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Osteoporosis and Sensorineural Hearing Loss

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Introduction

Osteoporosis is a disease that affects over five percent of the population worldwide (Özkırış, Karaçavuş, Kapusuz, Balbaloglu, & Saydam, 2013). This illness causes a loss of bone mineral density at different sites of the body. There has been evidence of a correlation between osteoporosis and sensorineural hearing loss, but studies have displayed conflicting results regarding this association. Furthermore, if this relationship exists, the exact physical cause of the sensorineural hearing loss is unknown. With the number of older adults increasing globally, it is important to examine this link. The aim of this poster is to analyze evidence of a potential correlation between osteoporosis and hearing loss, and to investigate possible explanations for this relationship.

Osteoporosis

Osteoporosis is a metabolic disease that causes “progressive changes in bone structure” (Kahveci, Demirdal, Yücedag, & Cerci, 2014, p. 145). It affects both men and women, typically ages 50 and older (Jung, Cho, & Lee, 2016). Women are usually affected more than men. This condition results in demineralization of bones at various locations in the skeleton, such as the temporal bone, femoral neck, and lumbar spine (Jung et al., 2016). Osteoporosis also causes low bone mineral density (BMD). The disease is diagnosed based on a T-score, which is a measure of the standard deviations away from normal bone density (Kahveci et al., 2014). A T-score of -2.5 or lower indicates osteoporosis, and a T score between -1 and -2.5 is indicative of osteopenia, a condition that is characterized by a BMD between that of people with osteoporosis and those with normal BMD (Kahveci et al., 2014).

Hearing Loss

Hearing loss (HL) is one of the “most common chronic conditions worldwide” (Upala, Rattanawong, Vutthikraivit, & Sanguankeo, 2016, p. 1), affecting approximately 24.9 million people across the globe (Upala et al., 2016). Presbycusis is a HL caused by aging. It is usually a “bilateral, symmetrical, and slowly progressive” (Özkırış et al., 2013, p. 648) sensorineural HL that affects the cochlea. Presbycusis is becoming more prevalent as the population ages; therefore, it is critical to identify additional factors that can increase the incidence of HL. Other elements that could contribute to sensorineural HL are genetics, ototoxic medications, diseases of the ear, noise exposure, and head trauma (Kim, Lee, Lee, & Kim, 2016). It has been proposed that osteoporosis could also be a risk factor for sensorineural HL.

Is there a correlation?

Some studies have disproved a relationship between osteoporosis and HL.

- ❖ Jung et al. (2016) observed over 1,000 postmenopausal women. After using statistical models to eliminate outside influences, the results did not show a correlation between osteoporosis and HL.

Other studies have displayed a clear relationship.

- ❖ In a study of postmenopausal women, Clark, Sowers, Wallace, Jannaush, Lemke, and Anderson (1995) found that women with low BMD in the femoral neck area were 1.9 times more likely to have HL than those with normal BMD.

- ❖ Kim et al. (2015) examined the link between BMD and HL in postmenopausal women. The results showed a higher prevalence of sensorineural HL in women with osteoporosis and osteopenia; in particular, participants with low BMD in the lumbar region were at a higher risk for HL. In osteoporotic women, the prevalence of sensorineural HL was 56.5%.

- ❖ Kahveci et al. (2014) discovered an increased rate of sensorineural HL in those with osteoporosis and osteopenia. The rate of HL in osteoporotic participants was higher than the rate observed in those with osteopenia. This study also found significantly increased rates of tinnitus in people with osteoporosis.

- ❖ Özkırış et al. (2013) demonstrated a higher incidence of sensorineural HL in the high frequency region in postmenopausal women. However, this study did not report a statistically significant difference in hearing ability between people with osteopenia and women with normal BMD.

After examining the literature, the evidence points to a positive correlation between osteoporosis and sensorineural HL.

- ❖ Upala et al. (2016) conducted a meta-analysis of studies relating to this subject. After a review of 16 articles, the authors concluded that there is a significant correlation between low BMD related to osteoporosis and HL.

What are the specific causes?

Although the exact cause for the correlation between osteoporosis and sensorineural HL is unknown, researchers have proposed several theories. Because osteoporosis causes a decreased BMD, it is hypothesized that demineralization of the temporal bone, and/or the cochlea, contributes to the development of sensorineural HL (Clark et al., 1995; Kim et al., 2016; Kahveci et al., 2014; Özkırış et al., 2013). Additionally, because the cochlea requires a specific ionic concentration, changes in the rate of bone resorption due to osteoporosis may disrupt this balance and negatively impact the functioning of the cochlea (Upala et al., 2016; Kim et al., 2016).

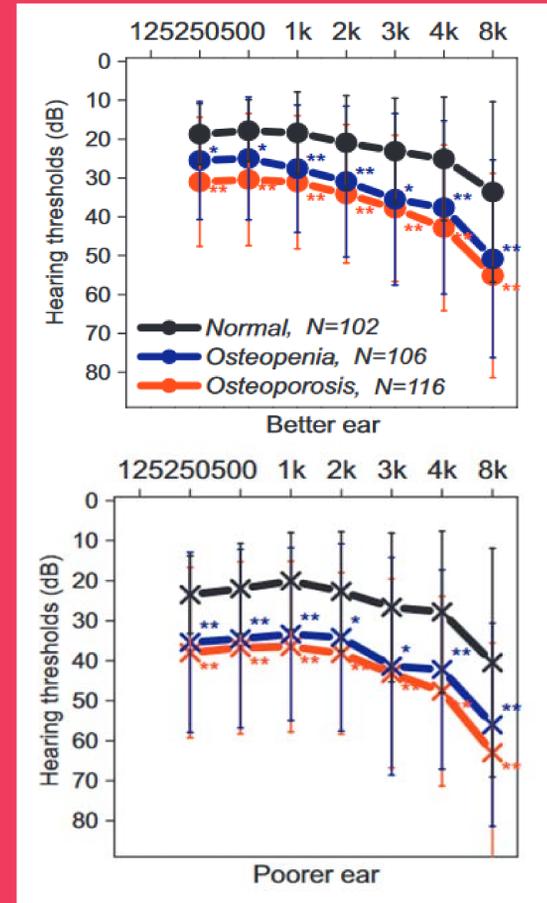


Figure 1: A comparison of hearing thresholds for people with normal BMD, osteopenia, and osteoporosis in the better and poorer ears of participants (Kim et al., 2016).

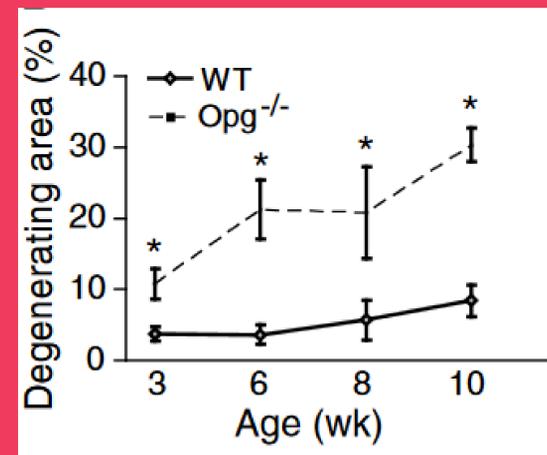


Figure 2: A comparison of the percentage of degenerating auditory neurons in normal mice (WT) and mice without OPG (OPG -/-) (Kao et al., 2013).

Recent Research

A recent animal study conducted by Kao et al. (2013) examined the relationship between osteoprotegerin (OPG), a protein that regulates bone remodeling, and HL in mice. In osteoporosis, the OPG gene malfunctions. The study compared mice with and without the OPG gene. The results are as follows:

- ❖ Mice without the OPG gene displayed progressive sensorineural and conductive HL.
 - ❖ The cochleae in mice without OPG showed demyelinated and clumped spiral ganglion neurons in the auditory nerve (Figures 2 & 3).
 - ❖ Apoptosis of neuronal cells was more likely in mice without the OPG protein.
 - ❖ OPG inhibits the ERK pathway, which has been associated with HL. In OPG-negative mice, the ERK pathway was activated, increasing the likelihood of HL.
 - ❖ Adding OPG to the cochleae of OPG-negative mice decreased apoptosis of neurons and inhibited the ERK pathway.
 - ❖ Addition of the bisphosphonate zoledronate decreased rates of neuronal apoptosis and HL in the OPG-negative mice.
- These findings have important implications for preventing HL in people with osteoporosis.

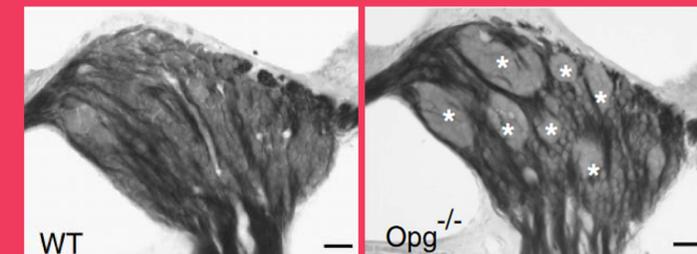


Figure 3: Sections of the auditory nerve in normal mice (left) and OPG-negative mice (right). The asterisks on the right represent areas of degenerated and aggregated neurons (Kao et al., 2013).

Conclusions

After review of the literature, most research confirmed a link between osteoporosis and sensorineural HL. Additionally, studies have proposed demineralization of the temporal bone, imbalance in the cochlea, and damage to the auditory nerve as possible causes of sensorineural HL resulting from osteoporosis. Although more research is required to better understand this association, current literature provides a starting point from which to expand this area of research.

References provided on separate sheet