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**MODERN APPROACHES TO REHABILITATION OF BALANCE**  
**DISORDERS IN ELDERLY PEOPLE**

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*Abstract*

**Introduction:** Elderly people suffer from balance disorders that can, unfortunately, lead to moderate or even severe injuries that limit the mobility and reduce their independence. Worldwide, it is estimated that 2.9% of patients over 60 years of age and 3.8% over 75 years of age present disturbances of balance, as a result of vestibular hypofunction or a combination of deficiencies in the vestibular, visual and somatosensory systems.

**Purpose:** Through this paper, we intend to highlight the importance of early evaluation of vestibular disorders and the efficiency of using the Multitest-Equilibre Framiral Platform in combination with the PosturoPro software. Both methods can make a significant difference for elderly people with balance disorders, both in assessing and recovering.

**Subjects and methods:** The Multitest-Equilibre Framiral Platform is used for the evaluation and rehabilitation of 20 patients aged 60 to 80 years (10 women and 10 men) in a rehabilitation clinic. The subjects were evaluated in both static and dynamic scenarios, by measuring the following indicators (prior to and right after rehabilitation): proprioceptive, visual and vestibular, related to various stimuli (pendulous, saccadic or optokinetic).

**Results and conclusions:** The results obtained after 5-8 sessions of dynamic multisensory rehabilitation on Multitest-Equilibre Framiral Platform have clearly demonstrated its usefulness in obtaining a fair and objective evaluation of balance disorders, and also its effectiveness in restoring the balance. The vestibular rehabilitation has reduced the risk of falling, has stabilized the balance, retrained the proprioceptive system and the walking and restored the independent living.



## **1. Introduction**

Elderly people suffer from balance disorders that can, unfortunately, lead to moderate or even severe injuries that limit the mobility and reduce their independence. Worldwide, it is estimated that 2.9% of patients over 60 years of age and 3.8% over 75 years of age present disturbances of balance, as a result of vestibular hypofunction or a combination of deficiencies in the vestibular, visual and somatosensory systems. (Herdman SJ., 2007)

The patients with vestibular disorders often complain of balance disorders, spatial orientation problems or dizziness related to position or movement. These early symptoms are almost always accompanied by secondary symptoms which can impair the quality of daily activities. The secondary symptoms include a decrease in muscular strength, a range of motion-impairment, a cervical or shoulder tension which may lead to headaches and muscle fatigue. (Shummway-Cook A., 2008).

Balance disorders associated with dizziness may be caused by multiple factors such as inner ear dysfunction, cardiovascular or neurological disease, cervical arthritis, unbalanced nutrition, visual acuity problems, or environmental factors and lifestyle. (Alexander BH & co., 1992)

Therefore, the management of the elderly person in vestibular rehabilitation therapy represents an important component in restoring the functional independence of affected people. In the last few years, more and more methods and innovating techniques have been found, and the progress in technology has made it possible to stabilize balance, to retrain the proprioceptive system, to improve stability, without adverse symptoms.

## **2. Problem Statement**

Due to the need of rehabilitation to dynamic postural stability, an essential condition for a more independent life for the elderly people, we consider the theme approached in this paper, i.e. the evaluation and the functional rehabilitation of balance, a priority to our area.

## **3. Research Questions**

Through this study, we intend to check whether the Multitest-Equilibre Framiral Platform, such a modern method of research, could be at least as effective as the other methods of assessment and rehabilitation of balance function.

## **4. Purpose of the Study**

Through this paper, we intend to highlight the importance of early evaluation of vestibular disorders and the efficiency of using the Multitest-Equilibre Framiral Platform in combination with the PosturoPro software. Both methods can have a significant impact on elderly people with balance disorders, both in assessing and recovering them.

We conducted this study starting with the hypothesis that the vestibular or proprioceptive rehabilitation by multisensorial stimulation can reduce, via the Multitest-Equilibre Framiral Platform, the postural instability, and improve balance.

## **5. Research Methods**

The experiment was performed in a rehabilitation clinic in Bucharest, over a period of 8-10 weeks, on a group of 10 men and 10 women aged between 60 to 80. All of them have manifested various forms of balance disorders associated with vestibular dysfunctions.



Figure 01. Multitest-Equilibre Framiral Platform

Through a mathematical analysis of the stabilometric signal, the Platform can evaluate the *qualitative index* using the color code and the *quantitative index* by instability postural index (IIP), Critical Point or Hausdorff Point.

Initially, a computerized posturography is performed in static and dynamic conditions; the subject was instructed to stand still on the platform. The subjects had to adopt a natural position with a foot gap aligned with the vertical projection of their shoulders.

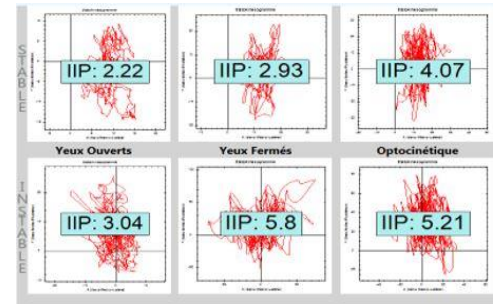


Figure 02. Recording stabilometric signal

The test was performed in a static condition, for three sequences, 30 seconds each one: open-eye conditions (YO) during which the subjects had to maintain their balance by focusing on a visual target located 2.5 meters in front of them, in the axis of their eyes. The next 30 seconds eyes closed (YF), after which 30 seconds eyes open, focusing on the target, but in darkness and with the optokinetic stimulus. (Fig. 03. A, B, C)

Maintaining the same position, the platform descends, and samples are also made in dynamics conditions, recording the parameters in the same situations: eyes open, eyes closed, optokinetic stimulus (Fig. 03. D, E, F), the platform is left in freedom in all three planes of the space.

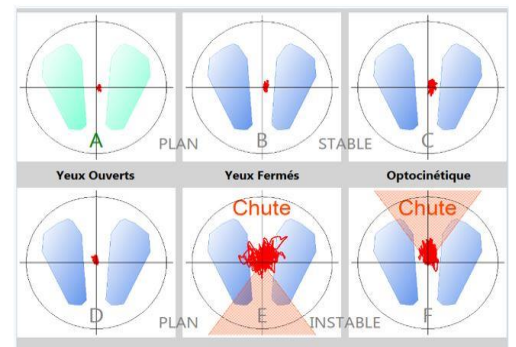


Figure 03. Registration condition

After the initial assessment, the patients were recommended 5-8 Dynamic Vestibular Rehabilitation Therapy sessions with Multitest-Equilibre Framiral Platform, an important tool in dynamic multisensory rehabilitation and actively sustained by the elderly. Of all the rehabilitation programs available to the Platform, only the fall prevention program (prévention chute) and re-education by impulse program (rééducation impulsionnelle) were selected for this study.

The fall prevention program was set for 5 minutes and it performed on an inclined plane, and on predetermined directions preset by the therapist (anterior-posterior, left-right); with a pause of 4 seconds when changing the direction (latency phase). During this exercise, the patient follows the instructions: eyes closed, eyes open focusing a target or optokinetic stimulus.

The re-education by impulse program uses the platform on unstable mode with impulses set by the therapist at the pressure of 1 bar, in the left-right and anterior-posterior directions, and with a latency of 3 seconds. As in the previous program, the time dedicated for this one was 5 minutes, and the subjects follow the therapist's instructions (eyes open, eyes closed).

At the end of the 5-8 sessions of rehabilitation, the tests (final assessment) were redone and the obtained data was processed statistically.

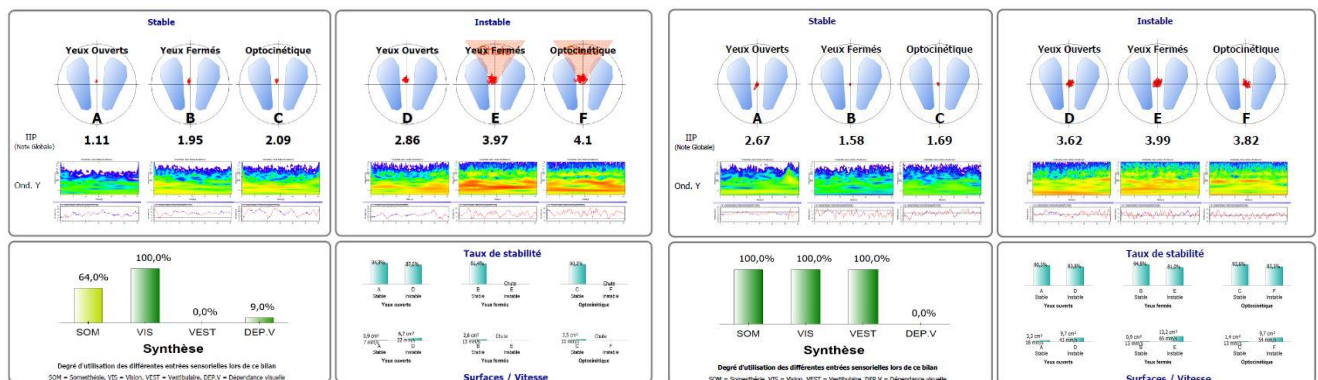


Figure 04. Comparison initial assessment – final assessment

## 6. Findings

The results obtained after 5-8 sessions of dynamic multisensory rehabilitation on Multitest-Equilibre Framiral Platform have clearly demonstrated its usefulness in obtaining a fair and objective evaluation of balance disorders, and also its effectiveness in restoring the balance.

Table 01. Synthesis of data

Parameters	Women		Men		Men and Women
	Average ± st. dev.	Valid results	Average ± st. dev	Valid results	Average ± st. dev.
Number of patients	<b>10</b>		<b>10</b>		<b>20</b>
Average age (years)	67.60±5.68		75.60±4.09		71.60±6.33
<b>Postural Instability Index (IIP)</b>					
<b>Stable platform, eyes close - B</b>					
Initial	1.94±0.73		2.74±0.91		2.34±0.90
Final	1.99±0.51	5	2.82±0.90	8	2.41±0.83
<b>Instable platform, eyes close - E</b>					
Initial	4.04±1.06		5.11±0.44		4.57±0.96
Final	3.95±0.79	6	4.80±0.66	7	4.38±0.83
<b>Instable platform, eyes open + optokinetic stimulus - F</b>					
Initial	4.55±1.07		4.78±0.56		4.66±0.84
Final	4.05±0.81	8	4.60±0.90	6	4.32±0.88

The statistical process proves that: the average age for men is 75.6, 8 years older than the average age for women which is 67.6. At a complete group scale, for both women and men, the average age is 71.6.

For women, at final assessment, the postural instability index for the platform B (stable platform, eyes closed), increased by 0.05 from 1.94 units to 1.99. The postural instability index for the platform E (unstable platform, eyes closed)

decreased by 0.09 units, from 4.04 to 3.95. For the platform F (unstable platform, eyes open and optokinetic stimulus), the average value IIP decreased by 0.50 units, from 4.55 to 4.05.

Also, the valid results on platforms were 5 for condition B, for E 6 and for F 8. The average IIP values on platforms and tests are shown in the graph of Fig. 05.

For men, at the final assessment, the postural instability index (IIP) for the platform B (stable platform, eyes close), increased by 0.08 from 2.74 units to 2.82. The postural instability index for the E platform (unstable platform, eyes closed) decreased by 0.31 units, from 5.11 to 4.80. For the platform F (unstable platform, eyes open and optokinetic stimulus), the average value IIP decreased by 0.18 units, from 4.78 to 4.60.

The valid results on platforms were 8 for condition B, 7 for E and for F 6. The average IIP values on platforms and tests are shown in the graph of Fig. 06.

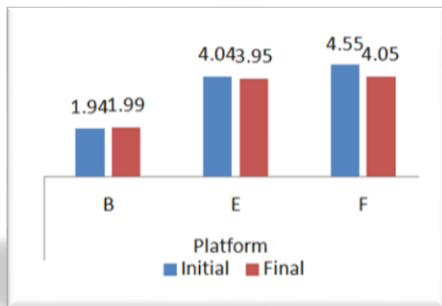


Figure 05. Average values for women

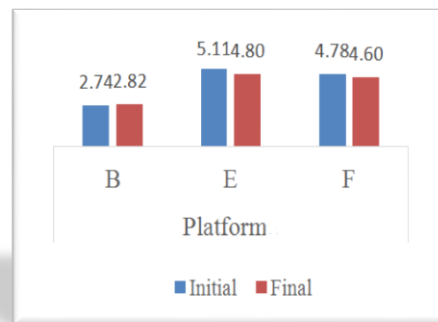


Figure 06. Average values for men

At the level of both genders, at the final assessment, the postural instability index for the Platform - Condition B (stable platform, eyes close), increased by 0.07 from 2.34 units to 2.41. The postural instability index for the Platform in condition E (unstable platform, eyes closed), decreased by 0.19 from 4.57 units to 4.38. The average IIP for F (platform unstable, eyes open, optokinetic stimulation), decreased by 0.34 from 4.66 to 4.32. The valid results, for each of the following conditions (platforms), have cumulative values for women and men, respectively: 13 for the condition B, 13 for the condition E and 14 for the condition F. The average values for IIP, on platforms and tests, are shown graphically in Fig. 07.

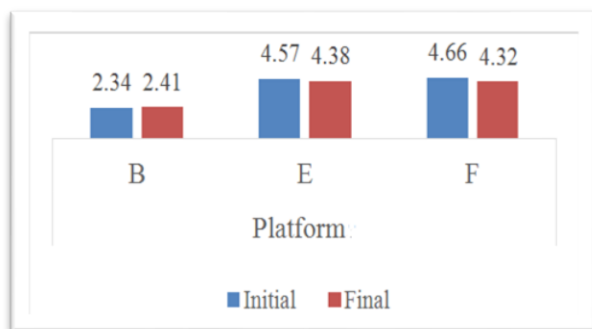


Figure 07. Average values for both genders

It should be noted that after the vestibular rehabilitation therapy on the Multitest Framiral Platform, the values of B condition will be increased. Due to the fact that training the patient in dynamic conditions (E & F), as well as the neuronal network plasticity, shows that the patient adjust its responses in static condition, in the same way as it responds to dynamic conditions. This structural and functional neuronal reorganization, shows that an anticipation strategy has been created with the aim of controlling the postural responses. (Lacour M, Bernard-Demanze L, 2015)

Table 02. Results of Wilcoxon nonparametric test

Test parameters	Initial vs Final					
	Women			Men		
	Platform					
	B	E	F	B	E	F
Z	-0.459 <sup>b</sup>	-0.408 <sup>c</sup>	-1.682 <sup>c</sup>	-1.478 <sup>b</sup>	-1.580 <sup>c</sup>	-0.714 <sup>c</sup>
P (Asymp. Sig. (2-tailed))	0.646	0.683	0.093	0.139	0.114	0.475

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

c. Based on positive ranks.

Analyzing the results of the Wilcoxon nonparametric test, we conclude that for both women and men, there are no statistically significant differences between the initial and final values of the postural instability indices for any of the conditions B, E or F. In all cases the threshold value significance  $p > 0.05$ , the values of Z statistics belong to the interval (-1.96, 1/96).

Test parameters	Final women vs Final men		
	Platform / Condition		
	B	E	F
Z	-2.080	-2.343	-1.285
P (Asymp. Sig. (2-tailed))	0.038	0.019	0.199

Table 03. Mann-Whitney test

Results of Man-Whitney nonparametric test, statistically shows significant differences between women and men for platform B and E conditions, for which  $p < 0.05$  and Z statistic values are lower than the -1.96 thresholds. In the case of Platform F, differences between women and men are not statistically significant,  $p > 0.05$  for  $Z = -1.285$ .

## 7. Conclusion

Positive changes were reported in the symptomatology of patients with balance disorders, and that fact has improved the gait and the postural stability. Because of the vestibular rehabilitation as a part of a multisensorial approach in balance rehabilitation in elderly, the dynamic functions were restored thanks to the process called sensory substitution.

The remaining inputs, visual and somatosensory inputs, developed through the manipulation of the visual cues (eyes closed, eyes open, optokinetic stimulation), and by manipulating the balance control (on stable or unstable surfaces). This dynamic platform has provided predictable perturbation which led, on the one hand to a feedback mechanism to control of posture, and on the other hand, to a feed-forward mechanism which allows the patient to anticipate the responses of postural muscles to prevent the balance perturbation. (Horak FB, 2010)

In conclusion, the vestibular rehabilitation, as a multisensory integration process, has reduced the risk of falling, has stabilized the balance, retrained the proprioceptive system and the walking and restored the ability to live independently for the elderly with balance disorders.

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