

Ear Deformations can be on One or Both Ears

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Abstract

Cosmetic ear surgery is a treatment that effectively, safely, and swiftly addresses issues related to protruding ears or deformities in the external ear structure. Ears that exhibit asymmetry with the face or have an irregular shape can lead to dissatisfaction with one's appearance, even if the ears function properly. The procedure for ear correction is straightforward and enables individuals to resume their normal activities quickly, leading to improved satisfaction with their appearance right away. Otoplasty, or ear surgery, is conducted on the outer ear of those who have ears that appear irregular or disproportionate in size. Ear deformities can affect one or both ears and may result from congenital factors or unfortunate incidents. Those eligible for ear correction include anyone who is unhappy with the look or size of the outer ears.

Introduction

The ears serve as the principal organs for hearing [1]. Each ear consists of three main anatomical sections: the outer ear, the middle ear, and the inner ear.

The outer ear is made up of the cartilaginous structure called the auricle or pinna and the external auditory canal. The auricle is located on the outer side of the head and is formed from elastic cartilage that is covered with skin. Its primary function is to gather sound waves and channel them towards the eardrum, which is found on the inside of the auditory canal. The auditory canal extends from the auricle and is shaped like an S, running through the temporal bone of the skull. This canal terminates at the tympanic membrane, which separates it from the middle ear.

The middle ear is mostly composed of the air-filled tympanic cavity. This cavity is bordered laterally by the tympanic membrane and medially by the partially fenestrated petrous bone. The openings in the petrous bone are classified as the oval window and the round window. The oval window acts as a boundary between the middle ear and the semicircular canals. The three ossicles of the middle ear—malleus, incus, and stapes—connect the tympanic membrane to the semicircular canals. These ossicles play a crucial role in sound transmission.

The inner ear includes the bony labyrinth and the membranous labyrinth. The membranous labyrinth, which contains endolymph, is surrounded by the bony structure that forms the chambers of the osseous labyrinth. There are three main components of the inner ear: the vestibule, the semicircular canals that are responsible for balance, and the cochlea, which is the main organ for hearing. The inner ear connects to cranial nerve VIII, which conveys signals from the cochlea, vestibule, and semicircular canals to the auditory centers located within the temporal lobes of the brain.

Microscope

Otologic surgery requires meticulous dissection of tiny structures to eliminate disease, maintain anatomical integrity, and restore functionality [2]. For this to be executed safely and effectively, it is essential to utilize high levels of magnification and suitable lighting. Historically, binocular microscopy has served as the foundational instrument in otologic procedures. The middle ear region is intricate and holds numerous concealed spaces in various directions. Visualizing these areas can be difficult due to the fundamental constraints of the microscope, as its optics are positioned at a distance from the tissues being examined. Consequently, the view is restricted by the narrowest section of the ear canal, and achieving a broader perspective often necessitates invasive actions, such as the removal of soft tissue and bone. The endoscope is particularly advantageous for navigating small surgical passages to reach the middle ear's concealed areas by bypassing the constricted ear canal, positioning the optics mere centimeters from the targeted tissue, thereby negating the need for destructive visualization tactics. Furthermore, the microscope poses issues regarding the comfort and ergonomics of the surgeon, as it often requires extensive neck bending. The educational experience for trainees is also limited because the operator enjoys a three-dimensional perspective, while the observer only receives a two-dimensional view through the teaching head. This difference in visual perspective leads to a frustrating scenario for both teaching and learning. The digital extracorporeal scope, known as the exoscope, serves alongside the endoscope and was developed to take the place of the operating microscope. In comparison to the microscope, it delivers a more immersive surgical perspective with better ergonomic design and enhances the educational experience, allowing all involved parties to share the same high-definition three-dimensional view while maintaining a more comfortable neutral neck position.

Endoscope

Despite facing skepticism over the years, the endoscope has emerged as a vital surgical instrument for minimally invasive procedures, granting access to concealed areas for visualization, removal, or treatment of diseases without unnecessarily disturbing surrounding soft tissue or bone [2]. Numerous surgical disciplines within otolaryngology have incorporated the endoscope as a critical element in their toolkit, such as rhinology and laryngology. The field of otology is currently experiencing a similar transformation, expanding the endoscope's role from merely observational to actively operative.

While binocular microscopy has long been the primary tool utilized in ear surgery, the endoscope has recently received considerable recognition and has been increasingly adopted. Otoendoscopy refers to the application of rigid endoscopes for the examination of the ear. Initially, endoscopes in otology were used exclusively to depict the anatomy of the ear. Beyond the surgical setting, endoscopes can assist in inspecting the outer and middle ear as well as in cleaning intricate mastoid cavities. Endoscopic ear surgery involves performing otologic procedures with rigid endoscopes. The binocular microscope delivers an excellent three-dimensional perspective for surgeries requiring direct line-of-sight; however, it offers a considerably restricted view of the various spaces and recesses within the middle ear, making transcanal procedures particularly challenging, especially in cases where the external ear canal is small or curved, as is common in pediatric patients. Additionally, the binocular microscopic view through the transcanal is constrained by the dimensions of the speculum in use. As a result, a bone removal procedure, such as mastoidectomy, becomes necessary to visualize and access intricate middle ear conditions when using binocular microscopy.

An endoscope serves as a tool for conducting transcanal ear surgeries, offering better visualization and access that surpass the capabilities of the binocular microscope, which has a restricted line-of-sight. In comparison to surgeries performed with a microscope and speculum that rely on line-of-sight, the endoscope employs a fisheye lens positioned very close to the anatomical regions of interest, presenting a wide-angle perspective and delivering a high-definition view of anatomical details that might not be discerned even with top-tier binocular microscopes. By facilitating improved transcanal surgical access, it is possible to forgo a postauricular incision when dealing with complex disease localized to the middle ear. The advantages go beyond simply avoiding an incision, as they can also eliminate the necessity of a mastoidectomy in certain situations, thus preventing disruptions to the natural dynamics of atmospheric gas supply and demand while preserving normal pressure balance in the middle ear. These advantages ultimately lead to reduced patient morbidity, shorter operative durations, and lower surgical expenses.

Exoscope

The extracorporeal video microscope, commonly referred to as an exoscope, is a newly introduced tool in the repertoire of microsurgery intended to substitute the traditional operative microscope [2]. It features a high-definition or 4K video camera equipped with optical or digital zoom and utilizes either a fiberoptic or LED lighting system. This apparatus is positioned above the surgical area using a manually controlled articulating holder or robotic arm, which relays a three-dimensional image to a high-resolution display situated at eye level, opposite the surgeon.

The exoscope presents numerous advantages when compared to the binocular microscope, including an expansive field of view; a longer focal length that provides sufficient workspace; enhanced manageability and maneuverability, allowing easy adjustments to the surgical angle; the capacity to share the surgeon's perspective with all members in the operating room; improved surgical ergonomics and comfort; reduced costs; lesser obstruction of the surgical area; superior for educational purposes; and enhanced image quality, magnification, depth perception, and illumination.

The exoscope has proven effective in procedures such as cochlear implants, mastoidectomies, resections of vestibular schwannomas, temporal lobe encephaloceles, and cholesteatomas.

One drawback of exoscopes is the scarcity of training prospects associated with new and advancing technologies. Nevertheless, as users gain experience, there seem to be no substantial differences in terms of operating durations or complication rates when the exoscope is compared with the microscope. Additional downsides include lower image resolution when using higher magnifications and diminished lighting in narrow surgical pathways, reinforcing the viewpoint that the exoscope works best in conjunction with an endoscope under such conditions.

Otoscope

An otoscope is a device made up of a handle, a light, a magnifying lens, and an optional speculum that can be inserted into the ear [3]. Certain otoscopes include a pneumatic feature that allows air to be blown into the ear canal to check the movement and condition of the eardrum. This tool is utilized to look at the outer ear, ear canal, and tympanic membrane. The purpose of an otoscopic examination is to detect various conditions or infections, clear away wax, or extract foreign objects. When inserting or removing the speculum, an evaluation of the ear canal is necessary. The ear canal should be clear and smooth, without signs of redness, scaling, swelling, discharge, lumps, foreign items, or excessive wax buildup. A thorough internal examination of the eardrum is carried out by a skilled professional. The eardrum is expected to have a slightly conical shape, a shiny and smooth surface, and a pearly gray hue.

Hearing Test

Many different hearing assessments are accessible to healthcare providers, some being more structured (like a hand-held audiometer) than others (such as listening to a whispered word, a ticking watch, finger rubbing, or a tuning fork) [4]. One reliable method that does not necessitate any special equipment is the whispered voice assessment. In this procedure, the clinician softly says a series of three letters or numbers (for instance, [5], B, 6)

while standing approximately two feet behind the patient and requests that the patient repeat the sequence. If the patient correctly identifies them, hearing is deemed normal, and testing is concluded. If any of the items are misidentified, the clinician presents different sets of three letters or numbers once or twice more. If 50% or more of the items in those sets are incorrect, the assessment is considered abnormal.

The clinician remains positioned behind the patient to avoid enabling lip-reading. Testing is performed on one ear at a time, while the other ear is covered by the examiner's finger, which blocks the ear canal while gently rubbing in a continuous circular motion (just occluding without rubbing does not provide sufficient masking). Before whispering, the clinician should softly exhale to ensure the whisper is as quiet as possible.

The medical approach focuses on enhancing the patient's hearing. A significant number of individuals with ear issues experience some level of hearing loss. For any irreversible hearing loss, the option of using a hearing aid should always be taken into consideration. A hearing aid works by amplifying sound or decreasing specific parts of the sound signal while boosting other sounds. There are various designs of hearing aids available. The in-the-ear model is a compact device that fits inside the ear canal, offering discretion and may be favored by some users. The behind-the-ear type is situated behind the ear. The all-in-one eyeglass hearing aid attaches to eyeglasses and is placed behind the ear. An older version includes the body-worn hearing aid, which is worn on the neck or attached to clothing.

Adenomas

Adenomas in the middle ear, specifically referred to as middle ear adenoma, appear to be specific to this location [6]. Over time, these tumors have been identified by several different terms, such as middle ear adenomatous tumor, carcinoid tumor of the middle ear, and neuroendocrine adenoma of the middle ear. The term utilized in this context is the one currently recommended by the World Health Organization. These tumors are quite uncommon, accounting for roughly 18% of middle ear tumors and only 9% of tumors occurring in the middle ear and temporal bone when analyzed together. They are found with equal prevalence among both genders and predominantly arise in adults across a broad age spectrum, with an average age of 45 years. Patients typically exhibit vague symptoms, particularly hearing impairment. There has not been any observed familial link associated with these tumors.

Middle ear adenomas typically appear as benign, unilateral masses within the middle ear, although they have the potential to invade bone. These tumors are generally small, with the average size reported to be under 1 cm. Histologically, they exhibit considerable variability, akin to well-differentiated neuroendocrine tumors or carcinoid tumors found elsewhere in the body. Their structure may be glandular, trabecular, solid, infiltrating, organoid, or consist of individual cells. Often, a single tumor displays multiple growth patterns. Necrosis and ulceration are uncommon occurrences. The neoplastic cells are usually epithelioid, but there are instances where they present as spindle-shaped or plasmacytoid cells. The cell borders are often indistinct, with eosinophilic, frequently granular cytoplasm. Nuclei are typically round or oval, positioned centrally or eccentrically, and have finely granular chromatin. Nucleoli and mitotic figures are generally absent. Occasionally, two distinct cell types may be observed, particularly in tumors with a glandular growth pattern, wherein the luminal cells tend to be flatter while the basal cells are more cuboidal in shape.

Middle ear adenomas are predominantly benign in nature. Recurrences have been noted in as many as 20% of instances and are generally linked to less aggressive initial treatments. Rare instances of metastasis have been reported. No specific histological characteristics or prognostic indicators have been identified that relate to the behavior of these tumors.

Surgical Approach

Surgical (cosmetic surgery) and non-surgical interventions, such as ear molding and splinting, are employed to correct ear deformities, aiming to restore proper hearing function and achieve symmetry of the auricles on both sides [7]. In contrast to surgical methods, non-surgical treatments tend to result in fewer post-procedural complications, are non-invasive and painless, and deliver enhanced outcomes. The optimal timeframe for these interventions is within the first six weeks after birth, making timing a crucial element for non-surgical options. Unfortunately, diagnoses of ear deformity typically occur after this critical period for non-surgical treatment. The potential of convolutional neural networks (CNN) in recognizing intricate patterns from two-dimensional images has been utilized for the automated identification of ear deformities. The findings indicated that deep learning (DL) effectively distinguished between normal and abnormal ear images with a high level of accuracy (94.1%). Additionally, another DL model was developed to assess the results of ear reconstructive surgeries. This model proved to be a strong evaluation tool capable of addressing the issue of low interrater reliability through its objective and dynamic assessment.

There are three primary elements that have notably impacted the continuous development of reconstructive surgery in the head and neck region. Firstly, advancements in microvascular methods and tools have resulted in enhanced results for free tissue transfers, thereby expanding the capabilities of what can be achieved in ablative surgical procedures. There has been a growing focus on the quality of life associated with treatment for head and neck cancers, which has resulted in efforts to reduce donor site complications, enhance the quality of harvested tissue, and improve both aesthetic and functional results. In some areas of the head and neck, free tissue transfer yields outstanding results both functionally and aesthetically, which have been demonstrated to enhance life quality following ablative surgical interventions.

Dental implants have established themselves as the accepted approach for replacing lost teeth. While osseointegration is typically reliable for most individuals, ongoing research and innovations, including changes in implant surface design and fixture characteristics, have consistently elevated the success rates. For the reconstruction of bone structures that support teeth, such as the maxilla or mandible, osseointegrated implants placed within free vascularized bone flaps can offer a reliable method for dental restoration in a population of patients facing significant challenges. Beyond dental restoration, osseointegrated implants also facilitate rehabilitation through facial prostheses. Given the intricate anatomy of the nose, ear, and eye, there is widespread agreement that these facial prosthetics often yield better aesthetic outcomes compared to autogenous reconstruction in certain situations. Prostheses that are retained by implants represent a practical alternative to autogenous reconstruction, achieving excellent symmetry, color matching, and anatomical precision.

Another aspect that has contributed to better results and precision in reconstruction planning is the utilization of three-dimensional data from computed tomography (CT) scans for virtual surgical planning and the creation of rapid prototypes and stereolithographic models. Despite significant advancements in surgical methods, challenges persist in re-establishing facial symmetry and accurately aligning bone or composite tissue structures with their original anteroposterior, vertical, and sagittal orientations. Ideally, these relationships should produce desirable facial proportions and support successful implant-assisted prosthetic rehabilitation. The employment of virtual surgical planning and biomodels derived from CT imaging has undeniably enhanced the evaluation of patients in three dimensions, leading to improved surgical outcomes. Moreover, it has contributed to a reduction in surgical time during operations, resulting in benefits such as decreased flap ischemia duration and lower costs for operating room usage [8].

Conclusion

Surgical procedures on the ear commence with an incision positioned behind the ear, specifically at the junction where the ear meets the head, ensuring that the resulting scar remains concealed and visually acceptable. Subsequently, the outer cartilage structure is reshaped to create a properly formed ear from malformed cartilage and folds. Further, if needed, excess skin and cartilage are excised, and the ears are secured in a natural placement closer to the head.

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