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Understanding benign paroxysmal positional vertigo and comparing its common treatment methods

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Abstract: The following honors capstone research project considers the neurological disorder referred to as Benign Paroxysmal Positional Vertigo (BPPV). BPPV is the most common cause of vertigo and typically effects individuals in the elderly population. BPPV usually results from free floating debris located in one of the semicircular canals within the inner ear. The symptoms of BPPV typically consist of episodes of dizziness or spinning (vertigo) accompanied by nystagmus (rapid involuntary eye movement). Even something as simple as looking to back a car out of a garage can cause the symptoms of BPPV to ignite. As a result, BPPV can have a significant toll on an individual's quality of life. As the older adult population continues to grow as a result of the aging baby boomer generation, the incidence and prevalence of BPPV will correspondingly increase.

Several very successful treatment methods have been developed to properly identify and combat the symptoms of BPPV. Each of these treatment methods are very similar, but result with different outcomes. This project looks to uncover the best possible treatment method for BPPV based on previously completed research. In addition, this project examines BPPV at a physiological and anatomical level while also describing the symptoms, vocational implications, and examination techniques consistent with current research on vestibular disorders.

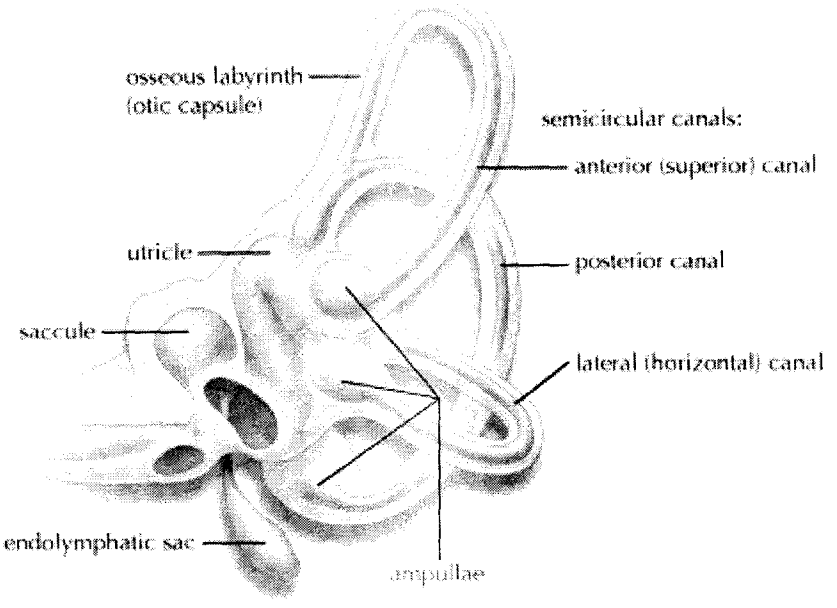
Basic Anatomy and Physiology of the Inner Ear – The Vestibular System

In order for an individual to properly understand what mechanisms are operating incorrectly in a patient suffering from Benign Paroxysmal Positional Vertigo (BPPV), one must have a basic understanding of the anatomical structures and physiological processes present within the inner ear. The ear in its entirety consists of three parts, the outer ear, the middle ear, and the inner ear. Each part of the ear is typically associated with hearing and functions in the receiving and conduction of sound waves. However, the inner ear has the additional function of regulating balance and spatial orientation. The inner ear is a bony structure made up of passages referred to as the labyrinth. The labyrinth can be divided into three different sections labeled the vestibule, the semicircular canals, and the cochlea. The cochlea portion of the labyrinth is responsible for hearing and is closely associated with the cochlear nerve which conducts sensory stimuli from the ear to the brain. Both the vestibule and the semicircular canal are structures within the inner ear that are concerned with balance or vestibular functioning. The vestibule, which is located between the cochlea and the semicircular canals, contains two membranous organs referred to as the utricle and saccule (Figure -1). Collectively, the utricle and the saccule are referred to as the otolith organs. The utricle contains hair cells that have connections to the vestibular portion of the auditory nerve. The utricle senses movement on the horizontal plane while the saccule senses movement on the vertical plane. The otolith organs both contain calcium carbonate crystals referred to as otoconia, which aide in the detection of motion. When an individual moves their head, otoconia stimulate hair cells that transmit nerve impulses to the brain. The semicircular canals consist of three different tube-like structures, each perpendicular to the next, with small sensory hair cells at their base also connected to the vestibular portion of the auditory nerve. These tubes are referred to as the posterior, anterior, and horizontal

semicircular canals (Figure – 1). Each of the three tubes responds to different directions of acceleration or deceleration in rotation. All of the semicircular canals contain endolymph fluid, which is a fluid high in potassium that flows throughout the vestibular system. Depending on what direction of movement that is taking place, endolymph fluid will move throughout the semicircular canals and stimulate a specific movement in hair cells. When these hair cells move, nervous impulses are transmitted to the brain via the vestibular portion of the auditory nerve.

In addition to vestibular balance, several other physiological functions work to sustain an individual's overall sense of balance However, somatosensory balance, visual balance, and vestibular balance are the three main contributors. Somatosensory, visual, and vestibular balance systems all operate in a highly interconnected manner in order to keep an individual's body in equilibrium and maintain proper balance. For example, if an individual suddenly moves their head, immediately endolymph fluid begins to travel throughout the semicircular canals within the inner ear. This movement of endolymph fluid causes sensory hair cells at the base of the semicircular canals to send impulses to the brain. The brain then interacts with the somatosensory system to move muscles and ensure that equilibrium is maintained while the visual system looks to keep objects in focus during this movement. All systems must operate in a synchronized manner in order to maintain balance. Overall, the vestibular system is the command center of balance. It integrates hearing, seeing, and feeling with head movements which it then relays to the brain in order to maintain balance.

Figure -1



(Image from Parnes, 2003, p 683)

Vestibular Dysfunction - Benign Paroxysmal Positional Vertigo

As it was previously mentioned, each system of balance operates in a synchronized manner in order to maintain balance and equilibrium during body movement. If one of these systems happens to be out of order, an individual will feel off balance or dizzy. There are several different causes for this disorientation and dizziness in an individual. A failure in sensory input, poor integration in the central nervous system, or diseased support systems (cardiovascular and metabolic) all can provide the feeling of disorientation or dizziness (Baylor College of Medicine, 2006). Benign Paroxysmal Positional Vertigo is the most common diagnoses made in many specialty clinics serving patients with dizziness (Solomon, 2000). BPPV is a vestibular dysfunction that results from calcium carbonate crystals, or otoconia, somehow making their way

from their original location in the one of the two otolith organs, to one of the semicircular canals (Typically, this movement of otoconia from the otolith organs to the semicircular canals is referred to as Canalithiasis, which is just one of the several different theories that attempt to explain BPPV). As it was previously mentioned, the semicircular canals respond to different directions of acceleration and deceleration in head rotation via the vestibular portion of the auditory nerve. Each semicircular canal is highly sensitive to the movement of endolymph fluid. When otoconia are present in the endolymph fluid within a particular canal it results in an adverse monitoring affect that causes the semicircular canal to monitor head position rather than head rotation (Solomon, 2000). When an individual moves their head in a specific manner consistent with the dysfunctional semicircular canal, conflicting nervous impulses are sent to the brain which result in the symptoms of BPPV. Otoconia can travel from the otolith organs to any of the three semicircular canals and cause the same or similar type of dysfunction (BPPV). However, the majority of cases of BPPV result from dysfunction of the posterior semicircular canal (Parnes, 2003). In a test that examined BPPV in 50 patients, the posterior semicircular canal canal was affected in the majority of cases, followed by horizontal semicircular canal, and the anterior semicircular canal which tends happen very rarely (Bertholon, 2002).

Benign Paroxysmal Positional Vertigo Symptoms and Causes

Because the semicircular canals within the inner ear contribute to an individual's sense of balance, the most typical manifestations associated with BPPV are vertigo, nystagmus, and nausea (Herdman, 1994). Vertigo consists of an illusionary sense of motion, usually described as a spinning sensation, and often thought of in terms of dizziness (Falvo, 2009). As it was mentioned previously, the visual and vestibular systems are interconnected. This connection is further evidenced by the involuntary movement of the eyes (nystagmus) that accompanies

episodes of vertigo. The symptoms of BPPV are typically the same from patient to patient. However, the duration of vertigo and nystagmus may be longer for some patients. Individuals with BPPV tend to have several episodes of vertigo until the disorder is properly treated. These episodes typically follow sudden head movements or jarring of the head. Additionally, approximately 50 percent of patients report imbalance between the classic episodes of vertigo resulting from BPPV (Bhattacharyya et al, 2008). Most commonly, these head positions that induce vertigo involve extension of the neck, with the head turned to one side (e.g. when looking up to a high shelf or backing a car out of a garage), or when the head tilts laterally toward the affected ear. In some cases, a patient can identify the offending head position, which they often avoid (Herdman, 1994). Due to the random nature of these episodes of vertigo, BPPV can have a significant strain on an individual's daily functioning. Often the direct cause of BPPV is idiopathic. However, age (very common in elderly patients), inactivity, head trauma, vestibular neuritis, a family history of BPPV, and other ear diseases, such as Meniere's syndrome, can result with BPPV (Solomon, 2000).

Vocational Issues and Health Care Implications

As it was indicated previously, the symptoms of BPPV can have quite a strain on an individual's daily functioning. Episodes of vertigo can render an individual completely disabled. During an episode, an individual can become nauseous and begin vomiting as well as feel like their environment is spinning out of control. Additionally, the risk of obtaining secondary injuries increases as a result of falling during an episode. These episodes of vertigo that occur as a result of BPPV can certainly cause a significant toll on an individual's work performance, and in some occupations, be hazardous due to the somewhat random nature of episode occurrences. For example, occupations that require employees to climb ladders frequently could be at a risk of

dangerous falls if an episode of vertigo was to erupt. On the other hand, individuals that primarily work at a desk will, at most, become nauseous and be unable to focus on a task during an episode. As a result, depending on an individual's field of employment, it may or may not be necessary to notify their employer so proper accommodations can be arranged. However, depending on the severity of the episodes of vertigo associated with BPPV, and certainly following treatment for BPPV, an individual should be able to continue to work in most environments.

BPPV is the most common vestibular disorder and is typically more prevalent in the elderly population. A primary complaint of dizziness accounts for 5.6 million clinic visits in the United States per year, and between 17 and 42 percent of patients with vertigo ultimately receive a diagnosis of BPPV (Bhattacharyya et al, 2008). As the baby boomer generation continues to age, the incidence and prevalence of BPPV is expected to increase. As a result, proper treatment and a more rapid diagnosis of BPPV will most likely be a component of future health care agendas. Additionally, the financial impact that BPPV will have on health care systems will be considerable. It is estimated that it costs approximately $2000 to make a proper diagnoses of BPPV, and that 86 percent of patients suffer some interrupted daily activities and lost days at work because of BPPV (Bhattacharyya et al, 2008). Overall, it seems that the total costs resulting from the examination, proper diagnoses, and treatment of BPPV will be very expensive. Certainly, more detailed research of BPPV is merited. The development of up to date evidence-based diagnoses and treatment techniques for BPPV could not only save individuals a vast amount of money, but more importantly, advance the diagnoses and treatment of individuals that struggle with this vestibular disorder.

Diagnosing Benign Paroxysmal Positional Vertigo

There are several different medical professionals who receive proper instruction on the diagnoses and treatment of BPPV, such as neurologists and physical therapists. However, because physical therapists are specifically concerned with overall body function, rehabilitation, and the intricacies of balance, they most commonly diagnose and administer treatment to individuals with BPPV. Typically, patients who are diagnosed with BPPV initially meet with a medical professional complaining about dizziness and the associated nausea typical of episodes of vertigo. The medical professional will then do a general evaluation of the patient as well as seek out information concerning the patient's symptoms. Characterizing exactly what the patient means by "dizzy" is the most important step in the evaluation process because there are many different causes of dizziness (Baylor College of Medicine, 2006). Once the medical professional has ruled out all other possible causes of dizziness, a Dix-Hallpike maneuver will administered if the patient is compliant as it does attempt to induce vertigo. The Dix-Hallpike maneuver specifically tests for the presence of BPPV. During the Dix-Hallpike maneuver, the patient's head, sitting in an upright position, is turned to the side. The patient is then moved from the sitting upright position to a supine position (lying down face up) with the patient's head hanging over the edge of the examination table. The Dix-Hallpike maneuver is designed to identify items specific to BPPV by inducing vertigo in a patient and observing the nystagmus that accompanies the episode. The direction of the repeated movement of the eyes during nystagmus identifies the problematic ear as well as the specific semicircular canal that is being affected. There are a number of other pieces of useful information that can also be identified during the Dix-Hallpike maneuver such as; the delay in the onset of vertigo of 1 to 40 seconds after the patient has been placed in the provoking position, the presence of a torsional nystagmus that appears with the

same latency as the complaints of vertigo, and a fluctuation in the intensity of the vertigo and nystagmus that crescendo and then decrescendo, disappearing within 60 seconds (Herdman, 1994).

There a number of other examination techniques that can be implemented to confirm the presence of BPPV in an individual. However, these procedures are much more costly than the Dix-Hallpike maneuver which is primarily a manual procedure as well as a low cost type diagnosing technique. Radiographic imaging is sometimes implemented in cases in which a patient has a clinical history of BPPV and also demonstrates additional neurological symptoms as well as patients that do not respond to manual maneuvers (Bhattacharyya et al, 2008). However, due to the limited nature of the resolution used in graphic imaging it is very difficult to identify the extremely small otoconia present in patients with BPPV. Recent advancements in technology have developed equipment that can quantify balance for comparison. Equipment like the Smart Balance Master allows medical professionals to both quantify and identify balance and vestibular disorders as well as determine if a disorder is getting better or worse (Hain, 2010).

Treatment Options

Several different evidence-based treatment options have been developed to treat the symptoms of BPPV. These treatment options for BPPV are typically very successful, and if carried out correctly, can eliminate the disorder in a matter of days, or in some cases, immediately following one treatment session. However, some treatment methods are more successful and cost effective than others and should be considered as the primary means of treatment for BPPV. The three most common and successful treatment options for BPPV are referred to as the Semont Liberatory Maneuver, the Canalith Repositioning Procedure, and

Brandt-Daroff Habituation. Each of these treatment procedures intends on removing or dislodging debris from the semicircular canals by taking a patient through a set of highly organized movements.

In the treatment option referred to as Brandt-Daroff Habituation, the patient is required to complete a set of exercises that moves them into the vertigo provoking position repeatedly, several times a day, and in some cases where the treatment is not effective the first trial, for multiple days (Herdman, 1994). In the Brandt-Daroff treatment procedure the patient moves quickly from a sitting position into a side-lying position that induces vertigo. The patient then remains in this position until vertigo stops, and then sits back up into the neutral sitting position. The patient then repeats this exercise again, this time moving to a side-lying position on the opposite side. The entire maneuver is repeated multiple times, several times a day until the vertigo stops. In a clinical study that evaluated 67 subjects with BPPV, 98% improved over a treatment duration that lasted from 3 to 14 days using Brandt-Daroff Habituation (Herdman, 1994).

Conversely to Brandt-Daroff Habituation, the Semont Liberatory Maneuver typically requires only one treatment session if successful. The Semont Liberatory Maneuver is very similar to Brandt-Daroff Habituation in that the patient is moved from a sitting position to the side-lying position that induces vertigo; however, the patient must stay in this side-lying provoking position for 2 to 3 minutes before being moved to the opposite side-lying position in which the patient remains for 5 minutes (During the movement from provoking side to opposite side the medical professional maintains alignment of the patient's neck and head). Following the short wait, the patient is then moved back into the sitting vertical position in which they are recommended to stay in for the next 48 hours. Additionally, the patient must avoid the

vertigo inducing, or provoking, position for 1 week following the treatment. In a treatment study that examined 711 patients with BPPV, 84% improved after only one treatment session of the Semont Liberatory Maneuver (Herdman, 1994).

The Canalith Repositioning Maneuver is almost identical to the Semont Liberatory Maneuver in that a patient is moved from the sitting position to the provoking side-lying position for 2 to 3 minutes. However, after this 2 to 3 minute delay, the medical professional will manipulate the patient's head lowering it below the examination table and turning it similar to the Dix-Hallpike diagnosing technique. The patient then returns to the upright position in which they are to remain for 20 minutes. In addition, the patient is recommended to avoid the provoking side-lying position for one week. In a clinical study that examined 30 patients suffering from BPPV, 90% of patients improved following one session of the Canalith Repositioning Maneuver (Herdman, 1994).

Conclusions

Benign Paroxysmal Positional Vertigo is not a life threatening disorder. However, it can cause a significant amount of distress in an individual's day to day life if left untreated. As the elderly population continues to grow as a result of the aging baby boomer generation, so will the cases of balance disorders like BPPV. Because there are conflicting beliefs, or theories, on the physiological cause of BPPV, the treatment methods implemented by medical professionals tend to vary. With evidence-based practice becoming more and more important for insurance company validation and overall patient satisfaction, the best available treatment options should be employed primarily in every patient suspected of having BPPV. Additionally, given that BPPV is more common in the elderly population, treatment options that are less invasive and

only require one treatment session, like the Semont Liberatory Maneuver and the Canalith Repositioning Maneuver, should be implemented. Additionally, unnecessary financial costs that come with multiple treatment sessions resulting from application of treatment procedures like Brandt-Daroff Habituation can be eliminated by using treatment approaches that only require one session. Implementing a universal treatment approach that first uses a treatment maneuver that only requires one session can both be financially sound and physically safe for patients suffering from BPPV.

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