The Influence of Hearing Aids and Cochlear Implants on Balance during Ambulation

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ABSTRACT

Objectives: Increasing evidence suggests that auditory inputs are important for maintaining postural stability, but little is known about their effects on dynamic balance. We hypothesize that hearing aids and cochlear implants have a corrective effect on balance during ambulation in the presence of sound localizing sources when compared to unaided situations. Study Design: Case control.

Methods: We tested 20 adults who were experienced users of bilateral hearing amplification (4 bilateral hearing aids, 8 bilateral cochlear implants, and 8 bimodal users) performing the Unterberger (Fukuda) stepping test, which is a common clinical measure of dynamic stability. Testing was carried out in the presence of a 65 dBA white noise point sound source located at ear level 1.85 m in front of the participant. The median of the absolute angle of rotation from the starting position after 50 paces was recorded. 15 subjects performed poorly during an initial screening in the unamplified condition (error >20 deg). We then retested these subjects in a unilaterally and bilaterally aided condition to determine if augmenting auditory input could improve their performance.

Results: Subjects performed better in the bilateral aided condition compared to the unaided condition (p=0.0322). Bilateral amplification was also better than in the unilateral condition (p=0.0163), which was no different from the unaided condition.

Conclusions: Our results suggest that hearing aids and cochlear implants can be considered as balance rehabilitation devices, but only when used bilaterally. Unilateral amplification provides little benefit perhaps due to poor sound localization of monaural listeners.

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INTRODUCTION

Age-related hearing loss is the 3rd most prevalent chronic disease in the United States, with 17% of adults reporting hearing loss. Only 20% of patients with age related hearing loss are using hearing rehabilitation devices [1]. When patients use this service it is often limited to unilateral amplification, even in the case of bilateral hearing loss.

Balance, like audition and other sensory functions, decreases with aging. The classical view of balance control is based on three main pillars: the vestibular organ, proprioceptive feedback, and visual cues. An increasing body of evidence suggests that the auditory system serves as a fourth supporting factor. Zhang et al. reported a significant benefit in postural balance in healthy subjects when presented with spatial auditory cues [2]. Sound localizing stimuli lead to a decrease in angle deviation in blindfolded healthy subjects performing the Fukuda test [3]. Sound localizing stimuli yield greater decreases in angle deviation in blindfolded healthy subjects when the source is at 0° in the azimuth plane as compared to 30, 45, 90 or via headphones.

Compared to healthy subjects, less focus has been given to balance and audition in the hearing-impaired. A recent study by our team showed an improvement in postural stability in patients exposed to a localizing sound source with hearing aids compared to without hearing aids [4]. Here, we show that hearing aids and cochlear implants have a beneficial effect on dynamic balance compared to unaided situations, especially in subjects with increased vestibular instability.

METHODS AND MATERIALS

Patients were selected from the roster of clinical appointments at the OHSU otology and audiology clinics. Subjects were informed that this was a study examining the impact of sound on balance and navigation under different auditory conditions. Inclusion criteria were use of hearing aids or cochlear implants for > 3 months, hearing loss > 35 dB in each ear, ability to understand verbal commands, and error > 20 degrees in a screen in the unaided condition.

Patients were tested in a standard conference room. A speaker located 1.85 meters in front of the patient at the patient's ear height played a 65dbA white noise during all conditions. Subjects wore goggles that completely obstructed light. Patients with bilateral cochlear implants, bilateral hearing aids, or bimodal were tested under four conditions: both devices on, only the left device on, only right device on, both devices off. Subjects performed a 50 pace Fukuda test and were then moved circuitously and in silence back to the start location to prevent them from gauging performance.

The mean angle of deviation from 0° in the azimuth plane was derived from floor markers.

RESULTS

Fifteen (15) subjects matched our criteria. Of these, seven had bilateral cochlear implants, four had bilateral hearing aids, and four were bimodal users. Ten of these subjects agreed to complete unilateral aided conditions. Subjects using bilateral cochlear implant, bilateral hearing aids, and bimodal (hearing aid and cochlear implant) users were pooled into one group.

Subjects performed better in the bilateral aided condition compared to the unaided condition (p=0.0322, n =15) as well as compared to the unilateral condition (p=0.0163, n=10). There was no statistical difference between the unilateral aided condition and the unaided condition (p=0.626, n=10).

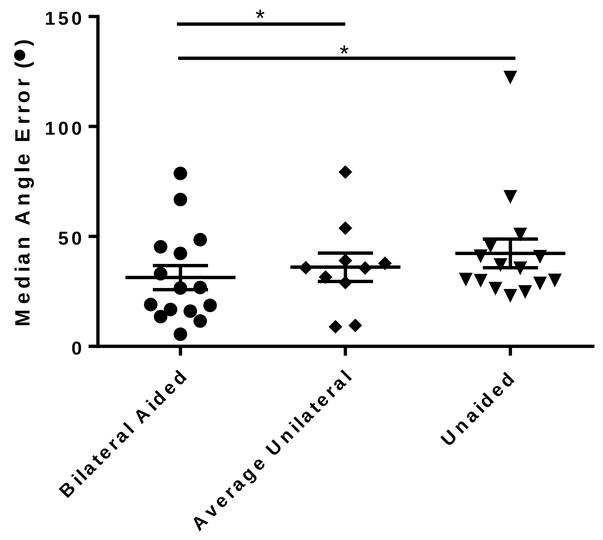

Figure 1. Median angle error in a dynamic balance task under bilateral aided, unilateral, and unaided conditions. Bars are ± SEM.

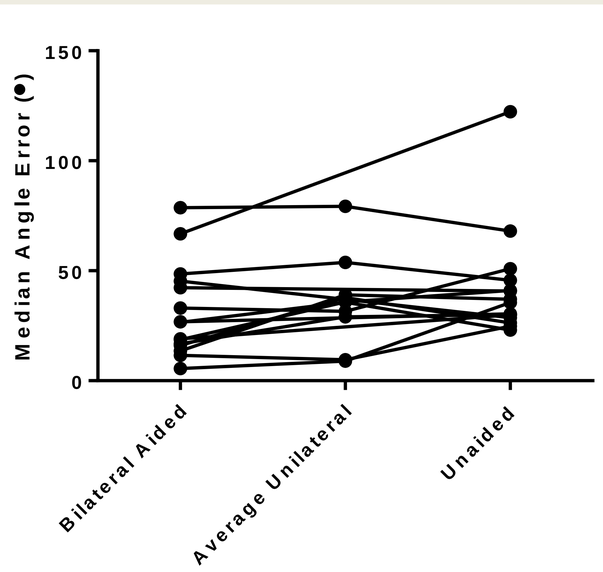

Figure 2. Individual median angle error in a dynamic balance task under bilateral aided, unilateral, and unaided conditions.

DISCUSSION

These results demonstrate that users of bilateral hearing devices perform better in a dynamic balance task with bilateral aids as compared to unilateral aids or unaided. It is notable that the use of unilateral aids was not statistically different as compared to the unaided condition. These findings also suggest that the use of bilateral hearing amplification may be of greater value in patients with vestibular disorders.

When debriefing subjects, a common trend was the belief that they had not moved much from the starting location or that they had not deviated towards one side or the other. Some subjects mentioned having a vague feeling that the speaker was moving, but decided to trust their instincts - believing that they were not deviating - versus the perception that the sound source was moving. The common reason for doing this was feeling uncomfortable with their ability to localize sound.

The pooling of bilateral cochlear implant, bilateral hearing aids, and bimodal users allowed us to compare the bilateral aided, unilateral aided, and unaided conditions. Recent research has suggested that hearing aids either do not improve or actually worsen sound localization abilities [5]. Since our study found an improvement in dynamic balance in bilateral aided individuals, it would be valuable to increase the sample size and determine if this trend holds for bilateral hearing aid users as well as compare performance between modalities. Another intriguing avenue of research would be to examine how patients with vestibular deficits but normal audition perform in this test with and without the benefit of a sound localizing source.

CONCLUSIONS

Our results suggest that bilateral use of hearing aids and cochlear implants can be considered as balance rehabilitation devices. Unilateral hearing amplification did not improve performance in this dynamic balance task, perhaps owing to poor sound localization of monaural listeners.

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