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EVALUATION OF EARPHONE INDUCED HEARING LOSS AND IT'S EFFECT ON VIDHURA MARMA

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ABSTRACT

More than 5.07 billion people in the world are mobile phone users and the count is increasing rapidly in a day today basis. Mobile accessories have also become an integral part of modern-day life. Earphones are one among mobile gadgets used vastly among all age groups of a population and recent reports suggesting that the peoples are using it in very high volumes. The present work is an attempt to evaluate the relevance of improper usage of earphones leading to NIHL and to explain the involvement of *Vidhura Marma* in it. A critical review on anatomy of ear, physiology of hearing, normal hearing range, noise induced hearing loss, earphones & *Marma* was done. A questionnaire was used for the survey to analyze the improper usage of earphones causing NIHL among young adults (18yrs – 30yrs). The result of this study leads to a conclusion that, the improper usage of earphones can lead to NIHL by causing *Abhighata* to *Vidhura Marma.*

KEYWORDS: Earphones, NIHL, *Vidhura marma, Marmabhighata, Badhiryata*

INTRODUCTION

In the modern-day history, one of the most developing technologies in telecommunications is the mobile phones. Mobile phones are powerful communication devices, first demonstrated by Motorola in 1973 and commercially available from 1984.[1] Nowadays, mobiles phones have become a very inextricable part of society and culture and they not only help us for communication but in assisting us in the day today activities too.

It is estimated that 5.07 billion people in the world are using mobile phones and the count is increasing rapidly in day today basis.[2] Around 70% of Indian population are included in it. Rise in the mobile phone usage have in turn increased the use of gadget related to it.one among the most used gadgets among them are earphones. These tiny parts of technology have become very requisite part of modern life and many young adults are even addicted to it. According to WHO, almost 50% of people uses their portable audio devices in very high-volume levels for an enthralling audio experience. Improper and unsafe listening practices of earphones leads to a type of hearing loss called as Noise Induced Hearing Loss. WHO estimates that 1.1 billion young people between the age of 12-35 years worldwide could be at risk of developing hearing loss due to unsafe listening practices of their portable audio devices.[3] Indian Council Medical Research reported (ICMR) that 10.7% of hearing impairment is because of improper usage of ear phones.[4] Thus, improper, and unsafe listening practices of earphones could lead to a condition called as Noise Induced Hearing Loss (NIHL).

Ayurveda is an ancient health science of India dedicated to curing and preventing the health of an individual. Among several concepts explained in *Ayurveda*, the concept *Marma* is highly unique. The term *Marma* is derived from the Sanskrit dhatu '*Mri'—Marma*, that means which causes death or disability. The definition of *Marma* by different *Acharyas:* According to *Raja Nighantu* and *Acharya Sharangadhara* – *Marmas* are the seat of *Jeeva* or life. Any injury to *Marma* causes harm to the life of the person. *Sharangadhara* opines that *Marmas* are the *Aadharas* of *Jeeva*. According to *Acharya Charaka* – *Marmas* are the site where a person feels severe pain compared to pain in other parts of body because as it is the seat of *Chetana*. According to *Acharya Vagbhata* – the place where prana resides is called *Marma* and injury or damage to *Marma* leads to *Vishama* and *Spandana*. According to *Acharya Aruna Dutta* and *Acharya Dalhana* – that which results in the *Marana* or death of the person on injury is called as *Marma*. According to *Acharya Sushrutha* – *Marma* is the point where conglomeration of *Mamsa*, *Sira Snayu*, *Asthi* and *Sandhi* is present.[5] Any injury to these sites results in grievous consequences based on the structure or structures that are predominantly involved in it. *Vidhura* is one among the *Marma* located in head, upon injury leads to deafness or hearing loss.

AIMS AND OBJECTIVE

This study was conducted to evaluate the relevance of earphone usage in causing noise induced hearing loss and to explain the involvement of *Marma* related to it.

MATERIALS AND METHODS

Anatomy of ear, physiology of hearing, normal hearing range, noise induced hearing loss, earphones & *Marma* was reviewed from google scholar, ayurveda classics and various modern textbooks.

Questionnaire was used for the survey to find out the relevance of improper and excess usage of earphones in causing noise induced hearing loss.[6]

ANATOMY & PHYSIOLOGY OF EAR

Ears are one among the sensory organs, that helps to process the sounds and allows the brain to interpret what an individual is hearing. Anatomy and physiology of ear can be studied under 3 headings: 1. External ear 2. Middle ear and 3. Internal ear.

External ear – consists of auricle or pinna and external acoustic meatus. Auricle is the part seen on the surface, made of cartilage, and lined by skin. External acoustic meatus is an S-shaped canal, 24 mm in length, medial 2/3rd made of bony part and lateral 1/3rd cartilaginous and is medially related to tympanic membrane.

Tympanic Membrane – it is thin, translucent partition between external acoustic meatus and middle ear, obliquely placed at an angle of 55^{o}c with the meatus and gives attachment to the handle of malleus in its inner surface.

Middle ear – also called as tympanic cavity, which is an air-filled cavity situated in between external and internal ear. The major contents of middle ear are ear ossicles i.e., malleus, incus and stapes which are interconnected. Handle of the malleus is attached to tympanic membrane and the footplate of stapes is attached to fenestra vestibuli or oval window.

Internal ear or labyrinth – a fluid filled cavity present in the petrous part of temporal bone. Made of bony labyrinth within which there is membranous labyrinth. Major contents are the cochlear apparatus and vestibular apparatus. Bony labyrinth consists of cochlea (anteriorly), vestibule (middle) and semicircular canals (posteriorly).

Cochlear apparatus – resembles the shell of a common snail. Has a central axis called modiolus around which cochlear canal makes 2 and 3 quarter turns. A spiral lamina divides the cochlea into 3 parts: Scala vestibuli (upper), Scala media (middle) and Scala tympani (lower). Scala vestibuli and Scala media is differentiated by a membrane called as vestibular or Reisner's membrane, while the membrane in between Scala media and Scala tympani is called the basilar membrane. Scala vestibuli communicates with Scala tympani at the apex of cochlea through a small opening called Helicotrema. The chamber of Scala vestibuli and Scala tympani is filled with a fluid called perilymph, and cavity of Scala media is filled a specialized fluid called endolymph.

Cochlear duct or spiral duct – the chamber of Scala media is also called as cochlear duct. Roof is made by the Reisner's membrane while floor is by basilar membrane up on which the end organ of hearing i.e., organ of corti is situated. Organ of corti comprises of hair cells (primary sensory organ of hearing) embedded in tectorial membrane and rods of corti. There are mainly 2 types of hair cells: outer hair cells (3 layered) and inner hair cells (single layered) and stereo cilia's and kino cilia are present on the hair cells. Organ of corti is innervated by the peripheral process of spiral ganglion which in turn continues as the cochlear nerve part of vestibulo-cochlear nerve.

Physiology of hearing starts as the sound waves are produced from a source, which'll be funneled into the external acoustic meatus by the help of auricle. The sound waves are conducted through the external acoustic meatus up to the tympanic membrane, where the waves compress and decompresses tympanic membrane to convert the soundwaves into mechanical vibrations. These vibrations are transmitted to the oval window via ear ossicles until the oval window is been vibrated by the foot plate of stapes. The intensity of sound waves is increased by ten times by the ear ossicles without changing the frequency as the vibrations pass through them. As the oval window vibrates, causing mechanical vibrations converting into fluid vibrations in the perilymph of Scala vestibuli. The vibrations reaching the endolymph through the vibrations of vestibular membrane leads to the vibrations in appropriate parts of basilar membrane. These vibrations of basilar membrane cause the stereocilia present on the hair cells to rub against the tectorial membrane in turn leading to the influx of anions into hair cells generating an action potential which triggers the release of neurotransmitter called as glutamate that helps to rapidify the conduction of electrical signal that is generated through the spiral ganglion into the cochlear nerve. This nerve terminates in

the dorsal and ventral cochlear nuclei, and further carried by fibres into the auditory area in the temporal lobe.[7]

Normal hearing range[8] - The sound pressure level determines the volume or loudness of a sound. The louder the sound, the value will be higher. The decibel (dB) level of sound is a measurement of how loud it is. The frequency of a sound describes how high its pitch. The frequency is expressed in hertz (Hz). A minimum auditory threshold of human is 0 dB and the dynamic range is between 0 – 160 db. If people are exposed to sounds exceeding 90 decibels every day or all of the time, they might develop chronic hearing impairment. Hearing becomes unpleasant when the sound pressure level exceeds 120 dB (threshold of discomfort), and it becomes painful when the sound pressure level exceeds 130 decibels (threshold of pain) and may even lead to acute hearing loss. Normal conversation will be between 30-60db, while loud music in rock concerts or night may be 120db.

EARPHONES AS TECHNOLOGY[9]

Earphones, these are small loudspeaker held or worn close to the listeners ear or within the outer ear. They are portable audio devices which act as electroacoustic transducers, which convert an electrical signal to a corresponding sound. There are different types of earphones, generally they can be classified into 2 types based on connectivity: 1) wired ear phones 2) wireless earphones.

Wired earphones – these are earphones with soldered headphone jack cables.

Wireless earphones – these have an inbuilt headphone jack which connects through Bluetooth connectivity. There are wireless earphones connected via neckband and newest invention called true wireless headsets, which have no cord to keep each bud connected to each other.

Another classification of earphones based on the ear adaption or position of ear piece: 1) over ear, 2) on ear and 3) in ear.

Over ear earphones – these have circular or ellipsoid earpads that encompass the ears.

On ear earphones – have the ear piece that rest upon the pinna, rather than around them.

In ear or canal earphones – these are very small earphones compared to other that are fitted in the external ear.

The sound output by earphones differs based on the brand and products. At maximum volume earbuds or headphones could produce volume of 105-110 db.

Concept of hearing loss

The simple definition of hearing loss is the inability of one to hear the sounds in normal range. Acc to WHO, by 2050 2.5 billion people are projected to have some degree of hearing loss and at least 700 million will require hearing rehabilitation.[10] Hearing loss can be classified into 2 types: 1) Organic 2) Inorganic.

Organic hearing loss – hearing loss caused due to any underlying anatomical or physiological lesions can be classified under this group. Thus, it can be further divided into: a) Conductive b) Sensorineural and c) Mixed.

a) Conductive hearing loss - Any disease process which interferes with the conduction of sound to reach cochlea causes conductive hearing loss. The lesion may lie in the external ear and tympanic membrane, middle ear or ossicles up to stapediovestibular joint.
b) Sensorineural hearing loss - Sensorineural hearing loss (SNHL) results from lesions of the cochlea, VIIIth nerve or central auditory pathways. Based on the causative factors can be further divided into congenital and acquired. Congenital aetiology includes the prenatal and perinatal factors that leads to the inner ear anomalies or damage. Prenatal factors pertaining to infant may be syndromic or non-syndromic and there may be anomalies that affecting membranous or bony labyrinth or both.Perinatal factors include birth injuries, prematurity and low birth weight, anoxia, sepsis and other factors. Acquired causes includes Infections of labyrinth—viral, bacterial or spirochaetal, Trauma to labyrinth or VIIIth nerve, Noise-induced hearing loss, Ototoxic drugs, Presbycusis, Meniere's disease, Acoustic neuroma, Sudden hearing loss, Familial progressive SNHL, Systemic disorders, e.g., diabetes, hypothyroidism, kidney disease, autoimmune disorders, multiple sclerosis, blood dyscrasia. The commonest form of SNHL is Noise Induced Hearing Loss (NIHL).
c) Mixed hearing loss - In this type, elements of both conductive and sensorineural deafness are present in the same ear. There is air-bone gap indicating conductive element, and impairment of bone conduction indicating sensorineural loss.

Non-organic hearing loss - In this type of hearing loss, there is no organic lesion. It is either due to malingering or is psychogenic.

NOISE INDUCED HEARING LOSS (NIHL): Hearing loss that develops due to chronic exposure to less intense sounds as compared to acoustic trauma where single brief exposure causes damage to ear. Based on the pathology involved NIHL is categorized as: 1) temporary threshold shift (TTS) and permanent threshold shift (PTS).

Temporary threshold shift (TTS) - The hearing is impaired immediately after exposure to noise but recovers after an interval of a few minutes to a few hours even up to 2 weeks. Degree of damage due to TTS depends on the noise—its intensity, frequency, and duration. Due to over acoustic stimulation, excessive glutamate will be released into the synapse which in turn leads to glutamate induced excitotoxicity and there will be decreased blood flow leading to cochlear hypoxia causing for the release of reactive oxygen species. Thus, damage will be occurring for the hair cells. As the acoustic stimulation reduces or stops, initiates the body repair mechanisms to look over the damage happened and correct it. Hair cells doesn't have the capacity to regenerate once the damage is permanent, they will be irreparable.

Permanent threshold shift (PTS) – Due to continuous episodes of TTS, the damage occurred to hair cells will be permanent, thus the hearing impairment will be permanent. Here, there'll be depolymerization of actin filaments of stereo cilia, rupture of Reisner's membrane, swelling over the nerve endings and tissues nearby and there'll be necrosis of the tissues.

Along with hearing impairment other symptoms are tinnitus, distortion or muffled sound, difficulty in understanding the sound in a noisy surrounding, head ache, sleep disturbances leading to chronic fatigue and stress and irritability.[11]

CONCEPT OF *MARMA*[12]

Enumeration of *Marma* – According to Acharya Sushruta there are 107 *Marmas* in the body while Acharya Charaka have mentioned 3 important *Marmas* (*Trimarmas*) as important among all others, thus he also confirms that there are more than 3 *Marmas* in the body.

Classification of *Marma* – Acharya Sushruta have classified the *Marmas* in 3 differernt ways. *Rachanasura*, *Parinamanusara* and *Pramananusara.*

Vidhura Marma: it is one among *Jatrurdhwa Marma*. According to *Acharya Sushruta*, *Vidhura marma* is type of *Snayu Marma* while *Acharya Vagbhata* opines that it is a type of *Dhamani Marma(Rachananusara*). According to *Parinamanusara* classification, *Acharya sushruta* have included *Vidhura Marma* in category of *Vaikalyakara Marma*.

Size of *Vidhura Marma* is told as ½ Angula. Location of Vidhura Marma is quoted as behind and below to ear (*Karna Prstah and Karna Adhah*) by both *Acharya Sushruta* and *Vabghata*. Anatomical structures related to Vidhura Marma are mastoid process of the bone, vestibulo-cochlear nerve, facial nerve, tympanic membrane, stylomastoid artery and labrynthine artery.

As *Vidhura Marma* is one among *Vaikalyakara marma* due to *Abhighata* can lead to *Badhiryata* to the person.

DISCUSSION

Earphone users are increasing among the world population in a significant rate and Improper usage of earphones can cause noise induced hearing loss.

The questionnaire was used to evaluate the hearing loss among earphone users. 10 Participants using earphones for more than 2 hours daily in higher volume were selected for survey. Results show that 60% of the participants have a score of 10 or more suggesting that they had a history of hearing loss.

The use of earphones above normal range (90 dB) is very harmful to ears especially inner ear, where the sensory organs of hearing are situated. Upon the excessive and improper usage of earphones, this can trigger the pathology of Temporary threshold shift inside the ear leading to temporary damage in the inner ear. This pathology might be reverted as the acoustic stimulation decreases or stops which stimulates the bodily repairing mechanisms such as anti-oxidant mechanism to repair the damages occurred within 24- 48 hrs.[13] Continuous and repeated episodes of temporary threshold shift, leads to pathology of permanent threshold shift which can cause the permanent damage to hair cells, cochlear nerve and to the various parts of inner ear. Thus, leading to noise induced hearing loss.

The improper and excessive usage of earphones can be taken as *Mithyayoga* and *Atiyoga* of *Srotrendriya,* which can lead to *Abhighata* to the *Vidhura marma*. *Vidhura marma* on *Abhighata* cause *Badhiryata* as explained by *Acharya Sushruta*. In the pathology of temporary threshold shift, there is an event which involves the reduced blood supply leading to hypoxia which may be correlated to *Abhigata* to *Dhamani* (branch of posterior auricular artery and Labrynthine artery) thus may be related to *Vidhura Marmabhighata.* In case of permanent threshold shift, the damage occurring to cochlear nerve and to other neural tissues may be related to *Abhighata* to *Snayu* part of *Vidhura Marma*.

CONCLUSION

Nowadays the usage of earphones has increased significantly and people are using it in high intensity sound. As, earphone is an external medium, their heavy and continuous usage may be taken as *Atiyoga* and *Mithyayoga* of *Srotrendriya*. Thus, the excessive and improper usage of earphones leads to *Abhighata* to *Vidhura Marma* which in turn results in *Badhiryata* of the person.

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