined surface.

Confirmation of torticollis includes the discovery near birth of a sternocleidomastoid mass that is associated with ipsilateral plagiocephaly and the classic head position: the face is turned to the contralateral side while the ear and shoulder on the ipsilateral side are preferentially held close together. When these signs are present, the diagnosis is made on physical examination alone. The children are best treated with physical therapy. Occasionally, full resolution of the mass leaves behind a tight tendinous stricture of the muscle belly. When this fails to respond to physical therapy, operative division of the sternocleidomastoid muscle is recommended. The procedure can be safely performed through a short transverse low-neck incision to fully divide the sternocleidomastoid muscle above its sternal and clavicular heads. Excellent results have been obtained with complete division and dissection of the ends combined with postoperative physical therapy.

ANATOMIC CONSIDERATIONS

First and second branchial clefts are responsible for almost all surgically important congenital lesions in the lateral neck. Each cleft is a depression on the outside of the developing head and neck (Fig 1A). The external ectodermally lined cleft is associated with an internal endodermally lined pouch that is a similar depression on the wall of the developing pharynx (Fig 1B). When the membrane between these two indentations dissolves, gills
The first four branchial arches have clinical significance. During development, the second arch predominates (A). Indentations between each arch form clefts on the external surface of the embryo (B) and pharyngeal pouches internally. Incomplete fusion may lead to fistulae or sinus tracts.

are formed. Although this does not happen in the human embryo, tiny perforations may develop in the closing membrane that give rise to the sinuses and fistulae of the branchial anomalies. The location of the internal orifice is directly correlated with the pouch of origin: first branchial anomalies originate from the external auditory canal, second sinuses and fistulas are found at the tonsillar fossa and third openings are through the pyriform sinus (Fig 2). With descent and fusion of the third and fourth pouches, the as yet unreported fourth branchial cleft fistula would also originate from the pyriform fossa.8

Knowledge of the branchial sinus internal opening is important to prevent recurrence. Suture ligation should occur close to these origins. The course of each fistula must be well understood (Fig 2). For example, second and third branchial cleft cysts are found in the lower third of the neck, but their tracts differ in relationship to the carotid artery and thyroid gland. These anatomic rela-
2 Branchial cleft fistula. The uncommon first anomaly originates in the auditory canal, traverses the parotid gland and exits near the mandible. The typical second cleft has an external opening on the lower one-third of the neck near the anterior border of the sternomastoid muscle. The tract bisects the carotid near its origin at the tonsillar fossa. The rare third anomaly opens near the second but traverses between the thyroid and carotid, passing posteriorly to its origin at the pyriform sinus.
tions are important landmarks for surgical excision, high
ligation, and to avoid nerve injury. In particular, the first
branchial cleft anomalies may come close to branches of
the facial nerve requiring full nerve dissection for success-
ful excision. Surgery on the second cleft must avoid the
hypoglossal and glossopharyngeal nerves. Dissection of
third fistulas may injure the vagus or hypoglossal nerves.

The branchial cleft/pouch combinations discussed
above reside between six branchial arches. The first four
arches are of clinical significance (Fig 1B). Each is com-
posed of three embryologic layers that give rise to an
associated nerve (ectoderm), artery, muscle and cartilage
(mesoderm), and glands (endoderm). The first arch
forms the apparatus of the ear while the second is associ-
ated with the styloid process and hyoid bone as well as the
root of the tongue and foramen cecum. The third arch has
no muscle or cartilage but its pouch forms the inferior
parathyroid glands and the pyriform fossa. The ventral
portion is associated with the thymus gland. Similarly, the
fourth arch again has no muscle or cartilage associations,
but the pouch forms the superior parathyroid glands and
a portion of the thymus as well as the ultimobranchial
body. Knowledge of the particular muscle and cartilage
associations is of less importance than the internal open-
ing of the fistulas and sinus tracts. Nevertheless, this in-
formation is of interest to pediatric and endocrine sur-
geons.

Thyroglossal duct anomalies occur when there is in-
complete resolution of thyroid descent. The thyroid gland
begins at the base of the tongue (foramen cecum) as a
diverticulum that descends down the midline of the neck
to its eventual home on the thyroid cartilage. Because the
second branchial arch is busy forming the hyoid bone at
the same time as the thyroid is descending through the
area; the tract may travel in front, behind or actually
through the midpoint of the bone. It was this knowledge
that led Sistrunk to advocate excision of the thyroglossal
duct with the midpoint of the hyoid bone and the soft
tissue on either side. Cysts may be present anywhere
along the tract from the pyramidal lobe of the thyroid,
itself a remnant of descent, to the foramen cecum. Fistulas
occur only after surgical drainage of infected thyroglossal
duct cysts.

Very rarely the thyroid gland itself fails to descend in
the neck, remaining at the foramen cecum. Typically, this
is discovered early after birth because of hypothyroidism
or dysphagia and aspiration. Occasionally euthyroid pa-
tients will have portions of the thyroid gland along the
tract descent. Differentiation of these masses is critical to
avoid surgical excision of functioning thyroid tissue.
Again, ultrasound is very helpful to make this determina-
tion. If there is any question, a thyroid scan completes the
investigation.

Midline dermoid cysts are thought to represent ecto-
dermal inclusions formed during midline fusion of the
embryo. These benign cysts are filled with ectodermal
elements that proliferate and can become infected. Be-
cause they are at the site of fusion, their attachments may
be deep but are always benign. Malignant degeneration
has been described, but the typical indication for opera-
tion is a slowly growing mass that may become infected.
The patient is positioned supine with the neck extended. A shoulder roll is necessary, particularly in smaller children to achieve adequate extension of the neck. The disparity of a large head and a small body must be accounted for in small children.
Before extension of the neck, a transverse skin incision is marked in an appropriate skin crease. An elliptical incision is necessary if there has been previous infection or a fistula that is adherent to the skin.
Dissection continues directly onto the cyst where it is gently freed from surrounding tissue. The cyst may initially be located eccentrically but always narrows down to the midpoint of the hyoid bone. The lateral horns of the hyoid are identified as they fuse in the midline. The lateral musculature is freed just medial to the site of fusion on each site. The midpoint of the hyoid is grasped on either side of the suspected tracts with strong clamps. The bone is excised with Mayo scissors or light bone cutters.
The mass is mobilized inferiorly along the suprathyroid fascia, leaving any suspected tracts with the midpoint of the bone. Once clear inferiorly, the anterior and superior muscles are gradually divided. As the last remnants of muscle are divided, care is taken to suture-ligate all possible accessory tracts leading to the base of the tongue. At this point, the anesthesiologist may help elevate the foramen cecum further into the incision. The tract is then suture-ligated with absorbable suture (inset). The muscles are re-approximated transversely in several layers using interrupted stitches. The bone is not re-sutured. The remainder of the wound is closed in layers with absorbable suture. Generally no drains are placed unless there has been previous infection or a large amount of dissection has created significant dead space.
The external opening of the branchial cleft anomaly is almost always located in the lower third of the neck. It is excised using a transverse elliptical incision in line with a previously marked skin crease. Depending on the age and size of the child, a single incision is sufficient for complete removal of the tract. The younger the child, the better to achieve the most cosmetic and reliable excision. If the child is older and the neck longer, a second incision is planned further up the neck directly over the carotid bifurcation. The site is marked before extension and turning of the head.
A small probe or suture may be advanced through the tract to help with palpation and visualization of the tract. Injection of methylene blue is messy and spillage obscures operative detail. Dissection of the tract begins inferiorly and laterally, gradually mobilizing the fistula from its subcutaneous attachments and the platysma. Once the tract has been well identified, the division continues anteriorly and superiorly. Some tracts appear lined with circular muscle which aids in full visualization and allows for firm traction to take place. Generally with traction and counter-traction, the investments of the tract into the surrounding tissue are well visualized and divided sharply or with electrocautery.
Cephalad retraction on the skin incision may allow for visualization of the carotid bifurcation and subsequent tract ligation. This maneuver is aided by digit pressure from the anesthesiologist on the appropriate tonsillar fossa. If dissection continues directly on the tract, all nerves are avoided. Inflammation or prior infection increases the chance of risk to the hypoglossal nerve that lies anteriorly. Care must be taken during retraction to very carefully elevate the tissues around the nerve to avoid damage. Dissection stays below the posterior belly of digastric as the bifurcation is reached. The base of the tract is suture-ligated with Vicryl. Wound closure is simple with re-approximation of the platysma, subcutaneous tissues and skin using absorbable suture. Drainage is usually not required unless there has been extensive dissection or prior infection.
This condition is not related to first branchial cleft anomalies. The area is often infected with *Staphylococcus aureus* that requires treatment before surgical excision. If resected during a time of active inflammation or infection, recurrence rates are high. An elliptical skin incision or a skin flap are the best approaches for identification of sometimes multiple glands in the subcutaneous tissue over the zygomatic arch. Full visualization and excision of the glands is necessary to prevent recurrence. Although the opening may be small, the incision is sometimes out of proportion to the expected removal. Care must be taken to explain to the family the surgical procedure involved for these small masses.
Patients are positioned as for branchial cleft excision. A short transverse incision is marked in a skin crease before full patient positioning. Dissection continues through subcutaneous tissue to identify the lower third of the sternomastoid muscle just above its sternal and clavicular heads. With gentle dissection, the tendinous tissue is dissected free from the underlying carotid sheath and divided with cautery. The deep cervical fascia is similarly divided to achieve full and complete separation of the muscle. If the incision is placed slightly lower, care must be taken to divide both the sternal and clavicular heads. The cut ends of muscle are left free as the platysma, subcutaneous tissue and skin are closed in layers with absorbable suture. Generally no drains are placed. Physical therapy begins immediately after operation.
EXPECTED OUTCOME

Excellent outcomes can be expected when the surgical principles of complete excision occurs during a time when there is no inflammation or infection. Generally, the younger the patient, the more successful the excision and improved cosmetic results. Perioperative antibiotics are helpful especially when excising fistulas because many of the wounds are contaminated with oral flora or skin organisms. If the incision is placed in a skin crease, the wound heals almost without trace. Recurrence of branchial cleft or thyroglossal duct anomalies results from incomplete excision or inadequate suture ligation of the tract. Recurrence is generally heralded by infection and wound break down. The ensuing drainage is allowed to settle with local wound care, warm soaks and systemic antibiotics as necessary. Generally, at least 6 weeks to 3 months should be allowed to pass before re-excision. A careful evaluation for a third branchial anomaly using direct laryngoscopy may be helpful for recurrences of suspected second clefts. Most thyroglossal duct cysts recur when the midpoint of the hyoid bone has not been excised; however, rare recurrences can be found when small accessory ducts escape detection at the first operation.

CONCLUSIONS

Benign head and neck masses can be classified into midline or lateral. Congenital anomalies require a thorough understanding of the anatomic and embryologic origins for complete excision without recurrence or nerve injury. Previously infected lesions require antibiotics, needle aspiration or drainage before surgical excision. Ample time should be given for the infection to settle down before definitive surgery. In general, excellent results can be achieved for almost all excisions of benign neck masses in children.

REFERENCES