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Disequilibrium and Its Management in Elderly Patients

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Abstract: Dizziness, a frequent occurrence in the elderly, carries substantial health and quality-of-life consequences for patients. Disequilibrium of the elderly refers to dizziness or ataxia (or both) without apparent localizing signs and is typically attributed to the aging process. In many cases, disequilibrium is multifactorial and worsened or triggered by multiple medications and iatrogenicity. This review provides an update of the literature concerning elderly multifactorial imbalance and discusses factors that may trigger falls. The author reviewed the underlying pathophysiology of disequilibrium along with an assessment of how current evaluation methods and exercise protocols are used to help prevent falls in the elderly. Patients must be stimulated to perform customized physical exercises under safe conditions, considering their general state of health. The objectives of current programs are to encourage patients to develop an efficient personalized strategy of equilibrium and to increase their level of physical activity, autonomy, and safety to reduce the potential for falls.

Key Words: disequilibrium; dizziness; elderly; falls; prevention

Dizziness is a frequent occurrence in the elderly, and it carries substantial health and quality-of-life consequences, as it is associated with balance disorders, functional and psychosocial decline, and an increased risk for falls. Up to 65% of individuals older than 60 years experience dizziness or imbalance, often on a daily basis. Several subtypes of dizziness have been described, including vertigo; presyncopal lightheadedness (caused by orthostatic hypotension, decreased cardiac output, vasovagal attack, or hyperventilation); and disequilibrium, along with psychophysiological, ocular (e.g., occurring in patients who have had a lens implant after cataract removal, in the correction of astigmatism, or are required to use higher magnification), multisensory, and physiological dizziness (e.g., motion sickness or height vertigo) [1]. The term *presbyastasis* has been proposed to encompass the disequilibrium of aging and usually refers to dizziness or ataxia (or both) without apparent localizing signs. It is typically attributed to the aging process, and some have argued that disequilibrium should even be considered as part of a general geriatric syndrome [2]. For the patient, disequilibrium is often described as a feeling of unsteadiness in standing or walking that is not present while sitting or lying down. Patients with disequilibrium often complain of vertigo, lightheadedness, or a similar "head" sensation as the primary symptom, but disequilibrium can also occur in isolation [3].

Resolving the problem of whether dizziness without a localizable lesion should be attributed to aging per se is difficult, as most elderly exhibit a degree of measurable sensory or central nervous system deficit as compared with younger people. The fear of falling in the elderly can induce a post-fall syndrome and may also initiate certain spatial and temporal gait parameter changes, resulting in slower gait speed, shorter stride length, increased stride width, and prolonged double limb support time [4]. Rapid treatment is, therefore, required to prevent psychological distress, leaving patients too afraid to leave home or engage in other physical activities.

Health care professionals use various strategies to try to improve equilibrium in elderly patients. Recent data suggest that vestibular rehabilitation therapy plays an important preventive role in reducing falls in at-risk elderly patients experiencing disequilibrium [5–7]. Vestibular rehabilitation, the primary treatment for many

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causes of dizziness, consists of several tailored exercises designed mainly to substitute for loss of vestibular function by relying more on other senses—to enhance gaze stability during head movements, to increase motor control, to create sensory conflicts, and to develop more efficient postural strategies.

This review considers the underlying pathophysiology of disequilibrium and discusses current evaluation methods and how exercise protocols can improve equilibrium to help prevent falls in the elderly.

ETIOLOGY AND RISK FACTORS FOR DISEQUILIBRIUM

Magnetic resonance imaging (MRI) studies of elderly patients with disequilibrium and gait disturbances of unknown cause have revealed frontal atrophy and subcortical white-matter T_2 hyperintense foci [8]. Pathological studies also suggest frontal atrophy, ventriculomegaly, reactive astrocytes in the frontal periventricular white matter, and increased arteriolar wall thickness [9]. The aging vestibular system shows a gradual attrition of neural and sensory cells, including a reduction in the number of hair cells and nerve fibers [10,11]; centrally, the number of cerebellar Purkinje cells declines gradually over time [12]. Neuronal and fiber loss also occurs in the extrapyramidal system [13], and postural control undergoes gradual deteriorations with age, along with an appreciable reduction in general reaction time. Numerous processes, therefore, deteriorate with time, and chronic disequilibrium in the elderly is generally multifactorial.

Several risk factors have been linked with disequilibrium in the elderly. Intrinsic factors result from sensory visual impairment such as in glaucoma, age-related macular degeneration, or loss of visual acuity resulting from various etiologies. Additional intrinsic factors include muscle weakness; neurological lesions; neuropathy associated with diabetes; osteoarticular and musculotendinous disorders, such as arthritis of the hip or knee; narrowing of the lumbar vertebral canal; and lumbago-sciatica. The ingestion of multiple medications without sufficient precautions concerning side effects and interactions are notable risk factors for dizziness. In elderly patients in particular, it is necessary to be particularly vigilant with treatments prescribed for hypertension (notably diuretics), anxiety, or depression and also with the intake of over-the-counter (OTC) drugs. Cognitive impairment and high levels of alcohol consumption are other important considerations.

Extrinsic or environmental risk factors such as stairs and other indoor obstacles and the sensation of darkness at home may also contribute to the provocation or aggravation of disequilibrium [14].

CLINICAL EVALUATION OF EQUILIBRIUM AND GAIT

The first step in determining the cause of dizziness is to define exactly what the patient is experiencing and to determine any associated symptoms. The greatest challenge in the evaluation of patients is to pinpoint, among the many potential causes of the presenting symptoms, the type of psychological manifestations and whether they are a cause or a consequence of vertigo [15].

Clinical features can forecast a cause to which dizziness can be attributed in the majority of older patients and thus guide general practitioners in their choice of treatment and in referral to an appropriate specialist. The presence of syncope, falls, or cardiovascular comorbidity increases the probability of a cardiovascular diagnosis. Although otolaryngological investigations are rarely diagnostic, symptoms described as vertigo generally predict peripheral vestibular disorders.

The diagnosis of dizziness can be difficult, especially in elderly people in whom symptoms reflect dysfunction in more than one body system and signs on examination could indicate early features of neurodegenerative disorders [16]. Although many cases of dizziness are actually neurological [17], an MRI scan alone is unlikely to determine a specific cause for dizziness [18], and vestibular tests may fail to discriminate dizzy subjects from controls and to differentiate between various dizziness syndromes [19].

Establishing the patient's medical history is of particular importance. Information concerning the physical, cardiovascular, sensory, and neurological status of the patient and detailed information on routine use of all prescribed and OTC drugs are critical.

It is also essential that a complete and accurate clinical examination of gait and stance be performed, and the opinion of a neurologist may have to be sought. The spontaneous gait of elderly patients can be evaluated along with the speed, trajectory, and length of stride, the size of the base of support, and the amount of arm swing [20]. Other clinical elementary tests must be performed. In the "timed up-and-go" test, the patient is simply asked to stand up, walk three meters, turn, walk back, and sit down again [21,22]. People taking longer than 30 seconds are classified as physically dependent, whereas those taking less than 20 seconds are considered normal. There is some controversy, however, concerning the time taken, with some authors giving a 14-second cutoff point; this is probably dependent on the population studied, with some patients in hospital and others in community dwelling. Shumway-Cook et al. [23] added an additional task, either cognitive or manual (walking with a glass in the hand), but concluded that it did not add to the ability to predict falls. The "Tinetti test" [24] is also a common test to evaluate stance and gait, even if it is

more time-consuming. Another test to predict the likelihood of falls is standing on one leg, as instability is the major cause of falls in normal elderly patients [25]. More than 50% of patients older than 75 years had difficulty in standing on one leg for more than 5 seconds.

Collectively, these tests enable us to characterize different features and distinguish a diagnosis of frontal ataxia wherein patients seem to have forgotten the mechanisms of locomotion, with their feet crossing each other and moving in wrong directions, which results in a Parkinson-type gait (festinating gait and flexed posture) or an uneconomic posture (a "walking-on-ice" posture pattern that renders patients prone to sudden buckling of knees, usually without falls, suggesting features of psychogenic dysfunction) [26]. We should also apply an evaluation scale of the repercussion of dizziness in patients' quality of life, such as the "dizziness handicap inventory" questionnaire [27].

An accurate otoneurological evaluation should be performed. We start with some bedside tests, including Romberg, Unterberger, head-shaking, and Halmagyi tests and the Dix-Hallpike maneuver. Sometimes a videonystagmography or electronystagmography examination is added, assessing gaze nystagmus, saccades, smooth pursuit, optokinetic nystagmus, and rotational and caloric tests. Additional tests can also be performed to evaluate otolith function. Hearing assessment and dynamic posturography provide valuable data. Computed tomography,

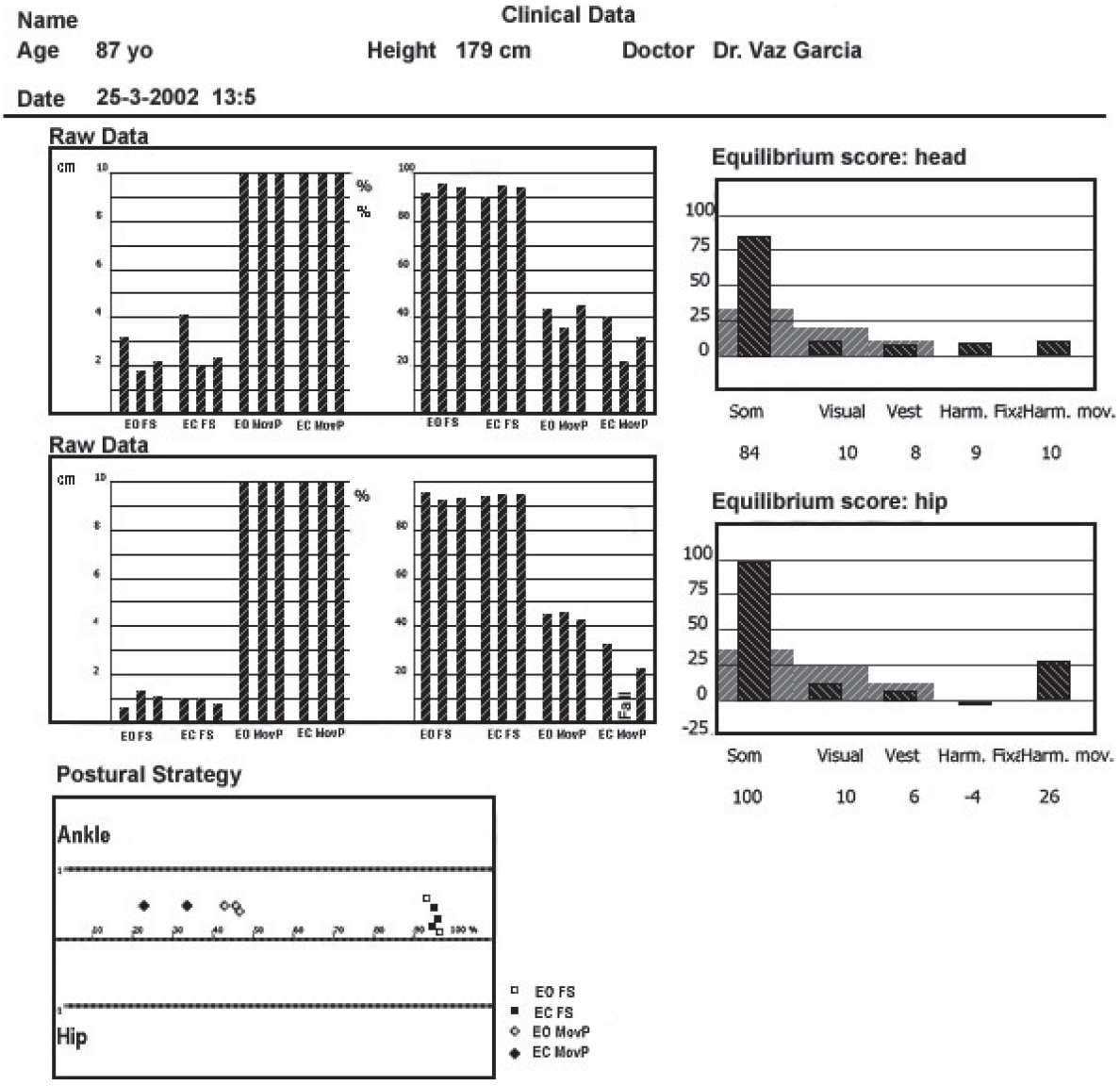

Figure 1. Multisegments posturography (STATITEST) examination of a patient showing a predominance of the somatosensory input. Shown are ankle strategies in the four situations (eyes open [*EO*] and eyes closed [*EC*] over a firm surface [*FS*]; eyes open and eyes closed over a movable platform [*MovP*]). One fall was recorded.

MRI scans, ultrasonography, and ophthalmological examination may be used in conjunction with other objective examinations.

Dynamic posturography is an important tool to evaluate balance disturbances. Deficits assessed by different types of sensory tests (e.g., Sensory Organization Test [SOT], Clinical Test of Sensory Interaction on Balance [CTSIB]) reflect somatosensory, visual, or vestibular system function. In all, patients stand on a platform that measures postural sway in different conditions (with eyes open and closed, on fixed and movable support surfaces and, in some systems, with sway referred to visual surround and support surface). According to the type of dynamic posturography, other different parameters and measures can be obtained. For instance, it is possible to evaluate the center of gravity alignment during every condition: Postural strategy analysis determines whether a hip or an ankle strategy is being used, assesses postural automatic reactions to unexpected disturbances, evaluates the limits of stability, and determines sway scores at different levels of the body (Fig. 1).

A posturography device is currently used to screen for balance disorders [28,29]. This apparatus records sway in stance and gait in both roll and pitch planes. It has the advantage that it can be used in the standard clinical tests for stance and gait, including walking up and down stairs or over barriers, the timed up-and-go test, during standing on one or two legs, walking while rotating the head, and the like (Table 1). Trunk sway velocity, angle, and amplitude, and duration from different gait tasks can be compared with a normal population of the same age (Fig. 2).

Table 1. Tests Commonly Used with SwayStar Equipment in the Screening of Elderly Fallers

Standing on two legs eyes open (EO)
Standing on two legs eyes closed (EC)
Standing on the left leg EO
Standing on the right leg EO
Walking three meters rotating head
Walking eight tandem steps EO
Walking up and down stairs
Get up and go three meters

In a comparison of the scores achieved in elderly people, visual cues are seen as more important for postural control than in younger subjects [30,31], and it is likely that sway velocities are also greater in the elderly [31]. Regarding postural strategies, in a study comparing three different groups of patients suffering from Parkinson's disease, vestibular loss, or a somatosensory deficit to a normal population, the strategy was found to be

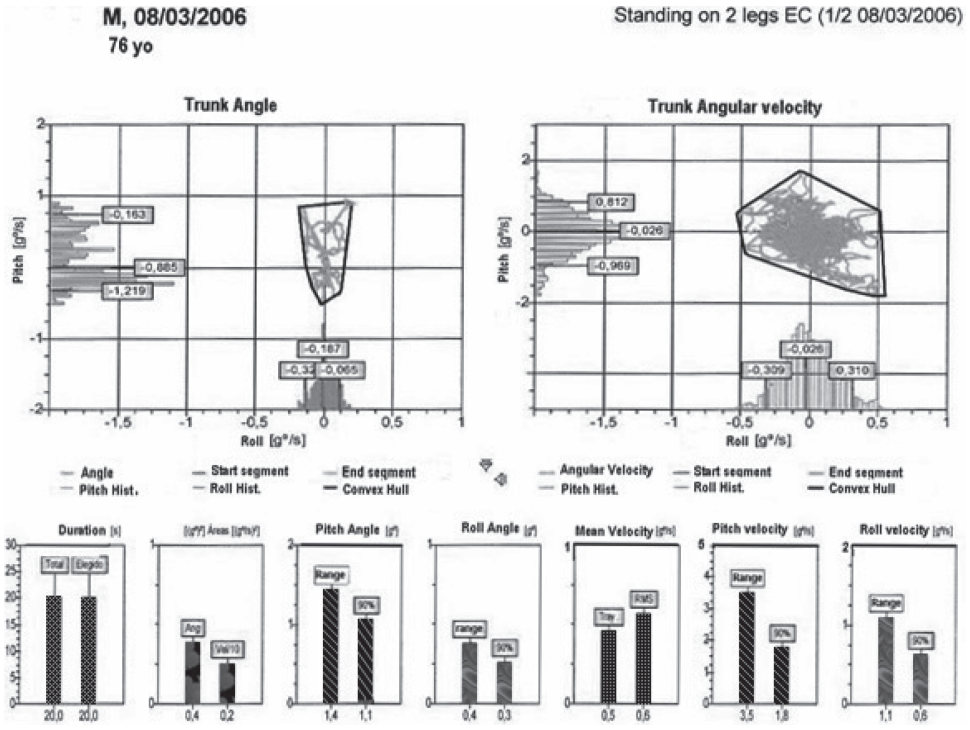

Figure 2. Trunk sway patterns of an elderly patient with disequilibrium performing the task of standing on two legs, eyes closed (*EC*), on a normal support surface (SwayStar system). Data are shown as an *x-y* plot of pitch (vertical axis) versus roll (horizontal axis). The row of plots shows the *x-y* plots of trunk pitch and roll velocities. The envelope of excursions in each plot is presented as the convex hull. Below are bars corresponding to the parameters evaluated: duration, areas, trunk angle, and velocity on pitch and roll planes. The data related with angles and velocities are compared with those from a population of the same age without disequilibrium complaints, with 90% confidence intervals. Root mean square of velocity and mean path velocity are also shown.

very complex in parkinsonian patients; an ankle strategy was seen in vestibular patients and a hip strategy in somatosensory deficit [32]. The posturography examination using force platforms (the large majority) is of interest in terms of the predictive value for subsequent falls. In a review of 175 articles published from 1950 to April 2005, the following were shown to be predictors of the potential for future falls: the mean speed and amplitude of the mediolateral movement of the center of pressure during normal standing (eyes open and closed) and the root-mean-square value of the mediolateral displacement of the center of pressure [33].

MANAGEMENT OF DISEQUILIBRIUM

In the elderly, our unwillingness to subject patients to extensive diagnostic evaluations can precipitate problems. For example, one study revealed a high prevalence of bilateral vestibulopathy in elderly patients experiencing disequilibrium or dizziness of uncertain cause [34]. The approach to the management of dizziness of nonlocalized cause in the elderly should be cautious and empirical.

Dizziness should be approached both as a symptom and as a syndrome. Physicians should exclude potential curable causes of dizziness and consider dizziness as a symptom of specific diseases. As dizziness in the elderly is often multifactorial, it should also be treated as a geriatric syndrome [35]. Physicians should, therefore, identify risk factors for recurrent dizziness. Specific causes of dizziness should be addressed, as should contributing factors. Vestibular and balance rehabilitation with an interdisciplinary collaboration should be rapidly initiated to avoid psychosocial complications, such as fear of falling [36].

As in the younger population, drug treatment may be helpful in the treatment of dizziness. For example, betahistine (a structural analog of histamine with partial histamine H_1-receptor agonistic and potent H_3-receptor antagonistic properties that promote and facilitate central vestibular compensation) may be useful to treat some cases of dizziness in the elderly [37–39]. A clinical study demonstrated oral betahistine to be a potent and effective drug for increasing cerebral blood flow in patients with chronic cerebrovascular ischemic disease [40].

Within the fall-prevention protocols, it is important to determine the cause of the disequilibrium, which remains a difficult task. Regular physical and intellectual activities and an adapted diet with vitamin D, calcium, and proteins are essential. Vision should be ameliorated with glasses. Shoes should be adapted to give good stability [41]. If necessary, affected patients should use a walking stick, a Zimmer frame (walker), or a wheelchair. The objective is to reduce the number of falls, to develop an efficient strategy of equilibrium, to increase the activity, autonomy, and safety of patients, and thus to improve their quality of life. Initially, to reduce the risk of falls, the house should be modified by evaluating and controlling the various, often combined factors that cause them. Rehabilitation should be initiated with simple exercises [42], such as standing up, sitting down (Fig. 3), or placing an item on the ground, to improve *functional mobility* (i.e., the balance and gait maneuvers used in everyday life [21]).

The difficulty level of rehabilitation exercises can be progressively increased by requiring patients to perform them with obstacles, on a moving surface (Fig. 4), or on a trampoline (Fig. 5). To improve muscle strength, patients are asked to step up and down a pavement or stairs (Fig. 6);

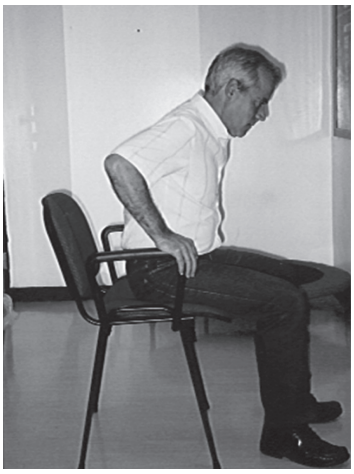

Figure 3. Sit-to-stand exercises.

Figure 4. Exercise over a foam surface to enhance the proprioceptive cue.

Figure 5. Training over a trampoline to enhance the proprioceptive cue.

Figure 6. Training over stepping obstacles.

Figure 7. Training in postural control over a movable platform (Bessou type).

Figure 8. Increasing the limits of stability using a visual feedback system.

Figure 9. Reading a book while turning the head.

Figure 10. Exercises to negotiate curbs.

to enhance postural control, they are asked to train over a movable platform (Fig. 7); and to increase the limits of stability, they use a visual feedback system (Fig. 8). To perform exercises similar to everyday life activities, patients are asked to read a book while turning the head (Fig. 9) and to negotiate curbs (Fig. 10). However, many more exercises can be performed according to balance deficits.

Optokinetic stimulation is used to enhance body stabilization [43] and in patients presenting with a downbeat nystagmus [44]. The difficulty of the exercises is progressively increased, with the progression indicated to the patients on each occasion. Before and after each session, the patients' stability is evaluated in various situations.

CONCLUSIONS

Disequilibrium of the elderly is defined as dizziness or ataxia (or both) without localizing signs that may arise from a variety of aging-related causes. The patient with disequilibrium will often experience as the primary symptom vertigo, lightheadedness, or a similar "head" sensation. Disequilibrium is a very frequent occurrence in the elderly, one that carries significant health and quality-of-life consequences for affected patients. In most cases, disequilibrium in the elderly is multifactorial and is either worsened or triggered by the ingestion of multiple medications and iatrogenicity.

The diagnosis of dizziness is difficult in elderly people, as symptoms often reflect early features of neurodegenerative disorders and general dysfunction. Though a full and accurate otoneurological evaluation, including hearing assessment and dynamic posturography, provide valuable data, establishing a patient's medical history is also important. Information concerning the physical, cardiovascular, and neurological status of a patient can help to guide effective management.

The approach to the management of disequilibrium in the elderly should be cautious and empirical. Such patients usually need to be followed up more closely than patients in whom a clear diagnosis is available. Vestibular and balance rehabilitation with an interdisciplinary collaboration should be rapidly initiated, and drug treatment may be helpful. As dizziness and imbalance have a strong association with falls, fall prevention strategies are essential. Such programs are an effective means to help patients develop an efficient strategy of equilibrium to increase their levels of physical activity. The development and use of effective prevention measures will not only economize the costs of treatments and hospitalization but, more critically, will contribute to improving the quality of life of elderly patients.

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