Anatomical Variations of the Facial Nerve in First Branchial Cleft Anomalies

C. Arturo Solares, MD; James Chan, MD; Peter J. Koltai, MD

Objective: To review our experience with branchial cleft anomalies, with special attention to their subtypes and anatomical relationship to the facial nerve.

Study Design: Case series.

Setting: Tertiary care center.

Patients: Ten patients who underwent resection for anomalies of the first branchial cleft, with at least 1 year of follow-up, were included in the study. The data from all cases were collected in a prospective fashion, including immediate postoperative diagrams.

Intervention: Complete resection of the branchial cleft anomaly was performed in all cases. Wide exposure of the facial nerve was achieved using a modified Blair incision and superficial parotidectomy. Facial nerve monitoring was used in every case.

Main Outcome Measures: The primary outcome measurements were facial nerve function and incidence of recurrence after resection of the branchial cleft anomaly.

Results: Ten patients, 6 females and 4 males, with a mean age of 9 years at presentation, were treated by the senior author (P.J.K.) between 1989 and 2001. The lesions were characterized as sinus tracts (n=5), fistulous tracts (n=3), and cysts (n=2). Seven lesions were medial to the facial nerve, 2 were lateral to the facial nerve, and 1 was between branches of the facial nerve. There were no complications related to facial nerve paresis or paralysis, and none of the patients has had a recurrence.

Conclusions: The successful treatment of branchial cleft anomalies requires a complete resection. A safe complete resection requires a full exposure of the facial nerve, as the lesions can be variably associated with the nerve.


Anomalies of the first branchial cleft, although uncommon in clinical practice, are a challenging group of lesions that may be present in both adults and children. These anomalies represent fewer than 10% of all branchial cleft defects. They usually come to the clinician’s attention because of an obvious external sinus tract or because of recurrent infections. They manifest clinically in the periauricular and cervical region that is located in a horizontal plane above the hyoid bone. Successful management requires a thorough understanding of the embryology and interrelationship of the anomaly to the facial nerve.

To accomplish a safe resection, superficial parotidectomy and exposure of the facial nerve are required. D’Souza et al reported that the incidence of temporary facial nerve palsy was 21% in the patients in whom the nerve was identified and 29% in the patients in whom the facial nerve was not identified. The incidence of permanent facial paralysis was 1% in the patients in whom the nerve was identified and 12% in the patients in whom the nerve was not identified. The risk of facial nerve injury increases in patients who have had multiple infections or surgical procedures.

We reviewed the experience of the senior author (P.J.K.) at 2 institutions (The Cleveland Clinic Children’s Hospital, Cleveland, Ohio, and Albany Medical Center Children’s Hospital, Albany, NY), with special attention to the anatomical relationships with the facial nerve. We present detailed diagrams demonstrating the relationship of the anomaly to the facial nerve and emphasize that successful total resection without complications requires exposure of the lesion’s relationships to the facial nerve.
A total of 10 patients underwent surgical procedures for first branchial cleft anomalies at Albany Medical Center Children’s Hospital (n=4) and the Children’s Hospital at The Cleveland Clinic (n=6) that were performed by 1 surgeon (P.J.K). The patient data were collected by the senior author in a prospective fashion, including preoperative computed tomographic scans and immediate postoperative diagrams that were maintained in a surgical diary, which was created to document the type of lesion and to record its anatomical relationships to the facial nerve. The patients were assessed postoperatively for facial nerve function and were routinely followed up for recurrence for at least 1 year.

<table>
<thead>
<tr>
<th>Patient No./Sex/Age, y</th>
<th>Type</th>
<th>Side</th>
<th>Relationship of Lesion to Facial Nerve</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/M/4</td>
<td>Sinus</td>
<td>Right</td>
<td>Deep</td>
</tr>
<tr>
<td>2/F/14</td>
<td>Fistula</td>
<td>Left</td>
<td>Deep</td>
</tr>
<tr>
<td>3/M/3</td>
<td>Sinus</td>
<td>Right</td>
<td>Superficial</td>
</tr>
<tr>
<td>4/F/2</td>
<td>Cyst</td>
<td>Left</td>
<td>In-between</td>
</tr>
<tr>
<td>5/F/9</td>
<td>Sinus</td>
<td>Right</td>
<td>Deep</td>
</tr>
<tr>
<td>6/F/11</td>
<td>Sinus</td>
<td>Left</td>
<td>Superficial</td>
</tr>
<tr>
<td>7/F/2</td>
<td>Fistula</td>
<td>Right</td>
<td>Deep</td>
</tr>
<tr>
<td>8/F/11</td>
<td>Sinus</td>
<td>Right</td>
<td>Deep</td>
</tr>
<tr>
<td>9/M/12</td>
<td>Fistula</td>
<td>Left</td>
<td>Deep</td>
</tr>
<tr>
<td>10/M/23</td>
<td>Cyst</td>
<td>Left</td>
<td>Deep</td>
</tr>
</tbody>
</table>

*All patients were treated by the senior author (P.J.K.) from 1989 to 2001 at 2 different institutions.*

**METHODS**

A total of 10 patients underwent surgical procedures for first branchial cleft anomalies at Albany Medical Center Children’s Hospital (n=4) and the Children’s Hospital at The Cleveland Clinic (n=6) that were performed by 1 surgeon (P.J.K). The patient data were collected by the senior author in a prospective fashion, including preoperative computed tomographic scans and immediate postoperative diagrams that were maintained in a surgical diary, which was created to document the type of lesion and to record its anatomical relationships to the facial nerve. The patients were assessed postoperatively for facial nerve function and were routinely followed up for recurrence for at least 1 year.

**SURGICAL TECHNIQUE**

The patients were prepared, draped, and positioned for a standard parotidectomy using a facial nerve monitor in all cases. Wide exposure was achieved with a modified Blair incision. The lesion was classified according to its type (cyst, fistula, or sinus). A superficial parotidectomy was performed in all cases to expose the facial nerve and its branches and to identify the relationship of the lesion to the facial nerve. The lesions were identified as being medial to the facial nerve, lateral to the facial nerve, or between branches of the facial nerve. Once the facial nerve and its branches had been fully identified, the anomaly was completely resected. Facial nerve function was assessed postoperatively by physical examination.

**RESULTS**

Ten patients with first branchial cleft anomalies were treated between 1989 and 2001 (Table). Six patients were female and 4 were male, with a mean age of 9 years at presentation. All patients underwent preoperative computed tomographic scans to image the anomaly, as well as for surgical guidance. Three lesions were fistulas, 5 were sinuses, and 2 were cysts. Five lesions presented on the left side and 5 on the right side. Seven lesions were medial to the facial nerve, 2 were superficial to the facial nerve, and 1 was between the branches of the facial nerve (Figures 1 through 10). There were no complications related to facial nerve paresis or paralysis. One patient developed a postoperative wound infection that resolved with oral antibiotic therapy. None of our patients has had a recurrence after a minimum of 1 year of follow up.

**COMMENT**

**EMBRYOLOGY**

During embryological development, 5 branchial arches can be identified, all of which traverse mesodermal arches that are separated by grooves or clefts. Each cleft is in contact with a pharyngeal pouch. The first branchial cleft is unique in that it is the only cleft that does not become obliterated completely by the eighth week of gestation and persists as a definitive structure in the embryo, as it penetrates the underlying mesoderm toward the first pharyngeal pouch. The dorsal portion produces the external auditory meatus; the middle portion forms the cavum conchae; and the ventral portion disappears. The membrane at the bottom of
the cleft becomes the outer layer of the tympanic membrane. The ventral portion of the first pharyngeal pouch evolves to form the eustachian tube. The dorsal portion of both the first and the second pharyngeal pouches contributes to form a portion of the middle ear.1,10

First branchial anomalies are an uncommon group of lesions that arise from incomplete closure of the ventral portion of the first branchial cleft.6 These anomalies are closely related to the parotid gland and have variable relations to the facial nerve.1,10 The relationship of a first cleft anomaly to the parotid gland has been demonstrated to be variable, presumably because of the later development of the gland. The fate of the first branchial apparatus is complete by the sixth or seventh week of development, which means that a first branchial anomaly would be formed by this period. The parotid gland, on the other hand, first appears at the sixth week of development. The facial nerve and its muscles migrate upward between the sixth and eighth week of development.1 It can be inferred from the embryological patterns that a first branchial cleft anomaly may be found superficial to, deep to, or within the branches of the facial nerve.1,10

CLASSIFICATION

There have been various attempts to classify first branchial anomalies. In 1971, Arnot11 proposed the first classification of these anomalies. A type 1 lesion was defined as any cyst or sinus in the parotid gland, lined by squamous epithelium, that presented in early adulthood. He proposed that these lesions were secondary to cell rests buried during obliteration of the cleft. A type 2 lesion was defined as a cyst or sinus that developed during childhood in the anterior triangle of the neck, with a communicating tract to the external auditory canal. These lesions, according to Arnot, resulted from incomplete

Figure 3. A 3-year-old boy presented with a sinus opening at the introitus of the external auditory canal. The sinus paralleled the normal external auditory canal and entered the middle ear through a dehiscence in the hypotympanum. The lesion was superficial to the facial nerve.

Figure 4. A 2-year-old girl presented with a left-sided sinus opening anterior to the sternocleidomastoid muscle. Computed tomography demonstrated a concomitant right parotid mass. Surgical exploration revealed a first branchial cleft anomaly, splaying the superior and inferior branches of the facial nerve. The sinus tract in the neck turned out to be a second branchial cleft anomaly that was unrelated to the first branchial cleft.

Figure 5. A 9-year-old girl presented with a sinus opening in the right external auditory canal. The sinus paralleled the normal external auditory canal and terminated deep to the facial nerve.

Figure 6. A 12-year-old girl presented with a left postauricular abscess. She was found to have a sinus opening in the left external auditory canal. Surgical exploration revealed that the abscess was connected to the sinus tract that paralleled the normal external ear canal, crossing superficial to the facial nerve.
obliteration of the cleft. Later, in 1972, Work\textsuperscript{12} proposed another classification. In his classification, a type 1 lesion consists of a duplication of the membranous external auditory canal. These cystic lesions are lined by squamous epithelium and end in a cul-de-sac at the bony plate at the level of the mesotympanum. Type 2 anomalies are duplications of the membranous external auditory canal and pinna. These lesions contain skin and cartilage. In 1980, Olsen et al\textsuperscript{1} proposed a simplified classification that divided the type 2 anomalies into cysts, sinuses, and fistulas. A cyst has no communication with the external ear canal or an external opening in the anterior triangle of the neck; a sinus, on the other hand, is a blindly ending space from an opening in the external ear canal. Finally, a fistula is a patent ductlike structure with openings both in the external ear canal and in the anterior triangle of the neck.\textsuperscript{3}

Despite the available classifications, confusion still exists in correlating these classifications with the anatomy, embryology, and clinical and epidemiological data. In our series, classifying the anomalies as cyst, sinuses, or fistulas proved to be clinically useful.

**RELATIONSHIP OF THE LESION TO THE FACIAL NERVE**

Reports in the literature suggest that the anomaly is superficial to the facial nerve in the majority of cases.\textsuperscript{5,6,13-17} In our series, of the 5 sinuses, 3 were deep to the facial nerve and 2 were superficial. Of the 2 cysts, 1 was deep and 1 was superficial to the inferior division and deep to the superior division of the facial nerve. While the relationship of a branchial cleft anomaly to the facial nerve is variable, especially with cystic or sinus lesions, in our experience all lesions with an external fistula in the neck connecting to an opening in the external ear canal (n = 3) were deep to the facial nerve. Miller et al\textsuperscript{13} reported that most branchial cleft sinuses lie superficial to the facial nerve, while fistulas usually pass deep to the facial nerve.

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**Figure 7.** A 2-year-old girl presented with a fistulous tract that extended from the right external auditory canal down to the anterior border of the sternocleidomastoid muscle. The fistulous tract was deep to the facial nerve and displaced the nerve laterally.

**Figure 8.** An 11-year-old girl presented with a sinus opening in the external auditory canal. She had a postauricular abscess from an infected redundant first branchial cleft sinus. The sinus extended along the normal external auditory canal and terminated deep to the facial nerve.

**Figure 9.** A 12-year-old boy presented with a fistulous tract that extended from the left external auditory canal down to the anterior border of the sternocleidomastoid muscle. The fistulous tract was deep to the facial nerve and displaced the nerve laterally.

**Figure 10.** A 23-year-old man presented with a parotid mass that on surgical exploration was found to be a cystic structure that extended deep to the facial nerve. Histopathologic examination revealed a lesion that was compatible with a first branchial cleft cyst.
As the nerve courses over the fistula tract, it can lie more inferior than usual, rendering it at risk for trauma during surgery.

**SURGICAL MANAGEMENT**

The unpredictable relationship of the anomaly with the facial nerve and the frequency of lesions being deep to the nerve place the patient at risk of facial nerve injury during surgery. Therefore, injury is best avoided by identification of the specific lesion type and by understanding its anatomical relationship to the facial nerve. Preoperative computed tomographic scans are very helpful in outlining the relationship of the lesion to the surrounding structures in the neck and in planning the surgical approach. The computed tomographic scan, however, does not replace careful surgical dissection of the facial nerve. Since the treatment of these anomalies requires a complete resection, and given the risk of facial nerve injury, a wide exposure with complete dissection of the facial nerve is necessary to perform this operation safely. We advocate the use of facial nerve monitoring in all cases, especially for those lesions that have been repeatedly infected.

**CONCLUSIONS**

The treatment of first branchial cleft anomalies requires understanding of the various specific types of lesions (cyst, sinus, or fistula) and their relationship to the facial nerve. Successful surgery mandates complete resection and facial nerve preservation. Both of these goals are best accomplished by initial dissection and exposure of the facial nerve, followed by a safe excision of the anomaly.

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Corresponding author: Peter J. Koltai, MD, Department of Otolaryngology and Communicative Disorders, The Cleveland Clinic Foundation, A71, 9500 Euclid Ave, Cleveland, OH 44195 (e-mail: koltapi@ccf.org).

**REFERENCES**