



High-definition otoscopic device for humanitarian mission: how i do it

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Abstract

Background Despite a high prevalence of chronic otitis media and related complications, many African dispensaries and clinics lack microscopes or fiberoptic equipment for examining external ear ducts and tympanic membranes.

Method An alternative, inexpensive, and readily available device designed for ear wax removal is presented as a clinical ear and anterior nasal cavity examination tool. The device connects to Wi-Fi or cellular networks, providing high-definition images of the ear and anterior nasal cavity through a smartphone interface. Its use, utility, strengths, and limitations are discussed.

Conclusion This paper describes a novel, cost-effective, and user-friendly device for examining the external ear, tympanic membrane, and anterior nasal cavity of patients throughout humanitarian missions.

Keywords Innovation · Surgery · Technical · Otolaryngology · Otorhinolaryngology · Ear · Tympanic membrane · Humanitarian

Introduction and relevant surgical anatomy

The global distribution of disabling hearing loss demonstrates significant geographic disparity, with approximately 80% of cases located in low- and middle-income countries, especially Sub-Saharan Africa regions [1]. Moreover, these regions frequently lack adequate healthcare infrastructure and resources to detect and diagnose hearing disorders and, consequently, to implement appropriate audiological rehabilitation programs [1, 2]. Therefore, exploring tympanic membrane anatomy can be difficult without fiberoptic equipment or microscopes given its low surface area (approximately 85 mm²).

Description of the device

An ear wax removal device is currently available for patients who wish to remove ear wax from their external ear canal themselves (Fig. 1). Although otolaryngologists do not theoretically recommend this approach due to the risk of tympanic membrane or external ear canal injuries, it remains available on various commercial websites for approximately \$30. The device incorporates a high-precision optical system (Bebird R1 earscope, Heifeng Zhizao (Shenzhen) Technology Co, China) featuring a

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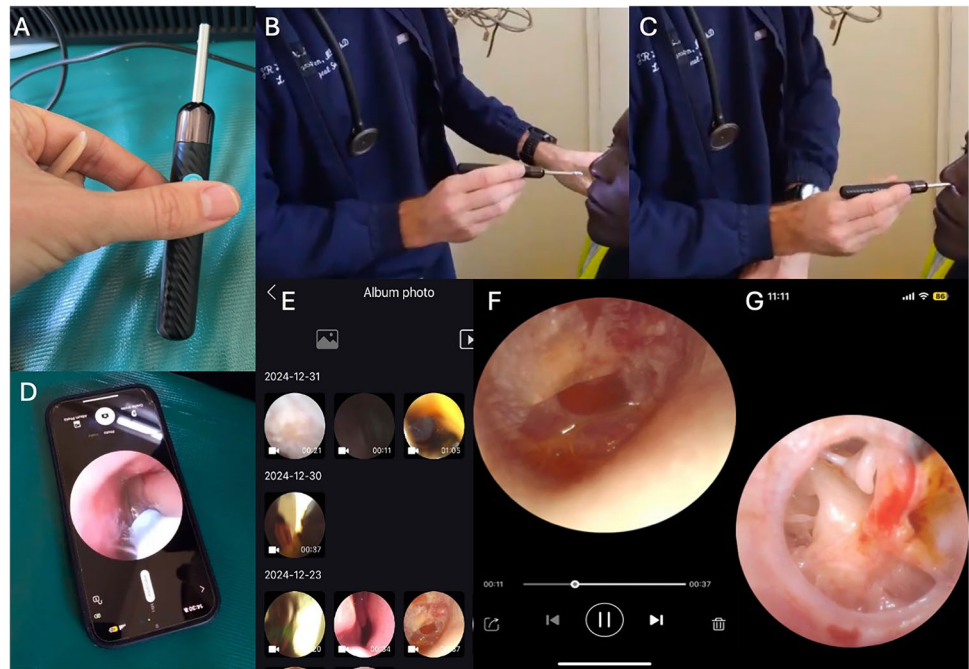
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Fig. 1 Otoscope Device for Humanitarian Outreach. The device, which is the same size as a pen, can be modified through removal of the tip extremity for enhanced safety (A). It can be introduced into the external ear canal or nasal cavity (B, C), providing direct high-definition images on the smartphone application (D). A gallery of recorded videos and images is available on the smartphone (E), with capabilities for video (F) and image (G) storage



3-megapixel sensor, six LED illumination sources, and 1080P resolution capability. Real-time visualization of the external auditory canal and tympanic membrane is achieved through a dedicated smartphone application (Suear, compatible with iOS and Android platforms) via Wi-Fi connectivity. The system enables enlarged image and video capture during otoscopic examination with a frame rate of 20 fps, facilitating direct data transfer between the earscope and mobile devices. The several steps for using the device are reported in Fig. 1.

This device was implemented during a humanitarian healthcare initiative at a public dispensary hospital in Iten, Kenya, where the primary investigator conducted otoscopic and anterior rhinoscopic examinations on patients presenting with otorhinolaryngological symptoms. The hospital works without a dedicated otolaryngologist, with ear, nose, and throat care provided by two general practitioners whose diagnostic capabilities are limited to basic light source examination without proper otoscopic or microscope equipment. However, despite the lack of medical material and technology, most practitioners in Kenya have smartphone, and, consequently, can use these devices. Implementation of this diagnostic device facilitated the identification of chronic otitis media, such as cholesteatoma, tympanic membrane retraction, which were missed through conventional basic otoscopy, resulting in enhanced diagnostic accuracy and subsequent optimization of therapeutic interventions. Similar but limited findings have been found for anterior nasal examinations. The recording of examinations led to the possibility to evaluate a potential treatment by the comparison of pre- to post-therapeutic pictures/videos.

The integration of clinical data, including patient histories and digital media captured by this device, with artificial intelligence platforms and large language models presents opportunities for enhanced diagnostic accuracy and improved patient outcomes [3, 4].

Indications

The use of this ear wax device can be indicated for the baseline or follow-up assessments of patients with hearing and nasal symptoms, including acute or chronic otitis media, external ear duct foreign body, anterior nasal disorders, nasal foreign body, or other non-infectious diseases of the external ear duct.

Limitations

The inability to have adequate access to the posterior part of the nasal fossae, or the entire nasal fossae in case of severe septum deviation or inferior turbinate hypertrophy. Getting pictures/videos can be difficult for patients with acute infection of the external ear duct (pain, discharge), external ear duct stenosis, or important ear wax.

How to avoid complications

Ensure that the external part of the device is rounded, especially if the medical user has removed the ear wax extraction tip (Fig. 1A). This tip, while not essential for diagnostic examination, can restrict the depth of device insertion into the external auditory duct.

Pre-use considerations

Before examination, a comprehensive medical history should be obtained, with particular attention to excluding acute external otitis, which may result in significant discomfort during otoscopic evaluation. Furthermore, in cases involving foreign body presence in either the external auditory canal or anterior nasal cavity, the practitioner must use an appropriate technique to prevent iatrogenic posterior displacement of the foreign body posteriorly.

Specific information to the patient

Patient compliance during examination is essential for safety and diagnostic accuracy. Prior using the device, informed consent should be obtained, particularly when images or videos may include patient-identifying information for electronic medical record documentation.

Summary of 10 key points

1. Ear wax removal device can be useful for humanitarian missions in dispensary without ear examination material.
2. Ear wax removal is cost-effective, safe, and effective to get adequate pictures or videos of the external ear duct, tympanic membrane, and anterior nasal cavity.
3. The Wi-Fi and the use of a smartphone are required.
4. The system enables enlarged image and video capture during otoscopic examination with a frame rate of 20 fps, facilitating direct data transfer between the earscope and mobile devices.
5. The pictures and videos can be stored in the smartphone or medical record for follow-up evaluations.
6. In resource-limited settings lacking traditional fiberoptic or microscopic instrumentation, this economically viable device offers significant diagnostic capabilities for identifying and assessing pathological conditions of the external auditory canal and tympanic membrane.
7. If implemented in a humanitarian mission, this device can have a substantial impact on the basic ear clinical examination.
8. Prospective longitudinal studies including substantial patient populations from low- and middle-income regions are essential to definitively evaluate this device's clinical efficacy, cost-effectiveness, and potential impact on healthcare outcomes in resource-limited environments.

Author contributions J. Lechien: design, acquisition of data, data analysis & interpretation, drafting, final approval, and accountability for the work; final approval of the version to be published; agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. L. A. Vaira: design, acquisition of data, data analysis & interpretation, drafting, final approval, and accountability for the work; final approval of the version to be published; agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Declarations

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