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An Innovation of Hearing Aid

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ABSTRACT – The human ear is an organ of hearing and balance. It detects and analyzes sound through a transduction mechanism, which is the process of converting sound waves into electrochemical impulses. Auditions cannot be adequately performed if the anatomy is abnormal. Hearing aids are small amplifiers that fit into the ear, used by people who are partially deaf. In this effort, adaptive hearing aids have been designed to improve hearing for the deaf. To improve hearing for deaf people, it should correct speech imperfections and adjust the volume of acoustic impulses intelligently. With the use of electret microphones, the sound is recorded from all sides. The signal emanating from it is first amplified using a low-pass filter. This paper is to diagnose the patient case scenario for the hearing-impaired patient, to identify the wearability issue of the patient's hearing aid. At the same time study, the theory of hearing loss and find out the causes of hearing loss, and provide a proposal for the design of suitable equipment for the study (3D). For this reason, we propose to make improvements to the old hearing aids by adding a volume knob.

KEYWORDS: Hearing-Impaired, Hearing Aid, Volume Knob, and Human Ear

1.0 INTRODUCTION

Workers are exposed to noise in any working environment, but it can be harmful when it is too loud and long-lasting. Continuous exposure may damage the sensitive structures in the inner ear and cause noise-induced hearing loss (NIHL). A study done in the United States of America (USA) estimated that nearly 40 million adults developed hearing loss from exposure to loud noise. The World Health Organization (WHO) has previously noted that noise exposure appears to be increasing despite the other environmental health problems, which have diminished over time through regulation. NIHL is one of the most common occupational injuries among workers in manufacturing industries in Asia. In Malaysia, 21.9% of employees were reported to suffer from hearing impairment [1]. The study of Robert T. Sataloff and Joseph Sataloff declares that good hearing should not be taken for granted, it is not valued by the public, even by the medical community. Although hearing loss may not be widely regarded as a punishment from God, it is still seen as a shameful weakness. , or signs of aging and senility, and it is associated with loss of sexual attraction. Often patients do not seek medical treatment of their own free will. Many deny and tolerate hearing loss for quite a long time before being forced by family members to seek medical

The problem with this lab is that the patient has been diagnosed with noise-induced hearing loss. The patient wore his first hearing aid only for a short time because it caused the patient's stability and balance to become abnormal. The patient's disability could not be accommodated with the technology of the past. Until now the patient does not use a hearing aid and the patient faces problems if there is a new voice. Loud sounds picked up by hearing aids are amplified less than soft sounds, and the level of amplification will always depend on the patient's hearing loss This study's main objective is to diagnose patient case scenarios for hearing disability patients. Next, to identify the issue of the patient's hearing aid wearability. They also study the theory of hearing impairment and find out the causes of hearing loss. Lastly, to provide a proposal for the design of equipment that is suitable for the study (3D).

2.0 LITERATURE REVIEW

The human ear is a hearing and equilibrium organ that detects and analyses sound by transduction (or the conversion of sound waves into electrochemical impulses) and preserving a sense of balance (equilibrium

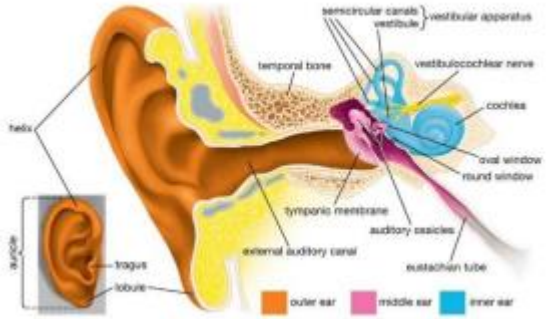

Figure 1 : Human ear

Humans have three distinct sensory organs in their ears - the outer ear, middle ear, and inner ear (figure 1). The outer ear's job is to gather sound waves and direct them toward the tympanic membrane. The inner ear houses the auditory ossicles, a chain of three minuscule bones that span it. The inner ear is a complex network of caverns and fluid-filled channels buried deep within the temporal bone's petrous rock. The eighth cranial nerve, often known as the vestibulocochlear nerve, has extremely specialized terminals that make up these sensory organs[3]. The outer ear is the region of the ear that has the most interaction with the outside world is the outer ear, also known as the auricle, which is made of cartilage. It features several anatomical demarcations, including the helix, the antihelix, the tragus, and the antitragus, which together form the acoustic meatus, a depression. The tympanic membrane serves as the meatus's internal terminus. It has a tube-like shape. This canal is made up of two cartilaginous thirds and one bone third. The two external thirds of the canal have an oil gland lining that secretes cerumen to keep the canal free of foreign items and insects. The middle ear is located at the tip of the outer ear and is constrained both internally and outward by the oval window and the tympanic membrane[3]. The middle ear is there is air in the middle ear cavity. The epitympanic chamber (attic) and the tympanic chamber (atrium), which are its top and lower chambers, respectively, are divided. Due to its rectangular-like design, it is comparable to a room. The carotid artery, the inner ear, the eustachian tube, and the mastoid are its anatomical neighbors.

This room is filled with three ossicles, specifically the malleus, incus, and stapes. To transmit vibrations to the inner ear, these bony structures must be suspended by ligaments. As a result of the stapes' activity, the vibrations that enter this region of the middle ear are then conveyed to the inner ear[3]. The inner ear is the bony labyrinth and the membranous labyrinth are two separate structures that make up the inner ear. The vestibule, a chamber in the bone labyrinth filled with semicircular canals responsible for detecting equilibrium, is where the vestibular portion of the viii cranial nerve develops. The hearing organ is called the cochlea. The vestibulocochlear nerve, which is made up of the cochlear portion of the viii cranial nerve, derives its name from Greek, which signifies the shell of a snail[3]. The human ear can distinguish between subjective aspects of a sound, such as its volume and pitch, by identifying and assessing different physical elements of the waves. Surgery can restore hearing to within 25 to 30 decibels when the fixed stapes are removed from the inner ear. The inner workings of the cochlea are as follows. Pressure waves in the perilymph of the Scala vestibuli cause nerve impulses to be sent to the brain. The basilar membrane vibrates, which causes the organ of Corti

to move against the electoral membrane. The cochlear nerve aids in transmitting audio information directly to the brain's highest cerebral levels. Pitch, loudness, and location information are processed at lower stages of the brain when appropriate responses like contraction of the intra-aural muscles are started. The importance of these neural connections may predate the

evolutionarily significant growth of the cerebral cortex[3]. Types of hearing loss is a medical condition called hearing loss that impairs a person's ability to hear sounds. It can affect one or both ears whether the effect is mild, moderate, moderate, severe or profound. The consequences of hearing loss can be extensive and severe. This includes the inability to speak to others, which hinders language development and can result in social isolation, loneliness, and frustration, especially in older people with hearing loss. Hearing loss is inadequately accommodated in many places, which impacts academic achievement and employment outcomes[4]. Additionally, we look at the signs, causes, and contributing factors of hearing loss here[5]. Instead, we found three types of hearing problems depending on the part affected. Sensorineural Hearing Loss An individual has issues with their auditory nerve or cochlea. It can be brought on by being exposed to loud noise, illness (meningitis), ototoxic medicines, heredity, or the aging process. Treatment options for sensorineural hearing loss include cochlear implants and hearing aids. There is a problem in the structure of the inner ear, either in the hearing organ, which is the cochlea, or the auditory nerve. Among the reasons for sensorineural hearing problems are; i. Prolonged exposure to noise ii. Head injury iii. Disease iv. genetics/heredity v. age factor vi. medicines ii. Conductive Hearing Loss

This can happen if earwax or fluid builds up in the ear canal, or if the eardrum or middle ear bones are damaged (ossicles). Congenital abnormalities such as atresia or microtia may prevent sound waves from reaching the ear and stimulating the acoustic nerve. Depending on the exact problem, there are several therapy approaches. Surgery to correct structural problems, procedures to clear obstructions, or using hearing aids, cochlear implants, or bone-anchored hearing aids are all treatment options (BAHA). Among the causes of conductive hearing problems: i. Ear structural abnormalities (Figure 4)ii. Infection in the middle ear (otitis media) iii. Perforated ear drum iv. Clogged ear canal

3.0 METHODOLOGY

There are various degrees of classification for materials used in earplugs and earmuffs. There are hard and soft materials, to put it simply. Various fundamental polymers fall under each of these categories. There are several modifications to the mixture that change the physical qualities of each basic plastic [6]. The doctor can select the type of earmold material that will help the patient the most because the imprint material is placed inside the ear canal. The three materials used to make earmolds are silicone, acrylic, and polyvinyl chloride. Each type of material has advantages and disadvantages. For instance, silicone earmolds are soft and excellent for children because of how easy the material is to work with. Acrylic earmolds can help older patients with dexterity issues because the earmold is hard so inserting and removing the earmold is easier [5] (Table 1).

Table 1: Type of material

Type of material	Advantages	Disadvantages
ACRYLIC ▪ Poly-methyl-methacrylate ▪ Hydroxy-ethyl-methacrylate	▪ Little deterioration or shrinkage with time and use ▪ Easy to grind, drill, re-tube, glue, and buff ▪ Smooth surface helps with insertion and removal ▪ Easy to clean	▪ Will not compress to insert past narrow areas in the canal ▪ Leaks easily when the ear canal changes shape ▪ Potential for injury when struck, especially if it shatters
	▪ Advantages and disadvantages of poly-methyl-methacrylate, but used for ITE/ITC and CIC shells	
VINYL ▪ Poly-vinyl-chloride ▪ Poly-ethyl-methacrylate	▪ Comfortable when a tight fit is needed for high-gain hearing aids ▪ Some types of vinyl (poly-ethyl-methacrylate) soften at body temperatures and harden at room temperatures, helping insertion	▪ Shrinks, hardens, and discolours with time, necessitating replacement approximately annually ▪ Tubing is difficult to replace removal is difficult and a new tube needs toxic solvent or locking devices to retain it ▪ Softer vinyl needs a toxic solvent to polish them – cannot be worn for 24 hours
SILICONE ▪ dimethyl-methyl-hydrogen-siloxane ▪ poly-dimethyl-siloxane	▪ Comfortable when a tight and/or long canal fit is needed, especially for the softer grades of silicone. ▪ Little shrinkage with time. ▪ Low incidence of allergic reactions	▪ Impossible to grind and buff; difficult to drill ▪ Tubing cannot be glued – a mechanical tubing lock is required

4.0 RESULT

3D model of ITC Hearing Aid. Front View of ITC Hearing Aid with Label and Dimension Side View of ITC Hearing Aid with Label And Dimension (Figure 2):

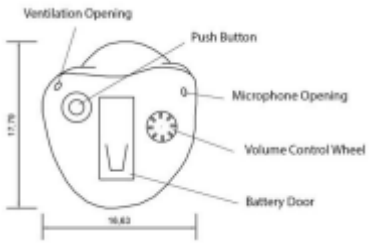

Figure 2: Orthographical View of ITC Hearing Aids

The function of ITC hearing aid parts: 1. Push Button The power button is a round button that turns electronic devices on and off. Almost all electronic devices have a power button or power switch. Normally, the device turns on when the user presses the button and turns off when they press it again. 2. Battery Door The main function of the battery holder is to keep the cell safely and securely in place while transmitting power from the battery to the device in question. 3. Ventilation Opening This hole conducts sound directly to the ear canal. The earmold has a vent on the other side to improve sound quality. The vent helps you hear your voice more naturally. The occlusion caused by blocking the ear can make the sound of your voice seem hollow. 4. Microphone Opening The microphone receives sound and converts it into a digital signal. The amplifier increases the strength of the digital signal. The speaker produces the amplified sound into the ear. 5. Sound Outlet The speaker produces the amplified sound into the ear.

6. Volume Control Wheel There may be a volume control wheel on ITC instruments. With the tip of a finger, the Volume Control wheel can be infinitely rotated in both directions. You can change the volume in particular listening conditions to a level that feels comfortable to you using the volume control. i. Turn the wheel forward to raise the volume. ii. Turn the wheel toward the back of your head to lower the volume. Figure 12: Orthographical View of ITC Hearing Aids Figure 12 shows the orthographic view of the ITC Hearing Aid that was drawn using AutoCAD. Researchers are focusing on the latest In-The-Canal hearing aid, which we plan to innovate on the old device by adding volume control. ITC hearing aids are very delicate because they are made to fit inside the ear canal. For fear of being judged, many people refuse to wear hearing aids. The smallest model-size hearing aids available are those made by ITC. There are hearing aids with no loudness settings, automatic hearing aids, and manual hearing aids. Not everyone will enjoy the compact design of hearing aids that can be used without manual volume control. Not all patients, including those with more severe hearing loss, should use ITC hearing aids. These hearing aids may not always be loud enough to provide the best results. A dedicated remote control or smartphone app must be used to make the majority of adjustments you might want to make.

CONCLUSION

The conclusion for the four laboratory works that have been done is to diagnose the patient case scenario for hearing-impaired patients. In addition, to identify problems with the patient's hearing aid wearability. Next, study the theory of hearing loss and find out the causes of hearing loss. Finally, we provide a suitable equipment design proposal for (3D) studies.

RECOMMENDATION

The development of future hearing aid, it is better to implement the IoT to make it easier to control or monitor the hearing aid as today, almost everyone has at least one mobile phone. Next, it is recommended to implement the rechargeable battery system as in modern wireless earbuds so that they can be charged easily when needed.

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