Auricular Reconstruction for Microtia: Part I. Anatomy, Embryology, and Clinical Evaluation

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Learning Objectives: After studying this article, the participant should be able to: (1) Understand external ear anatomy and embryology. (2) Develop an approach to evaluation of microtia, including otologic considerations.

In the first of a two-part series, we review issues pertinent to the anatomy, embryology, and criteria for comprehensive management of children with microtia. The salient aspects of external ear anatomy, including the nerve and blood supply, lymphatic drainage, and aesthetic anatomic relationships, are described. An overview of the embryologic development of the external and middle ear and its relationship to auricular deformities is presented. The clinical spectrum of microtia and its classification are discussed. The appropriate initial evaluation of these patients and the rationale and criteria for middle ear surgery are reviewed. Options for treatment, optimal timing, and coordination of the otologic and plastic surgical management of these children are discussed. The surgical techniques for external ear reconstruction, including autologous and prosthetic methods, both historic and contemporary, are briefly discussed.

EXTERNAL EAR ANATOMY

The external ear is composed of three primary components, the helix-antihelical complex, the conchal complex, and the lobule. The three-dimensional relief of the ear is supported by the auricular cartilage, which is composed of highly convoluted elastic cartilage1 (Fig. 1).

Nerve Supply

Sensibility of the normal external ear is derived from several cranial and extracranial branches. Cervical nerves (the great auricular nerve, C2 to C3) and the lesser occipital nerve (C2) innervate the posterior aspect of the auricle and lobule. These nerves have a variable size and distribution, but in the majority of dissections, the lesser occipital nerves have been found to be dominant and innervate the superior ear and the mastoid region, whereas the inferior ear and a portion of the preauricular area are supplied by the great auricular nerve.2 The anterior surface and the tragus are supplied by the trigeminal nerve (auriculotemporal nerve V3). The auricular branch of the vagus nerve (Arnold’s nerve) provides sensibility to the external auditory meatus (Fig. 2).

Vascular Supply

Two separate but intercommunicating arterial networks derived from the external carotid system supply the auricle.3 One network supplies the triangular fossa-scapha, and the other supplies the concha. The triangular fossa-scapha network is derived from one subbranch of the upper auricular branch of the superficial temporal artery and from branches of the posterior auricular artery, which come through the earlobe and triangular fossa and over the helical rim. The conchal network is derived from perforators (usually two to four vessels) of the posterior auricular artery. The superficial temporal artery also sends several small auricular branches to supply the anterior surface of the ear. The rich communications between the superficial temporal and postauricular arterial
systems allow for either system to support the ear. Venous drainage flows through the posterior auricular veins into the external jugular, the superficial temporal, and the retromandibular veins (Fig. 3).

Lymphatic Drainage

The lymphatic drainage patterns of the external ear are generally felt to reflect embryologic development. As such, it has traditionally been considered that the concha and meatus drain into the parotid and infracavicular lymph nodes, whereas the external auditory canal and superior auricle drain into the mastoid and superior cervical lymph nodes. Recent use of sentinel lymph node biopsy and lymphoscintigraphy in melanoma and other neoplastic disorders, however, has demonstrated lymphatic drainage patterns in the head and neck that are more unpredictable and less discrete than those described classically.

Muscles

The anterior, superior, and posterior auricularis muscles constitute the extrinsic musculature of the external ear. The intrinsic musculature is largely vestigial and includes the helicis major and minor, the tragalicus, the antitragicus, and the transverse and oblique muscles (Fig. 4).

Anatomic Relationships

The relationships, dimensions, and proportions of the external ear have been thoroughly reviewed by Tolleth (Fig. 5). Ear width is approximately 55 percent of length. The long axis of the ear is tilted posteriorly from the vertical axis of the face at an angle ranging from 2 to 30 degrees. The axis of the ear and the nasal bridge, although similar, are not identical: the angle between them approximates 15 degrees, with the ear more vertical. The helicirum protrudes 1 to 2 cm from the skull, with the projection increasing from superior to inferior. In a normal ear, the rim is positioned 10 to 12 mm from the mastoid at the superior helix, 16 to 18 mm from the mastoid at midaur, and 20 to 22 mm from the mastoid in the lower third. Although these measurements are most commonly used as a reference in setback otoplasty to avoid the classic “telephone” deformity, they must also be carefully assessed and reproduced for an anatomically correct ear reconstruction in patients with microtia.

Embryology

Both the first (mandibular) and second (hyoid) branchial arches contribute to auricular

![Fig. 1.](left) External ear anatomy. CH, crus helicis; H, helix; T, tragus; AT, antitragus; L, lobule; A, antihelix; TF, triangular fossa; SC, superior crus; C, cavum conchae; CY, cymba conchae; TA, tuberculum auriculae. (Center) Ear elastic cartilage anatomy, anterior surface. LT, lamina tragi; CU, cauda helicis. (Right) Ear elastic cartilage anatomy, posterior surface. TS, transverse sulcus; P, ponticulus.)
development. The pinna begins developing between the third to sixth weeks of embryonic life, when hillocks appear on the arches, and is fully formed by the fourth month. The anterior three hillocks, derived from the first arch, form the basis of the tragus, the helical root, and the superior helix. The second arch contributes the posterior hillocks, which develop into the antihelix, antitragus, and lobule. The pinna develops around the external meatus, which begins to canalize at week 28 (Fig. 6). The cavity of the middle ear begins to form in the first pharyngeal arch at 4 weeks. The middle ear cleft is present at 8 weeks, and the cavity is fully formed at 30 weeks. The mastoid cells develop after birth. The malleus and incus arise from the first arch cartilage by 8 weeks of age, and begin to ossify at 4 months. Concurrently, the stapes forms and ossifies from the second arch cartilage (with the exception of the medial lamina of the footplate, which is derived from the otic capsule).³

Microtia occurs as a broad range of deformities, involving to variable degrees the first and second branchial arches. Failure of development or adverse events that occur early, during the sixth through eighth weeks of gestation, are felt to lead to the clinical spectrum of microtia. Later gestational insults most often result in less profound expressions of ear deformity. The auricular deformities may be accompanied by facial nerve abnormalities, middle ear maldevelopment, mandibular hypoplasia, and lip and palatal clefts. The most common clinical presentation of microtia (approximately 60 to 70 percent) is that of an isolated deformity.¹⁰ Despite absence of other readily identifiable clinical manifestations, however, radiographic examination will often demonstrate pathologic disease in the mandible (most notable in the condyle), temporal bone, and vertebra of these patients. Isolated microtia is felt to represent the mildest form of hemifacial microsomia.¹¹⁻¹⁴

Fig. 3. (Left) Arterial supply of the anterior auricular surface. The superficial temporal artery (STA) has upper, middle, and lower terminal branches, the most superior of which provides an anastomotic network to the anterior auricular surface with branches of the posterior auricular artery that penetrate anteriorly in the region of the triangular fossa (●), concha (●), helical margin, and lobule (○). (Center) Arterial networks of the anterior auricular surface. The superficial temporal and posterior auricular arteries contribute to the triangular fossa-scaphe network (vertical slashes) and the conchal network (horizontal slashes). (Right) Arterial supply of the posterior auricular surface. Branches of the posterior auricular artery (PA) penetrate the cartilage at the triangular fossa (●), cymba conchae, helical root (●), cavum conchae (●), and lobule (○) to anastomose with branches of the superficial temporal artery. (Adapted from Park, C., Lineaweaver, W. C., Rymly, T. O., et al. Arterial supply of the anterior ear. Plast. Reconstr. Surg. 90: 38, 1992. Used with permission.)

Fig. 4. The auricular muscles. Three extrinsic muscles: anterior (A), superior (S), and posterior (P); and six intrinsic muscles: helical muscles, large (HL) and small (HS), muscle of the tragus (T), muscle of the antitragus (AT), transverse muscle (TM), oblique muscle (O).

Types of Microtia
A number of classification systems for microtia have been proposed. Microtic auricular deformities are usually classified according to the vestigial structures present.¹³,¹⁵⁻¹⁹ Nagata has proposed a concise categorization of this disorder, directly pertinent to the surgical correction of each deformity. This system defines lobule-type, concha-type, and small concha-type microtia²⁰⁻²⁴ (Fig. 7). Anotia, the most severe form of microtia, represents the complete absence of the external ear. Those microtic ears with a remnant ear and lobule without the concha, acoustic meatus, and tragus are categorized as lobule-type microtia. In concha-type microtia, the lobule, concha, acoustic meatus, tragus, and incisura tragica are present to variable degrees. Classically, the features of small concha-type microtia include the remnant ear and lobule with only a small indentation representing the concha. As certain microtia variants exist with a well-developed external ear save for hypoplasia of the middle third,
small concha-type microtic ears are probably best characterized by the presence of a small concha.

**EPIDEMIOLOGY**

The cause of microtia is felt to be heterogeneous, including genetic aberrations, teratogens, and vascular abnormalities. Excluding known chromosomal anomalies, large multinational registries of congenital malformations suggest the prevalence of microtia to be from 0.76 to 2.35 per 10,000 births. It is generally held that there is a lower incidence of microtia among whites (and probably blacks) than in Hispanics and Asians. The proportion of anotia and microtia also varies between races, with the lowest proportion of anotia seen in whites. In unilateral cases, the right side appears to be more frequently affected than the left side, especially when the ear malformation occurs as an isolated deformity. There is a male excess, again most pronounced in isolated forms of microtia. Anotia and microtia are associated with other congenital malformations, to a comparable degree. Among associated malformations, facial clefts and cardiac defects are the most common (about 30 percent of these infants are so affected), followed by anophthalmia or microphthalmia (14 percent), limb reduction defects or severe renal malformations (11 percent), and holoprosencephaly (7 percent). A maternal parity effect is also seen, with an increased risk at four or more pregnancies. This is more pronounced for anotia than for microtia. Microtia has long been felt to represent one end of the spectrum of hemifacial microsomia. Although debates in the literature continue, mounting evidence points to the commonality of not only “isolated microtia” and hemifacial microsomia but also oculoauriculo-vertebral dysplasia and Goldenhar syndrome, as variants of the same condition, each exhibiting variable degrees of auricular malformation.

**DIAGNOSTIC STUDIES AND EVALUATION IN MICROTONIA**

Initial assessment of patients with microtia should include a thorough physical examination: evaluation of facial and ear structure, symmetry, and animation, and dental occlusal relationships. A family history and subsequent genetic study/counseling will address any syndromic issues. A complete audiologic evaluation and radiographic study of the temporal bones is critical in all patients with microtia. Classically, it has been held that a small external auditory canal is associated with a mixed hearing loss, whereas an atretic canal has been linked primarily to a conductive hearing loss. In addition, the presence of a tragus in a microtic ear has been considered an indication of a functional middle ear. A normal middle ear is rarely found in conjunction with microtia, but the status of the middle ear is not directly related to the external deformity. Although the severity of the external deformity appears to correlate with the severity of the temporal bone abnormalities, no such association between the severity of the dysmorphic features and the degree of hearing loss has been noted. It is therefore important to conduct a
complete radiographic and audiologic evaluation for every child with microtia, regardless of clinical presentation. It must be remembered that the middle ear is formed later embryologically than is the external ear. Thus, although patients with relatively minor unilateral deformities often hear and speak well, attempts to correlate function with the presence or absence of certain anatomic remnants of the hypoplastic external ear remain unreliable.

Sensorineural, conductive, and mixed (sensorineural and conductive) hearing loss may be present in the microtic ear. The predominant hearing deficit in microtia/aural atresia is conductive hearing loss (80 to 90 percent). However, sensorineural hearing loss has been found to account for 10 to 15 percent of the hearing loss in these children and should not be overlooked. To evaluate these patients, and before any ear surgery, audiometric studies, including an auditory brainstem response, are performed to determine the degree of sensorineural and conductive hearing losses. In the case of an associated atretic external auditory canal, the status of the middle ear and the need to rule out a cholesteatoma are of great concern. The middle ear deformity may range from minor ossicular chain disruption (the stapes is usually normal) to complete loss of the tympanic cavity. A high-resolution computed tomographic scan of the temporal bone will best evaluate the status of the ossicles and middle ear cleft, providing critical anatomic information for any proposed otologic surgery. Nuclear magnetic resonance imaging may also be helpful in defining the course of the facial nerve, which is often displaced in middle ear malformations.
CONSIDERATIONS FOR OTOLOGIC SURGERY

It is well accepted, and intuitively obvious, that binaural hearing affords improved sound localization and speech perception. Tradition has held that middle ear reconstruction is not indicated for unilateral microtia with normal hearing in the contralateral ear. This is based on the observation that patients with microtia often fail to achieve true binaural hearing following middle ear surgery because they continue to rely almost exclusively on the normal ear. This approach is also supported by experimental observations suggesting that the auditory neural structures critical for binaural processing develop only if binaural hearing is undisturbed early in life. As such, the classic treatment of children with unilateral microtia has focused primarily on the preservation of the normal ear, with amplification of the affected one. Conversely, more recent studies have demonstrated that children with unilateral hearing loss from any cause are at risk for delayed language development, attention deficit, and poor school performance. In addition, the plasticity in the developing auditory system may be greater than originally suggested, as a number of patients may exhibit binaural processing, albeit subnormal, even after long-term deprivation. These considerations have led to an increased interest in middle ear exploration in an attempt to improve hearing in children with congenital auricular deformities.

Middle ear surgery, in experienced hands, results in some hearing improvement in approximately 70 percent of cases. These interventions, although encouraging, entail certain risks, such as injury to the facial nerve and a decrease in sensorineural hearing levels. This potential morbidity suggests that middle ear surgery should be undertaken only when a final air-bone gap of 30 dB or better may be expected. Many authorities argue that because of the modest hearing obtained with surgical intervention, the risks do not warrant surgical intervention. In addition, some degradation of hearing may occur postoperatively, usually as a result of stenosis of the new external auditory canal. In approximately one-third of these patients, surgical revision will be required. Although long-term studies are scarce, in suitable candidates it appears that a speech reception threshold of 30 dB can be achieved in greater than two-thirds of patients. The risk of facial nerve injury in experienced hands approximates that of cholesteatoma surgery and the risk of sensorineural hearing loss is comparable to that reported for stapedectomy, suggesting a favorable risk/benefit ratio for middle ear exploration in selected patients.

The current approach to middle ear surgery involves careful evaluation of the status of the ossicles, mastoid, and facial nerve with specific selection criteria to establish those patients who will be appropriate candidates for surgical exploration. A rating system suggested by Aguilar and Jahrsdoerfer assigns a cumulative point scale to identify those patients who will benefit from middle ear surgery. In this system, one point is given for the presence of each of the following: an open oval window, an adequate middle ear space, a normal facial nerve course, a malleus-incus complex, adequate mastoid pneumatization, an incus-stapes connection, good external ear appearance, and canal stenosis with a malleus bar. Two points are given for presence of the stapes. A score of 8 or more suggests a good surgical candidate, with an anticipated success rate of approximately 60 percent. A score of 5 or less contraindicates surgery, as does a predominately sensorineural hearing loss, complete lack of pneumatization of the mastoid, or obstruction of the mandibular condyle and/or glenoid fossa.

In bilateral microtia, early and conscientious use of bone-conductive hearing aids is imperative for social hearing and speech development. Traditional dictates have held that if adequate auditory acuity is not achieved with the use of hearing aids by approximately 1 year of age, middle ear exploration on the most favorable side should be performed. However, as previously noted, not all patients are favorable candidates for surgery. This is especially true in bilateral deformities, which are often more severe, and carry higher risks for surgical intervention. If otologic surgery is deemed appropriate, the anticipated success rate approximates only 50 percent in bilateral cases. The hearing deficits in many of these children are either not treated surgically or the surgical intervention is delayed until later in childhood.

Most of the hearing deficits in children with bilateral microtia are managed primarily with hearing aids. There have been a number of advances in conductive hearing devices, but a
The major limitation of hearing aids has been their fixation to the mastoid. Bone aids have been traditionally applied transcutaneously to intact skin. The aids are applied with adhesives, headbands, or spectacles, which pose numerous problems for young children. The small size of the nose and lack of an external ear provides little support for spectacles, and adhesives are difficult to use and may lead to dermatitis or local skin reactions. During the 1980s, bone-anchored hearing aids secured with an osseointegrated implant were developed. The implant is usually composed of a ceramic with a titanium and/or gold core that is compatible with magnetic resonance imaging. These implants were initially used in adults with discharging ears, but have been studied in children with congenital deformities 2 years of age and older. The bone-anchored hearing aid has demonstrated marked improvement over conventional aids in hearing threshold levels, as well as in aiding previously refractory ears, likely because of its improved anchorage to the mastoid. These implants are well tolerated in children with congenital deformities, with minimal adverse effects, and the success of these implants has obviated the need for middle ear exploration in certain cases. These aids have a functioning and retention rate of over 95 percent on long-term follow-up, with a soft-tissue reaction rate of about 30 percent (these infections rarely lead to implant removal). The location for securing a conductive hearing aid must be carefully considered in the planning of auricular reconstruction to ensure good coaptation and hearing, and avoidance of surgical incision sites. Unfortunately, a purely implantable bone conduction aid, which might obviate a number of these issues, has remained largely in the experimental realm, and is not yet a central part of the clinical strategy.

If middle ear reconstruction is deemed appropriate, it must be carefully coordinated with the auricular reconstruction, taking into account canal position, the vascular axis of the flaps, and location of the incisions used in external ear reconstruction. This may require an additional stage in the auricular reconstruction. Flexibility on the part of both the otologist and the plastic surgeon is necessary. Brent, in his extensive experience, prefers to delay the middle ear surgery until the auricular reconstruction is completed, and this has been the standard approach to management in most patients. Others have proposed integrated protocols in which the atresia repair and the auricular reconstruction are divided into stages, beginning with initial placement of the cartilage framework, followed by the atresia repair in a three- to five-stage procedure. Both approaches appear to work well. However, for either technique to be successful, a joint management plan customized to meet the reconstructive goals of each individual patient is crucial.

**History of Auricular Reconstruction**

Early attempts at external ear reconstruction were rather crude and were primarily directed toward the reconstruction of partial losses resulting from trauma. Because of the paucity of knowledge on grafting and flap physiology, and the lack of anesthesia, one can easily surmise that these attempts were fraught with high complication rates and less-than-ideal results. Nevertheless, as experience with moving and shaping tissue was gained, legitimate inroads were made. In 1597, Tagliacozzi applied his now classic pedicled arm flap technique in the reconstruction of a monk’s ear, and in the mid 1800s Dieffenbach used a folded mastoid flap to repair a traumatic ear defect.

Until the mid-twentieth century, total ear reconstruction for microtia remained an elusive goal and was deemed impossible by most surgeons. The experimental and clinical use of autogenous costal cartilage reported by Pierce and others in the early 1930s ushered in a new era in reconstruction that could be uniquely applied to ear reconstruction. Most ear reconstructive techniques have been derived from the formula that uses a framework placed beneath the skin to create an ear form. Numerous materials have been used to fabricate the ear framework, but autologous cartilage has long been considered the standard material. Modern auricular reconstruction has been credited to Tanzer, who thoroughly detailed the principles, techniques, and critical evaluation of total ear reconstruction using carved autologous costal cartilage. Borrowing from these principles, Brent, Nagata, and others have refined the technique of ear reconstruction to an art form. A history of ear reconstruction through the mid-twentieth century is nicely chronicled by Converse.

**Timing of Auricular Reconstruction**

The primary factors considered in determining the most appropriate timing for auricular reconstruction are divided into stages, beginning with initial placement of the cartilage framework, followed by the atresia repair in a three- to five-stage procedure. Both approaches appear to work well. However, for either technique to be successful, a joint management plan customized to meet the reconstructive goals of each individual patient is crucial.
reconstruction include the age of external ear maturity, the availability of adequate donor-site rib cartilage, and the school age and risk of peer derision.\textsuperscript{61} Although ear width will continue to increase until age 10, it has been established that 85 percent of ear development is attained by 3 years of age.\textsuperscript{63,64} Rib cartilage is rarely of sufficient size until the age of 5 to 6 years, which coincides with the beginning of school. In addition, the autologous cartilage construct will usually grow at a rate comparable to the normal ear, and sometimes to a size slightly larger that the native ear. The cartilage framework is thus carved to match the dimensions of the opposite normal ear or, in very young patients, it is made slightly larger.\textsuperscript{26,62,65} Brent noted that with a minimum 5-year follow-up, 48 percent of the reconstructed ears grew at the same rate, 41.6 percent grew several millimeters larger, and 10.3 percent lagged several millimeters behind the native ear.\textsuperscript{66} Weighing all these factors, Brent and many others have recommend performing ear reconstruction between the ages of 4 and 6 years, during preschool, to complete the reconstruction before the child enters first grade. However, some surgeons, especially those using the Nagata technique, may delay the surgery until a later age. The recommended age of surgery in Japan is 10 years; a chest circumference (at the level of the xiphoid) of at least 60 cm is also an acceptable criterion. This may relate to the relatively large volume of cartilage needed for reconstruction as required by the Nagata technique.\textsuperscript{20–24,67}

**CHOICE OF AURICULAR FRAMEWORK**

There has been continued debate over the use of autologous versus nonautologous auricular frameworks. Proponents of each of the different framework materials cite legitimate reasons for their specific material preferences. These include the number of operative procedures and donor-site morbidity (more with autologous cartilage constructs), erosion or migration of the implant, and infectious complications or exposure of the implant (more with alloplastic constructs).

Autologous costal cartilage is the most commonly used and preferred material for ear reconstruction. It has a demonstrated track record for durability and stability over time but is not without shortcomings. Harvest of the costal cartilage results in a visible anterior chest-wall deformity in most patients, and although local application of Marcaine into the harvest site may ameliorate it somewhat, considerable pain and discomfort is present in the initial postoperative period. The cartilage framework is usually harvested from the synchondrosis of the sixth, seventh, and eighth ribs. Preservation of perichondrium on the surface of the cartilage may help with construct adherence to the recipient site and promote graft viability. The entire perichondrial sleeve has been elevated with the costal cartilage graft, but because of problems of significant chest-wall depression and deformity, most authors prefer to leave at least some remnant of the perichondrium in situ to support cartilage regeneration at the harvest site. To satisfy the needs of both the construct and the chest-wall donor site, the superficial perichondrium is usually harvested with the graft, leaving the posterior perichondrium at the donor site.\textsuperscript{2,61,62,68,69} Most authors advocate harvest of the contralateral cartilage. Fukuda and Yamada prefer harvesting the ipsilateral cartilage, placing the superficial perichondrium side down to enhance contact with the mastoid surface and construct stability.\textsuperscript{70}

Cronin and later Ohmori et al. described use of the Silastic framework for auricular reconstruction.\textsuperscript{71–75} The initial aesthetic results were often excellent, and donor-site deformity was a nonissue. Long-term follow-up, however, demonstrated spontaneous exposure of the implant with failure of the reconstruction in many cases. In addition, minor abrasions or trauma also resulted in exposure and failure. The complications entailed in this technique have prompted Cronin and Brauer to abandon the use of silicone implants for ear reconstruction.

The use of porous polyethylene has been recently advocated by Reinisch.\textsuperscript{76} A total of 116 patients over an 8-year period demonstrated an initial high complication rate. With technique modification, however, good short-term (2 years) results were reported. The inertness and porous quality of porous polyethylene provide better tissue anchorage, a major advantage over smooth Silastic implants. The performance of these constructs over time has not been established, and this technique remains to be proved safe and reliable.

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Self-Assessment Examination follows on the next page.
Auricular Reconstruction for Microtia: Part I
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1. Sensibility to the external auditory canal is provided by which of the following nerves?
   A) Lesser occipital nerve
   B) Maxillary division of trigeminal nerve
   C) Auriculotemporal nerve
   D) Auricular branch of vagus nerve
   E) Greater auricular nerve

2. The conchal vascular network is derived primarily from which of the following sources?
   A) Subbranch of the upper auricular branch of the superficial temporal artery
   B) Occipital artery
   C) Perforating branches of the postauricular artery
   D) Direct branches of the superficial temporal artery
   E) Mastoid artery

3. The concha and meatus portions of the external ear preferentially drain to which of the following lymph nodes?
   A) Parotid and infraclavicular lymph nodes
   B) Superior cervical lymph nodes
   C) Postauricular lymph nodes
   D) Posterior cervical lymph nodes
   E) Submandibular lymph nodes

4. The tragus is derived from which of the following embryonic precursors?
   A) The hyoid arch
   B) The first branchial arch
   C) The second branchial arch
   D) The first branchial cleft
   E) The posterior hillocks

5. Which of the following statements about microtia is true?
   A) The incidence of microtia varies from 5.20 to 10.55 per 10,000 births.
   B) Anotia and microtia are rarely associated with other congenital malformations.
   C) There is a female preponderance for microtia.
   D) In unilateral microtia, the right side predominates.
   E) Limb reduction defects are the most common associated malformations.

6. The presence of which one of the following external ear parts is associated with a functional middle ear?
   A) Lobule
   B) Helix
   C) Concha
   D) Tragus
   E) Antitragus
7. AT WHAT AGE WILL THE EXTERNAL EAR ATTAIN 85 PERCENT OF ITS ADULT SIZE?
   A) 2 years
   B) 3 years
   C) 5 years
   D) 8 years
   E) 10 years

8. WHICH OF THE FOLLOWING REPRESENTS THE MAJOR SHORTCOMING OF THE SILASTIC FRAMEWORK
   FOR AURICULAR RECONSTRUCTION?
   A) Migration of the implant
   B) Poor definition
   C) Cost
   D) Exposure
   E) Temporal arteritis

To complete the examination for CME credit, turn to page 2626 for instructions and the response form.