Eur Arch Med Res 2018; 34 (Suppl. 1): S33-S36

Impact of Technological Advancements in Otolaryngology

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Abstract

Otolaryngology mainly deals with the organs that are located inside the body and bony compartments. This makes the diagnosis and treatment complicated to some extent. Inventions and advancements in new devices help doctors to identify and cure the diseases rapidly and effectively. In addition, target-specific therapies prevent nearby structures from the adverse effects of the treatment. The aim of this review was to search the database and to limit our search for the last 10-year period. New devices are emerging daily, and some new inventions might be overlooked. The most commonly used ones or interestingly efficient inventions that relieve the need for surgery are considered. Furthermore, the most commonly used multidisciplinary devices are thought to be beyond the scope of this review. In addition to otological genetic treatments, genetic advancements are not mentioned. For easy reading, topics have been further divided into subsections of otolaryngology as well as chronologically classified. Unfortunately, the database provided no support for the overall use or beneficial studies about those below-mentioned devices.

Keywords: Technology, otolaryngology, device

INTRODUCTION

Scientific developments help in healing the diseases more rapidly, not just because of the evolution of new methods and techniques but also the development and invention of new medical devices. Unfortunately, the invention and demand cycles for new devices are cumbersome; most of these new state-of-the-art pieces may be proven not to be so useful or cost-effective, whereas others are being introduced in an inevitable manner.

The aim of this review was to search various databases and the internet website of the Food and Drug Administration (FDA) for new achievements. However, there were uncountable gadgets, so the search was systematically limited within the last 10-year period and did not include instruments that are shared with other branches.

The genetic investigations are thought to be beyond the scope of this review. In addition, nanotechnological or chemical achievements will be discussed in other studies. The achievements are classified and divided into relevant topics for convenience and easy reading.

Otology

Microtia and aural atresia are congenital malformations of the ear. The results of total reconstructions of the ear with autogenous costal cartilage cannot always be satisfactory due to a lack of the shape and definition of a normal ear. Three-dimensional print technology mimics the unaffected ear to build up a new auricle composed of polylactic acid compatible with the body as an implant (1, 2).

Eustachian tube dysfunction (ETD) is one of the important causes of conductive hearing loss. Since therapeutic methods have been insufficient to treat ETD, a balloon catheter is placed into the cartilage portion of the eustachian tube, and dilation is provided via inflation of the balloon. The results of the Eustachian tube dilation procedure are curable in both clinical and laboratory in the long-term (3, 4).

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Cite this article as:
Gürpınar B, Başkadem Yılmazer A, Uyar Y. Impact of Technological Advancements in Otolaryngology. Eur Arch Med Res 2018; 34 (Suppl. 1): S33-S36.

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Received: 22.09.2018
Accepted: 24.10.2018
DOI: 10.5152/eamr.2018.36855

Cochlear implant (CI), also referred to as "bionic ear," is being used in humans since 1972. Bilateral CI use appears to have benefits on spoken language, comprehension and expression, sound localization, and fever distortion in speech production. If there is any defect in patency and integrity of the cochlea or related neural structures, CI is not feasible, but auditory brainstem implantation (ABI) is another option that is placed directly to the brainstem close to eight nerve nuclei bypassing the cochlea and cochlear nerve. Especially for patients with post-lingual hearing loss, ABI provides good support in combination with lip reading (5-8).

In case of sensorineural hearing loss due to inner ear anomalies, hearing aids, CI, or ABI is mainly supportive. Therefore, biological interventions are needed for the protection, repair, and regeneration of the inner ear. Gene transfer technology (GTT) is currently promising to provide a cure in genetic anomalies of the inner ear. In GTT, the main approaches for gene delivery are systemic, transtympanic, and cochlear. The gene therapy reagents include viral vectors, siRNA, and small particles. Auditory nerve preservation and fiber regeneration, hairy cell (HC) preservation, and HC regeneration have been performed experimentally on animals yet via biologically relevant genes (9).

In addition to the hearing functions of the ear, balancing system defects are also in the scope of improving technology. Bilateral vestibular dysfunction affects the quality of life negatively; recently, vestibular implants are performed in some cases, but not routinely. The device with three leads is placed on the postauricular area. The leads are inserted into the perilymphatic space adjacent to the membranous labyrinth of each semicircular canal (10). To our knowledge, there are few cases in the literature, so the long-term results remain unknown.

Special glasses (SEETROËN®) are invented that help to prevent motion sickness. They have a blue liquid that can flow in front of and around the eyes. The liquid stays horizontal with the ground, regardless of how the vehicle moves, and so provides a sort of stability to the eyes and a reference point for the brain (11).

A new achievement in the field of tympanostomy tube insertion is SOLO TTD®, a small handheld device with the ear tube preloaded at the tip. Ear surgeons have everything they need for ear tube surgery in this one device. It performs the tympanostomy and without holding back the surgeon's hand, inserts the tympanostomy tube itself.

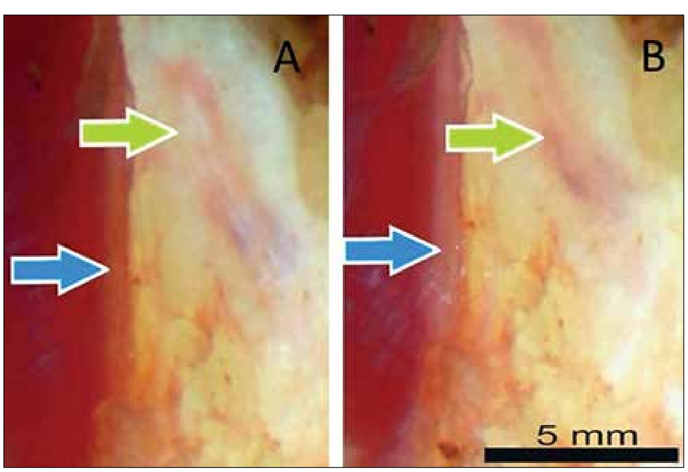

Figure 1. Collimated polarized light imaging helps to spot the nerve tissue. (A) Green arrow shows the nerve, but when polarization is changed, it is not seen in (B). Blue arrow shows the opposite

Rhinology

Chronic sinusitis may often require repeat surgeries; those secondary interventions are more dangerous because of the altered anatomy of the sinuses. Thus, navigation systems are being used and developed. Medtronic® launched its StealthStation ENT surgical navigation system that works by generating an electromagnetic field around the target patients' anatomy during surgery so instrument positioning can be dynamically tracked.

Intersect ENT is a releasing SINUVA® sinus implant for treating nasal polyp disease in adults who underwent previous surgical sinus procedures. The device elutes mometasone furoate for 90 days to reduce inflammation directly at the polyps. Patients receiving SINUVA experienced a statistically significant reduction in bilateral polyp grade ($p=0.007$), corresponding to 74% relative reduction in the extent of ethmoid polyp disease compared with controls (12).

STS Medical® has launched a sinus stent, indicated for the treatment of chronic sinusitis, as part of functional endoscopic sinus surgery to help keep the sinus cavity open post-surgery. It can also be used to address nose job failures, chronic allergic rhinitis, and as an option over sinuplasty. The device is flexible and designed to anchor in place and not move around. It is then left within the lumen for up to 4 weeks, allowing the surrounding tissue to heal. Removal of the device is an in-office procedure that does not require anesthesia.

Spirox® developed an absorbable nasal implant designed to support the nasal cartilage and prevent nasal valve collapse, which can contribute to nasal obstruction. No adverse changes in cosmetic appearance have been reported.

Head and Neck Surgery

A new technology is introduced to spot the nerves within the tissue during surgeries optically (13). The technology uses collimated polarized light imaging, and by rotating the polarization, one can spot the nerve tissue (Figure 1).

SnooZeal® is a new snoring prevention device. It places electrodes above and below the tongue, stimulates the tongue to give it a workout, trains the tongue muscle, and helps to keep it at least partially contracted even at night and keep it from completely relaxing and collapsing during the night (Figure 2) (14).

Inspire Medical Systems® has received FDA approval. Upper airway stimulation is used as an option for patients who are poor candidates for continuous positive airway pressure. The system includes a neurostimulator to which two leads are connected. One runs to the chest in order to continue to sense the person's breathing state, and the other lead is used to stimulate airway muscles to open up the passageway in concert with the lungs. The procedure does not alter the patient's airway anatomy, and the device can be turned on and off and reprogramed as needed.

Another neurostimulator to treat sleep apnea is the aura 6000® system. It includes an implantable neurostimulator with electrode leads going to the hypoglossal nerve that controls the movement of the tongue. Patients can turn the device on and off using a paired remote control, as well as wirelessly recharge it as necessary. It acts like a pacemaker for the tongue, cycling through stimulating different muscles of the organ to open the upper airway during sleep.

Researchers at the Universidad Politécnica de Madrid and Universidad Autónoma de Madrid have designed a tracheostomy device that identifies the trachea, makes an incision for an alternative airway, dilates the new airway, and maintains the airway by electrical and pneumatic means. Researchers aim to someday have the device be as commonplace and easy to use as automatic external defibrillators.

Figure 2. Electrodes stimulate the tongue above and below to train the muscles in order to prevent sleep apnea and snoring

Figure 3. OScan® contains two rows of fluorescent light-emitting diodes that illuminate the mouth and highlight lesions and dark spots

Cook Medical® launched a new set of access products for performing sialoendoscopies or removal of salivary stones and other obstructions within the salivary duct. A soft-tipped wire is used to introduce dilators that expand the duct and allow for placement of a sheath through which extractors can be introduced and manipulated safely to remove salivary stones.

Olympus® has released a new disposable tonsil adenoid debrider by combining monopolar energy with a malleable shaver blade. It allows the surgeon to cut and coagulate with a single device, reducing the need to exchange instruments. In addition, distal suction allows the shaver blade to be used as a suction device for blood and fluid, leading to better visualization of the surgical site.

Researchers from Stanford have developed a new smartphone-based diagnostic device to enable earlier diagnosis of oral lesions. OScan® creates detailed images of the oral cavity and screens the mouths for suspicious oral lesions. It contains two rows of fluorescent light-emitting diodes that illuminate the mouth and highlight lesions and dark spots (Figure 3).

Laryngology

PEG30®, a new type of synthetic polymer that mimics the viscoelastic properties of human vocal cords, was shown to restore vibration to the vocal folds that have become stiff and unable to vibrate due to scarring. It has been shown to be safe in many FDA-approved drugs and medical devices, so researchers are hoping to use the modified polymer as an "injectable device" that is applied directly into the vocal folds every 6 months (15).

Artificial Larynx is on its way; the Palatometer® is capable of reading how one's tongue contacts the palate during speech. To use the device, a person puts the palatometer inside the mouth and mouths words normally. It tries to translate those mouth

Figure 4. Non-invasive anti-reflux device

movements into words before reproducing them on a small sound synthesizer.

EndoGastric Solutions launched the EsophyX® Z+ device designed for use in transoral incisionless fundoplication procedures to reconstruct the gastroesophageal valve to treat patients with severe gastroesophageal reflux disease.

A noninvasive anti-reflux device is introduced by Somna Therapeutics®. This wearable device is placed over the neck only at nighttime and is believed to compensate for the relaxing effect of the upper esophageal sphincter (Figure 4).

CONCLUSION

As of today, technology helps in the diagnosis and treatment of many diseases that were deemed to be "impossible to reach to treat or unable to treat." In addition, the new inventions introduce new diseases that were unknown many years ago.

The state-of-the-art development in the medical field should address the prevention of the diseases. Many researchers are trying to find the cause of the diseases before they erupt. For now, new terms, such as "minimally invasive" or "delicate surgery," are brought into the vocabulary of surgical interventions, just because of new devices. It is a well-known fact that highly advanced technological devices can reach, see, identify, or remove the disease far better than human capabilities. Nevertheless, to our belief, human common sense should be the last decision factor in all of those aforementioned steps.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - B.G.; Design - B.G., Y.U.; Literature Search - A.B.Y.; Writing Manuscript - B.G.; Critical Review - A.B.Y.

Conflict of Interest: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

REFERENCES

1. Zeng W, Lin F, Shi T, Zhang R, Nian Y, Ruan J, et al. Fused deposition modelling of an auricle framework for microtia reconstruction based on CT images.
2 Witek L, Khouri KS, Coelho PG, Flores RL. Patient-specific 3D Models for Autogenous Ear Reconstruction. Plast Reconstr Surg Glob Open 2016; 4: e1093. [CrossRef]
3. Gürtler N, Husner A, Flurin H. Balloon Dilation of the Eustachian Tube: Early Outcome Analysis. Otol Neurotol 2015; 36: 437-43. [CrossRef]
4. Ockermann T, Reineke U, Upile T, Ebmeyer J, Sudhoff HH. Balloon Dilatation Eustachian Tuboplasty: A Clinical Study. Laryngoscope 2010; 120: 1411-6. [CrossRef]
5. Medina M, Di Lella F, Di Trapani G, Prasad SC, Bacciu A, Aristegui M, et al. Cochlear Implantation Versus Auditory Brainstem Implantation in Bilateral Total Deafness After Head Trauma: Personal Experience and Review of the Literature. Otol Neurotol 2014; 35: 260-70. [CrossRef]
6. Hainarosie M, Zainea V, Hainarosie R. The evolution of cochlear implant technology and its clinical relevance. J Med Life 2014; 7: 1-4.
7. Lammers MJ, van der Heijden GJ, Pourier VE, Grolman W. Bilateral cochlear implantation in children: a systematic review and best-evidence synthesis. Laryngoscope 2014; 124: 1694-9. [CrossRef]
8. Sanna M, Di Lella F, Guida M, Merkus P. Auditory Brainstem Implants in NF2 Patients: Results and Review of the Literature. Otol Neurotol 2012; 33: 154-64. [CrossRef]
9. Fukui H, Raphael Y. Gene therapy for the inner ear. Hear Res 2013; 297: 99-105. [CrossRef]
10. Phillips JO, Ling L, Nie K, Jameyson E, Phillips CM, Nowack AL, et al. Vestibular implantation and longitudinal electrical stimulation of the semicircular canal afferents in human subjects. J Neurophysiol 2015; 113: 3866-92. [CrossRef]
11. Bridgeman B, Blaesi S, Campusano R. Optical correction reduces simulator sickness in a driving environment. Hum Factors 2014; 56: 1472-81. [CrossRef]
12. SINUVA Prescribing Information, Intersect ENT. December 2017.
13. Chin KWTK, Engelsman AF, Chin PTK, Meijer SL, Strackee SD, Oostra RJ, et al. Evaluation of collimated polarized light imaging for real-time intraoperative selective nerve identification in the human hand. Biomed Opt Express 2017; 9: 4122-34. [CrossRef]
14. Dong Y, Zhao M, Su M, Ding N, Zhang X. Efficacies of stimulation of genioglossus in mild-to-moderate obstructive sleep apnea syndrome patients after uvulopalatopharyngoplasty. Zhonghua Yi Xue Za Zhi 2014; 94: 1726-8.
15. Karajanagi SS1, Lopez-Guerra G, Park H, Kobler JB, Galindo M, Aanestad J, et al. Assessment of Canine Vocal Fold Function after Injection of a New Biomaterial Designed to Treat Phonatory Mucosal Scarring. Ann Otol Rhinol Laryngol 2011; 120: 175-84. [CrossRef]