תפקודה של המערכת הוסטיבולרית

בקרב אנשים מבוגרים עם פיגור שכלי

פרופ' אלי כרמלי

החוג לפיזיותרפיה, בית הספר למקצועות הבריאות ע"ש סטנלי שטייר,
אוניברסיטת תל אביב

עוז צור

המרכז הישראלי לטיפול בסחרחורת ובחוסר שיווי-משקל, רעננה

מחקר זה נערך בסיוע מענק מחקר מקרן שלם
הקרן לפיתוח שירותים לאדם עם מוגבלות שכלית התפתחותית ברשויות המקומיות
2007

קרן שלם/014/2007

תוכן עניינים

תקציר עברית

רקע :הסבירות לנפילות עולה עם עלייה בגיל .אולם, מעט מאד תשומת לב מחקרית ניתנת למאפייני שיווי משקל בקרב אנשים מבוגרים הלוקים בפיגור שכלי שאינם ב"כ מתלוננים על כך, ובמיוחד לוקה המחקר בחקר הקשר בין יציבות לתפקודים וסטיבולריים.

מטרה :לבחון את היארעות המגבלות במערכת הוסטיבולרית בקרב מבוגרים עם פיגור שכלי.

שיטות: 29 :נבדקים נבדקו בשני שלבים .הראשון כלל 4 מבחנים שונים לאבחון ליקוי ברפלקס ה VORוהשלב השני כלל מבחני יציבות באמצעות פוסטוגרף.

תוצאות .בעקבות ארבעת המבחנים, בתשעה נבדקים (30%) נמצא ליקוי ברפלקס VOR ממדידת הפוסטוגרף נמצא שמתוך 9 הנבדקים ,ל 7 מהם היו מימצאים חיוביים המעידים על ליקויי יציבה על רקע וסטיבולרי.

מסקנות: סקירת רפלקס VOR בקרב אנשים עם פיגור שכלי יכולה לתרום לגילוי מוקדם של הפרעות בשיווי משקל ולהמליץ על דרכי התערבות ומניעה.

תקציר באנגלית

Abstract

Aging increases fall probabilities. Yet, scientists paid little attention to intellectually disabled (ID) adults' balance deficiencies, nor to the relationship between their postural stability and vestibular functions. The purpose of this study is to evaluate the incidence of vestibular impairment in ID adults. Twenty-nine ID adults participated in this study. The procedure consists two phases. Phase one aims to identify Vestibulo- Ocular Reflex (VOR) deficiencies. Phase two aims to evaluate postural stability. According to the 4 clinical tests (S/D, HIT, HSN, D&H) nine patients (30%) showed a dysfunctional Vestibular Reflex. During the CDP test, out of the above nine subjects, seven (90%) showed a positive test and low functioning of vestibular system.

מבוא

Introduction

People with intellectual disability (ID) live long life than two decades ago. Hence that population suffers from increasing of diseases due to age, such as hart disease, blood flow and postural imbalance. Ageing people with ID are recognized as a group with special needs requiring special social dispositions. Falling is the main reason for the arrival of elderly people of 65 years and above to emergency rooms[1, 2]. Fall's probability increases with age, and impaired balance in older adults with ID present a special challenge to the health care system (Carmeli and Coleman, 2001).
Older adults generally serve as subjects of many researches aimed to identify extrinsic and intrinsic factors related to falls. As opposed to them, scientists paid little attention to ID adults in general and to their balance deficiencies in particular (Carmeli et al, 2003). Zur et al 2004 showed a correlation between vestibular dysfunction and falls in the elderly, but that correlation not yet known at the ID population. Studying the balance in ID older persons might be a valuable tool in evaluating these individuals' risks of fall and sustained accidents during movements.
The purpose of this study is to evaluate the incidence of vestibular impairment in individual adults with ID.

Method

Participants

Twenty-nine participants, 34 to 57 years of age (mean 48.6±, 16 males 13 females) were chosen from a non-randomly selected sample of 102 permanent residents from a foster home located in Ranana, Israel.

The selected participants, excluded minimal loss of visual acuity using the Graham field chart (able to see at least 5 lines at the eye doctor chart), able to verbally communicate, lived at least 5 years in the foster home, were well familiar with their care-takers and independent with all activities of daily life (ADLs).

The IQ level was evaluated by using the full scale Wechsler Abbreviated Scale of Intelligence) with mean of 57.88±6.70 (Hays et al., 2002).

Ethic Procedure

The study was performed in accordance with the Helsinki declaration approved by the National Institute of Child Health and Human Development, Office of the Medical Director, Division for Mental Retardation, Ministry of Social Affairs and by the ethics committee of the foster home. Oral and written consents were appropriately obtained for each participant and/or his caregiver.

Assessment of health status

Medical records include medications and health history.

Testing

The same professional physiotherapist performed all tests.

The testing procedures have been divided to two phases.

The first phase includes 3 clinical tests aimed to identify Visual Acuity, Vestibulo-Ocular Reflex deficiencies (VOR). Once the VOR has been accessed, participants moved to the second phase of the study, aimed to evaluate their level of postural stability, Vestibulo-Spinal Reflex (VSR), using the Dynamic Posturography (DPG).

First phase of testing procedure

Three clinical tests that evaluating the VOR: the Static and Dynamic Visual Acuity Test (VAT-S/D) (Herdman, 1994; Herdman, 2001), the Head Impulse Test (HIT) (Hamagyi, 1990), and the Head Shaking Nystagmus test (HSNT) (Aswvichianda, 1999; Kamei, 1988).

Tests procedure

The tests took place in the morning hours, and at least an hour after breakfast, in order to avoid discomforts such as nausea and lasted approximately twenty minutes each with a two-minute resting period in between tests. After which, the participants received an explanation regarding the process and rationale of the following test. All the tests were performed while the patient sat on an average chair with its center at a distance of 1.22 m from a Graham field chart.

Visual Acuity Test VAT-S/D (n=155) [11, 21]

The sensitivity of the clinical VAT-S/D for vestibular loss is approximately 85%, and its specificity 55%. [25] For this test, the clinical tool was a Graham field chart, hung on a wall at eye length, with 11 rows of numbers arranged on a descending scale from top to bottom, equivalent to 20/200 vision. The test was considered a success if the subject was able to read a row with no more than two mistakes. The VAT-S/D was divided into Static and Dynamic stages.

During the Static Test, the participant was asked to sit motionless and read complete rows from the Graham field chart to the maximum of their ability.

The test lasted 60 to 90 seconds. During the Dynamic Test, a similar process was employed except that the examiner stood behind and moved the participant's head, with both hands on the sides of his head, from side to side at a frequency of 2Hz. This was paced using a metronome set at 60 beats per minute.

The VAT-S/D test was scored according to a dichotomous scale, of 0 = normal VOR, recorded when the difference between the Static Stage and the Dynamic Stage is three rows or less; 1 = abnormal VOR, when the difference between the Static Stage and Dynamic Stage more than three rows. The VAT-S/D gave no indication which ear was affected.

Head Impulse Test (HIT) (n=155) [22]

The HIT, presented by Halmagyi,[22] aims to identify unilateral vestibular loss and shows a low sensitivity of approximately 35%, but a high specificity of 95%.[26] The patient was instructed to focus on the digit 0, black on white, 2.5 cm wide and 3 cm high, located on the third row between two other digits, equivalent to 20/70 vision. The tester sat facing the participant, to his right, and rotated the participant's head from side to side 20-30 degrees, at a high velocity.

The test was scored according to a dichotomous scale of 0 = normal VOR, if the participant managed to stay focused on the digit 0 whilst the head was moved; 1 = abnormal VOR if the tester identified at least two eyeball slidings towards the direction of the head movement followed by a quick shift of the eye in the opposite direction, indicating the side of the vestibular deficiency.[27]

Head Shaking Nystagmus Test (HSNT) (n=129)

As reported by Kamei,[24] the HSNT shows a low sensitivity of approximately 35% for identifying unilateral vestibular loss, but a high specificity of 92%.[24] The test took place in a dark room with the participant wearing internally lit Frenzel glasses. These glasses magnify the eyeball and prevent gaze stability, which enables the examiner to identify nystagmus when it appears. Each participant was instructed to close both eyes while the tester rotated their head 20 to 30 times around the vertical axis at a frequency of 2Hz, on nystagmus was measured on cessation.

The HSNT test was scored according to a dichotomous scale, of 0 = normal VOR in the absence of nystagmus, and 1 = abnormal VOR upon the appearance of more than three beats of nystagmus. The slow phase of nystagmus helps to determine the side of the lesion.

second phase of testing procedure

One laboratory test: the Computerized dynamic posturography (CDP, Equitest - NeuroCom International, Inc., Clackamas, Ore., USA).

Tests procedure

The test took place in the morning hours, approximately thirtin minutes for each participants. Each participants heared the rational of the test. Every one of them agreed to stand on the Lab mechin (CDP) and know that he/she can stop the test when ever he/she ask for. Each test done 3 times and the average is the result of this test.

Computerized Dynamic Posturography (CDP)

The CDP is used to check upon the sensory input and functional integration of the balance systems at three different systems, i.e. the visual, somato-sensory and the vestibular. In the same time the CDP is able to assess the patient's adaptive state. The CDP is an integral part of the comprehensive clinical evaluation. Body sways were measured based on the strength needed by the patient to maintain balance while standing on a forceplate and monitored with strain gauges located in the forceplate. Six stance conditions — the sensory organization test (SOT) is used to evaluate the patient's ability to react to vestibular, visual and somato-sensory cues and his choice of appropriate sensory input(s) to maintain his balance. The sensory cues are statically altered in conditions #1 and #2 - the classic Romberg test. These sensory cues are dynamically and systematically interrupted or distorted in various combinations (conditions #3-#6) to suggest immobility while the participant is actually moving. This test is aimed to measure the participant's ability to choose the right mechanisms enabling him to overcome these sensory disturbances. In addition, the motor control test (MCT) is used to measure the patient's capacity to regain balance in response to sudden body perturbation. The latency of the automatic postural response is measured as the laps of time, in milliseconds, between the force plate onset and the initiation of motor response to maintain balance. The normal SOT and MCT results of a normal participant are depicted in a graphical mode in Fig 1.

Statistical analyses

Statistical analyses were performed using the (SPSS 10).

Standard procedures were used for all variables to calculate mean ± SD, percentages and correlation coefficient (Pearson r).

Statistical significance was accepted at an alpha level $P < 0.05$.

Results

Participants did not conclude all 3 clinical tests (Table 1).

The tests checking the VOR show that out of a total of 29 participants, 4 (18%) presented SD positive; 4 (17%) presented a positive HIT and only one (4%) presented a positive HSN.

According to the clinical tests (S/D, HIT, HSN) seven participants (24%) out of 29 showed a dysfunctional Vestibular Reflex. During the CDP test, out of the above seven participants, six (86%) were found with a damaged and low vestibular functioning.

Two out of the same six participants were diagnosed with deficient balance system and low responsiveness to intentional balance disturbance.

It also seems that those two participants do not focus the central mass of their body in accordance with their basic center of support, which probably expose them to a higher risks of falls

Four participants (14%) of twenty-nine participants were diagnosed with positive S/D. An additional four participants (14%) were diagnosed with positive HIT and One more participant was diagnosed with positive HSN

Discussion

The basic task of the vestibular system is to provide gaze and postural stability. The vestibular system is sensitive to acceleration and deceleration of head movements. One of the vestibular system's main roles is to oppose gravity and maintain the body erected by constantly transmitting to the brain accurate positional information in order to prevent falls. Patients suffering from Vestibular deficient may become predictably unsteady unless they orientate their body in accord with a partially redundant visual reference.

With age there is a reduce in the vestibular system which becomes less sensitive. The number of their hair cells is low and their flexibility. The exact mechanism leading to vestibular dysfunction among adults with ID is not known. The observed abnormalities of the 4 clinical tests among 30% of the participants can be explained by the lack of vestibular compendium, and possibly due to early changes of vestibular receptors, known as a "pre mature aging" (Blomgern, 1989; Kramer & Hinojosa, 1999). In comparison with the healthy population of the same age, the findings are remarkable (REF). Nevertheless, it is important to mention that no single test of vestibular function exists to date that is 100% accurate in the diagnosis of individuals with vestibular dysfunction.

The HSNT is a clinical screening evaluation tool for central vestibular system disease, the head shaking awakes the manifestation of an underlying latent nystagmus. HSN reflects a directional asymmetry in vestibular responses. Baloh RW et al., 1977 suggested that the central velocity storage mechanism consists of a positive feedback interneuron loop at the level of the secondary vestibular neurons in the brain stem. Whereas the effect of vestibular storage in the healthy ID vestibular apparatus is manifest by a preservation of increased activity in the secondary vestibular neurons of the brain stem after return of the primary vestibular neurons to their baseline discharge rate after a head-movement stimulus. Alternately, head shaking may allows a spontaneous manifestation of nystagmus, so fare hidden by inhibitor mechanisms. A spontaneous nystagmus unilateral beat might be a clue to a peripheral vestibular lesion. ID individuals with asymptomatic or poorly diagnosed unilateral vestibular weakness, a Back and forth head shake leads to an asymmetry in the stimulation of the secondary vestibular neurons due to the ampullpetal-ampullofugal imbalance. It is also probable that the cognitive and vestibular deficiencies are limiting the brain spontaneous compensation and rehabilitation abilities. Yet, these do not explain why nystagmus appears after the head come to rest. The presence of a bilateral peripheral vestibular weakness is not usually cued by a nystagmus. It is well known that vestibular deficiencies can be ameliorated among the regular population by a brain spontaneous compensation (REF) or by directed exercises (REF). However, seven out of the nine patients show no compensation what so ever. The probable cause for this lack of amelioration is a central deficiency diminishing any possibility for brain spontaneous compensations.

Kamei T 1975, suggested that HSN is a recovery nystagmus that caused by a return of function on the side of lesion that then makes prior central adaptation in response to the original lesion inappropriate, and therefore HSN reflects adaptation in the vestibular nerve.

The sensitivity of the HIT was not equivalent to that for HSN in our study. Thus, HSN is superior over the HIT as a screening tool, and the clinician can be reasonably confident that a true vestibular lesion is present when HSN is abnormal. It is important to indicate that HSNT evaluates the upper end (> 1 Hz) of the frequency range, which is not measured with caloric test (i.e., low frequency) or by rotary chair (i.e., low-and-middle frequency) stimulation. Changes of the high-frequency VOR function among ID individuals demonstrating a positive HSNT could implicates a) a mechanical factors in the neck area; b) voluntary limitation to restrict of high-frequency head movement to such a levels which provoke dizziness. This finding seems more important due to the fact that the incidence of dizzy patients was low.

The postural instability of patients with positive D&HT reflecting BPPV which consist nystagmus associated with vertigo that is elicited by position changes, and increased by anterior-posterior sway. Once diagnosed, a specific treatment using canalith repositioning maneuver is proposed by Blatt PJ et al can improve balance in most patients. If balance does not improve with the treatment of the BPPV, then patients should be referred for balance exercises.

Three of the patients with a positive motor control test (MCT) show an imminent fall risk due to slow automatic responses. MCT used to measure the patient’s capacity to regain balance in response to sudden body perturbation. Thus, a low internal balance response to correct a sudden sway of central body weight outside of the central support point is revealed by MCT. Those three patients kept their central weight mass outside of the central support point even during a steady test of the COG.

From a clinical diagnosis and therapeutic perspectives it is important to determine a) the adaptive strategies currently in use by the patient; b) what type of abnormality is present; and c) whether the treatment aims and plans can be accomplish given restraints forced by the above information.

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				Digit T	**Head M.**	**Contact Glasses**	**Spinal Lying**						
Code	Birth Year	Age	Gender	S/D	HIT	HSN	BPPV	EO	EC	Dome	fEO	Fec	fDome
1	1950	54	ז					0	0	0	0	0	0
2	1956	48	ז					0	0	0	0	0	0
3	1958	46	נ					0	0	0	0	0	0
4	1950	54	נ			1		0	1	1	1	1	1
5	1939	65	ז		1			0	0	0	0	1	1
6	1958	46	נ	1				0	0	Anxiety	0	1	Anxiety
7			ז					0	0	0	S	1	1
8	1950	54	נ				1	0	0	0	0	0	0
9	1959	45	ז				1	0	0	0	0	0	0
10	1954	50	ז					0	0	0	0	0	0
11	1958	46	ז					0	1	1	S	1	1
12	1967	37	ז	1	1			0	0	0	0	0	0
13	1950	54	נ					0	0	#	S	1	#
14	1955	49	ז					0	0	0	1	1	1
15	1953	51	ז	1				0	0	0	0	1	0
16	1964	40	ז					NA	NA	NA			
17	1955	49	נ										
18	1956	48	נ										
19	1951	53	ז										
20	1953	51	ז					0	0	0	0	1	0
21	1954	50	נ					0	0	0	1	1	1
22	1956	48	נ					0	0	0	0	1	1
23	1959	45	נ					0	0	0	0	1	1
24	1960	44	נ					0	0	0	0	1	1
25	1956	48	נ		1			0	0	0	0	1	1
26	1948	56	ז					0	0	0	0	1	1
27	1947	57	נ	1	1			0	0	0	0	1	1
28	1970	34	ז					0	0	0	0	0	0
29	1966	38	ז					0	0	0	0	0	0

				Digit T	Head M.	Contact Glasses	Spinal Lying						
Code	Birth Year	Age	Gender	S/D	HIT	HSN	BPPV	EO	EC	Dome	fEO	fEC	fDome
4	1950	54	נ			1		0	1	1	1	1	1
5	1939	65	ז		1			0	0	0	0	1	1
3	1958	46	נ	1				0	0	Anxiety	0	1	Anxiety
8	1950	54	נ				1	0	0	0	0	0	0
7	1959	45	ז				1	0	0	0	0	0	0
	1967	37	ז	1	1			0	0	0	0	0	0
	1953	51	ז	1				0	0	0	0	1	0
	1956	48	נ		1			0	0	0	0	1	1
	1947	57	נ	1	1			0	0	0	0	1	1

The Shalem Fund
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مؤسسة "شاليم" لتطوير خدمات للشخص ذو التخلف العقلي في السلطات المحلية
פיתוח שירותים לאדם עם מוגבלות שכלית התפתחותית ברשויות המקומיות

צור·ZUR
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Postural deficiency in intellectually disabled adult with vestibular impairment

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ספריית קרן שלם

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