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ARTYKUŁ ORYGINALNY / ORIGINAL RESEARCH ARTICLE

Effectiveness of two method of rehabilitation in patients after of the vestibular neuronitis and vestibular neurectomy

Porównanie dwóch metod rehabilitacji przedsionkowej u chorych po przebytym zapaleniu nerwu przedsionkowego oraz po operacji przecięcia nerwu przedsionkowego

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ABSTRACT: Acute vestibular syndrome is a syndrome of clinical symptoms associaded with sudden damage to the periphery of the vestibular organ. The most important element in the treatment of patients with vestibular syndrome is motor rehabilitation, which is beneficial for central compensatory processes. The aim of the study was to compare the effectiveness of two methods of rehabilitation (training habituation versus sensory conflicts) in patients after vestibular neuronitis and vestibular neurectomy. The work material is the results of the overall balance of the Sensory Organization Test and the subjective assessment of severity of dizziness before and after rehabilitation performed by various methods. 20 subjects after vestibular neuritis (group I) and 20 patients after vestibular neurectomy (group II) were included in the study. In group I, the patients were admitted to the Otolaryngology Clinic Medical University of Warsaw within the framework of acute on duty with diagnosis of vestibular neuritis. In group II, patients had vestibular neurectomy due to Meniere disease with strong untreated vertigo. Both types of rehabilitation have a significant improvement in the overall balance of the Sensory Organization Test and the subjective assessment of the severity of vertigo irrespective of the extent of injury in the vestibular organ. Better results were obtained in the group after vestibular neuritis treated with conflicts sensory.

KEYWORDS: acute vestibular syndrome, training habituation, training sensory conflict, Sensory Organization Test

STRESZCZENIE: Ostry zespół przedsionkowy jest zespołem objawów klinicznych, które towarzyszą nagłemu uszkodzeniu obwodowej części narządu przedsionkowego. Najważniejszym elementem terapii chorych z zespołem przedsionkowym jest rehabilitacja ruchowa, wpływająca korzystnie na procesy kompensacji ośrodkowej. Celem pracy była analiza porównawcza skuteczności dwóch metod rehabilitacji (trening habituacyjny vs konflikty sensoryczne) u pacjentów po przebytym zapaleniu neuronu przedsionkowego i po operacji przecięcia nerwu przedsionkowego. Materiał pracy stanowią wyniki ogólnego bilansu równowagi Testu Organizacji Zmysłowej oraz subiektywnej oceny stopnia nasilenia zawrotów głowy, wykonanych przed i po zakończonej rehabilitacji prowadzonej różnymi metodami. Do badań włączono 20 osób po przebytym zapaleniu neuronu przedsionkowego (grupa I) i 20 osób po operacji przecięcia nerwu przedsionkowego (grupa II). W grupie I znaleźli się chorzy przyjmowani do Kliniki ORL WUM w ramach ostrego dyżuru z rozpoznaniem zapalenia neuronu przedsionkowego. W grupie II znajdowali się pacjenci po przebytej operacji przecięcia nerwu przedsionkowego z powodu choroby Meniere'a z silnymi, i nie poddającymi się leczeniu, zawrotami głowy. Oba typy rehabilitacji powodują istotną poprawę zarówno ogólnego bilansu równowagi Testu Organizacji Zmysłowej, jak i subiektywnej oceny stopnia nasilenia zawrotów głowy chorego niezależnie od rozległości uszkodzenia w narządzie przedsionkowym. Lepsze wyniki uzyskano w grupie pacjentów po zapaleniu nerwu przedsionkowego leczonych metodą konfliktów zmysłowych.

SŁOWA KLUCZOWE: ostry zespół przedsionkowy, trening habituacyjny, trening posturograficzny, Test Organizacji Zmysłowej

INTRODUCTION

Balance system receives stimuli from the surrounding environment through receptors in the vestibular organ, proprioceptors, and organ of vision. The information obtained from those receptors are analyzed by the central nervous system (CNS), and then thanks to the reaction of the neuromuscular system it comes to fixing the vision on the observed object and maintaining balance via vestibulo-ocular reflex (VOR) and vestibulo-spinal reflex (VSR) [1,2]. Disorders of the bioelectrical equilibrium in acute vestibular trauma lead to the occurrence of nystagmus (disturbances in vestibulo-ocular connections) and balance disorders (disturbances in vestibulo-spinal connections) [3]. Maintenance of those connections determines stabilization of the field of vision and keeping the correct posture. In physiological conditions during rest a symmetrical tonal stimulation coming from both vestibular organs reaches the complex of vestibular nuclei. During body movements and head torsion the number of resting discharges simultaneously increases in one of the vestibules and decreases in the second one within the borders of physiological stimulation [4]. Injury of the peripheral part of the balance organ causes a strong asymmetry in the influx of stimuli to vestibular nuclei which elicits so called "vestibular shock" [5]. In only few hours after injury of the vestibule compensatory mechanisms are triggered in the central nervous system: excessive bioelectrical activity in the vestibular nuclei on the healthy side is inhibited, whereas decreased activity on the affected side is enhanced. In this process, commissural connections between vestibular nuclei and central structures take part. Characteristic symptoms of the vestibular shock include vertigo with the feeling of rotation that is sudden, severe in the beginning, and has a tendency to slowly fade with time. Head movement and closing of the eyes exacerbate the symptoms. Vegetative symptoms, nausea, vomiting and excessive sweating are associated with vertigo. During the period of vestibular shock a horizontal-torsional nystagmus with a fast phase towards the healthy vestibule is observed [6]. Decreasing of the vestibular shock symptoms and recovery of the patient to physical fitness is a result of central compensation. The course of the central compensation is decided by the range of factors such as the efficiency of the central nervous system, age of the patient, condition of central nervous system vessels, influence of the drugs as well as emotional and mental factors. Compensation is impeded by the diseases of CNS such as: demyelinating, vascular, post-inflammatory, post-traumatic and neoplastic changes and toxic injuries. It is detrimental to use drugs inhibiting the CNS activity i.e. drugs with anti-vertigo, anti-emetic, sedative or anti-depressive effect. The process of compensation is not a stable process. It may happen that in seemingly healthy people in the situation of exhaustion, severe stress, during the change of used medications, period of no physical activity or after alcohol [7]. The results of incomplete compensation are disorders of dynamic vision acuity, postural instability and benign positional vertigo. Complete compensation occurs in the certain state when the patient does not have vertigo or balance disorders. During the time of proceeding of the compensatory processes vestibular rehabilitation, introduced in the first days after withdrawing of vegetative symptoms, when the patient is still in the bed, is essential. The essence and the assumption of vestibular rehabilitation is to obtain the state of central compensation or balance the disorders caused by the injury of the labyrinth on the level of the central system. In clinical practice compensation is a slow fading of subjective and objective symptoms coexisting with the injury of the vestibular organ [8]. The aim of vestibular rehabilitation is to regain or to improve the basic functions of the balance system: stabilization of gaze and posture, to eliminate the feeling of vertigo and instability as well as to improve the overall activity of the patient [9]. Among the causes of acute vestibular syndrome are vestibular neuritis, Meniere disease, traumas (also during surgeries, including status after vestibular neurectomy), vascular disorders, infections, intoxications, and others.

AIM OF THE STUDY

The aim of the study is to evaluate the process of rehabilitation using a method of habituation training and rehabilitation based on sensory conflicts in a group of patients after vestibular neuritis and after vestibular neurectomy.

MATERIAL AND METHODS

Twenty patients after vestibular neuritis (Group I) and 20 patients after the surgery of vestibular neurectomy (Group II) were included in the study. **IN GROUP I** there were patients who were admitted to the emergency room of the ENT Clinic of the Medical University of Warsaw with a diagnosis of vestibular neuritis. The mean age in this group is 52.75 years (min. 29, max. 81). There were 12 women and 8 men in the group. **IN GROUP II** there were patients after surgery of vestibular neurectomy due to Meniere disease with severe vertigo that did not respond to treatment. The mean age in this group is 50.3 years (min. 21, max. 72). There were 10 women and 10 men in the group. The general balance performance using Sensory Organization Test as a parameter of evaluation of the function of the balance system and results of subjective assessment of vertigo severity were evaluated in patients with acute vestibular syndrome before [day 7] and after completed

rehabilitation [day 21], performed using different methods. The procedure of the rehabilitation process consisted of two phases. **PHASE I** – On the third day from symptom initiation in patients with vestibular neuritis or on the third day after vestibular neurectomy all patients started rehabilitation using the habituation method under the supervision of a physiotherapist. One of the group included patients after intracranial surgery. To eliminate the risk of complications and standardize the method of proceedings in this group, exercises that could increase intracranial pressure were eliminated. **PHASE II** – After 7 days of habituation therapy patients were divided into subgroups: in 10 patients from the group of vestibular neuritis and in 10 patients from the group after vestibular neurectomy rehabilitation using habituation training was continued whereas the remaining 10 patients from the group of vestibular neuritis and 10 patients from the group after vestibular neurectomy started rehabilitation using the method of sensory conflicts in a posturographic cabin. Both types of rehabilitation were conducted through 2 following weeks. The improvement during phase I was evaluated on the basis of an individual rehabilitation card in which a score of subjective vertigo evaluation scale from 0 to 3 was noted (0 – no vertigo, 3 – very severe vertigo). Before commencing the second phase of rehabilitation Sensory Organization Test [SOT] was performed in all patients. The control examination of SOT was done after completing a two-week period of both types of rehabilitation.

Fig. 1. Rehabilitation using a method of sensory conflicts in a posturographic cabin.

METHODS OF REHABILITATION

Habituation training is a rehabilitation method for patients with vertigo and balance disorders, involving a particular set of exercises, that is recognized in Poland and worldwide. Habituation training is based on the phenomenon of habituation and its aim is to silence the pathological reactions to head and body movements in lying, sitting and standing position [7]. Cawthorne-Cooksey exercises were used 2 times a day in 10-minute sessions, 7 days per week. In the early period after labyrinth injury these exercises can exacerbate vertigo, and also nausea can appear, of which the patient should be informed before beginning the exercises. In the beginning of the training the exercises should not last longer than 5 minutes and as the patient is feeling better the time of the exercises can be gradually lengthened and their difficulty can be gradually increased. The exercises that do not cause subjective symptoms any longer should be gradually replaced by the new ones. Rehabilitation using a method of sensory conflicts based on Computer Dynamic Posturography [Fig. 1] according to the protocol included in the NeuroCom International System software [10]. Rehabilitation using this method is based on the exposition of the patient to variable stimuli from the moving ground and/or moving visual surroundings. The patient's task is to maintain the body's center of gravity in balanced position in the terms of sensory conflicts. Training in posturographic cabin is started from a low level of difficulty and during its duration the difficulty is gradually increased while evaluating the progress. The therapy is conducted for 10 consecutive days, in 20-minute sessions. During rehabilitation in the posturographic cabin the patient is secured with specially designed belts protecting them from falling.

The parameters that evaluated the effectiveness of rehabilitation were the Sensory Organization Test and a subjective scale assessing the level of vertigo severity. Sensory Organization Test (SOT), described by Nasher [10], is a test evaluating the ability of an examined person to maintain balance during changing conditions of stimulation of sense organs participating in control of the correct posture and in terms of so called sensory conflicts (moving ground and/or moving visual surroundings). It means that this is an examination with incoming contradictory information from different

sense organs. The examined person undergoes six tests during which functioning of the specific sense organs is evaluated: vision, proprioceptors and vestibular organ. The stimuli received by specified organs are excluded (tests with closed eyes), distorted (tests with changes of the position of visual surroundings) or unexpectedly included (rotational movement of the platform) to assess their functioning [10]. SOT consists of 6 tests. First 3 tests are conducted on a stationary ground and comprise SOT1, SOT2, and SOT3. Next 3 trials are performed on a moving ground and the range of platform movement is proportional to the patient's movements and tilting of the patient's center of gravity. Test on the moving ground comprise SOT4, SOT5, and SOT6. Test SOT5 is considered a "vestibular" test [11]. The tests are described below: 1. Standing on a firm ground, eyes open; 2. Standing on a firm ground, eyes closed; 3. Standing on a firm ground, eyes open, moving visual surroundings; 4. Standing on a moving ground, eyes open; 5. Standing on a moving ground, eyes closed; 6. Standing on a moving ground, eyes open, moving visual surroundings. The final score of each of those tests is a mean from 3 examinations. During each test the sway of the center of gravity from the balance state is evaluated. On the basis of mean results obtained in all of the tests computer software calculates general equilibrium score (GES) reflected as a "composite" parameter (composite equilibrium score). The higher is its value, the better is postural stability [1]. The results of balance analysis are given as percentage, where 100% is no swaying. The results might start from 0% when the patient lost their balance or raised their feet from the ground and reach 100% with minimal swaying of the body's center of gravity. GES is a mean of results of all 6 balance tests conducted in the posturographic cabin. Subjective scale assesses the level of vertigo severity in patient in 16 exercises. These are: movements of eyeballs - eyes open and closed, right and left head movements - eyes open and closed, right and left head and body rotating movements, transition from sitting to lying position and return to sitting position performed slowly, sideways body rotations, maneuver from sitting position to lying supine with tilted head performed slowly, rotations around the patient's axis - eyes open and closed, standing on one leg - eyes open and closed, walking forward – right and left, forward and backward head movements, walking backward – forward and backward head movements. Each exercise is assessed by the patient in a 0-3 scale, where 0 indicates no vertigo, 1 – mild, 2 - severe vertigo and 3 - exacerbation of vertigo. The final score of the subjective patient scale is a mean from 16 tests performed by the patient. Habituation training was used in patients on a daily basis under the supervision of a physiotherapist. In 10 patients from the group of vestibular neuritis and in 10 patients after vestibular neurectomy it was continued for consecutive 2 weeks.

METHODS OF STATISTICAL ANALYSIS

In the analyzed material two groups of variables were distinguished: continuous and discrete variables. A comprehensive statistical analysis was performed. Appropriate methods were chosen adequately to the type of variables. In the process of testing of statistical hypotheses a statistical significance level of p=0.05 was assumed. For each variable, depending on its type, relevant basic statistics were calculated. In line with the expectations, small group size resulted in an assumption of normal distribution of the variables not being met. For further analyses following tests were used: Wilcoxon signed-rank test, Mann-Whitney U test, Friedman ANOVA test and Kendall's coefficient of concordance, Chi-squared Pearson test, and Chi-squared maximum likelihood method. Statistical analysis was conducted using statistical software by StatSoft Inc. 2011, Statistica (data analysis software system) version 10.

RESULTS

Results of the general equilibrium score of Sensory Organization Test before and after rehabilitation in groups with pathological findings

In the group of patients after vestibular neurectomy treated with a habituation training method the result of the general equilibrium score of Sensory Organization Test before rehabilitation was 50.60; SD 12.73. In the follow-up examination the result of the general equilibrium score of Sensory Organization Test was 71.44; SD 14.02. The difference in the results is statistically significant at p=0.05.

In the group of patients after vestibular neurectomy treated with a sensory conflict method the result of the general equilibrium score of Sensory Organization Test before rehabilitation was 55.90; SD 13.83. In the follow-up examination the result of the general equilibrium score of Sensory Organization Test was 72.70; SD 13.39. The difference in the results is statistically significant at p=0.05.

In the group of patients after vestibular neuritis treated with a habituation training method the result of the general equilibrium score of Sensory Organization Test before rehabilitation was 57.40; SD 16.62. In the follow-up examination the result of the general equilibrium score of Sensory Organization Test was 71.56; SD 16.12. The difference in the results is statistically significant at p=0.05.

In the group of patients after vestibular neuritis treated with a sensory conflict method the result of the general equilibrium score of Sensory Organization Test before rehabilitation

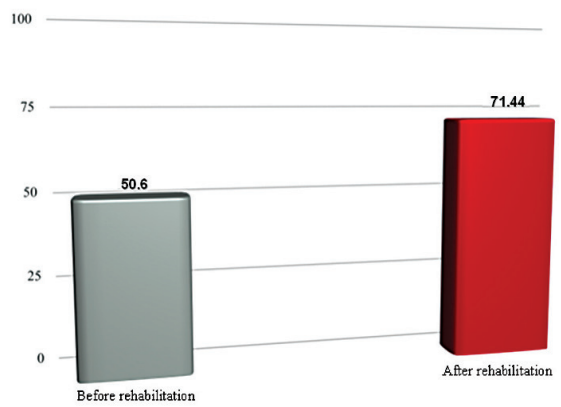

Fig. 2. Results of the general equilibrium score (GES) of Sensory Organization Test before and after rehabilitation in the group of patients after vestibular neurectomy treated with a habituation training method.

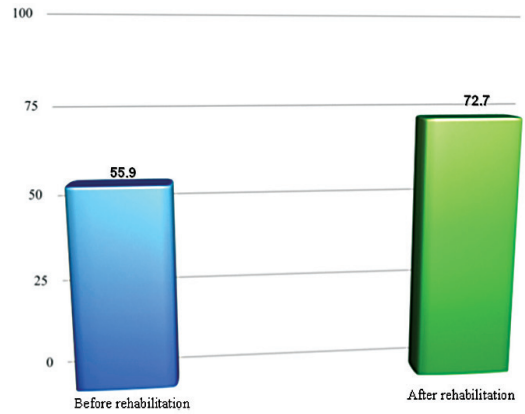

Fig. 3. Results of the general equilibrium score (GES) of Sensory Organization Test before and after rehabilitation in the group of patients after vestibular neurectomy treated with a sensory conflict method.

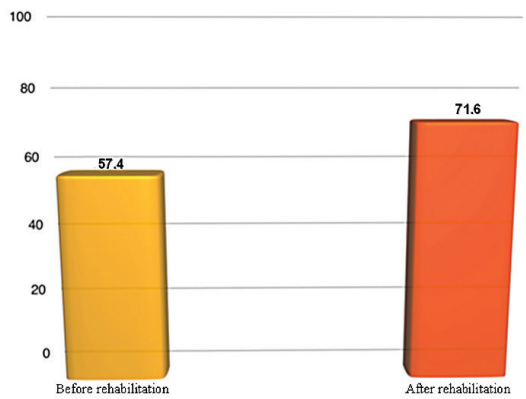

Fig. 4. Results of the general equilibrium score (GES) of Sensory Organization Test before and after rehabilitation in the group of patients after vestibular neuritis treated with a habituation training method

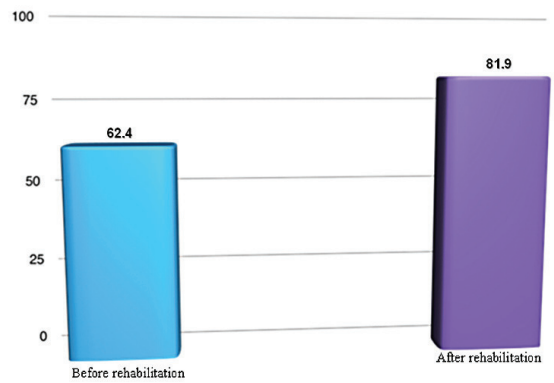

Fig. 5. Results of the general equilibrium score (GES) of Sensory Organization Test before and after rehabilitation in the group of patients after vestibular neuritis treated with a sensory conflict method

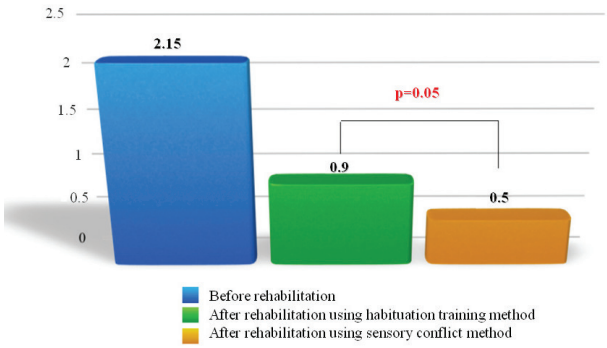

Fig. 6. Results of subjective evaluation of vertigo severity in group of patients after vestibular neuritis

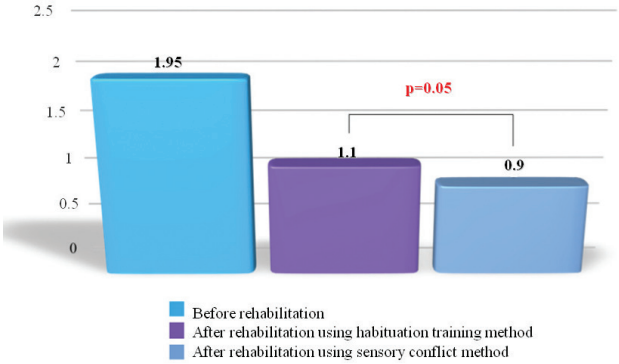

Fig. 7. Results of subjective evaluation of vertigo severity in group of patients after vestibular neurectomy

was 62.40; SD 11.08. In the follow-up examination the result of the general equilibrium score of Sensory Organization Test was 81.90; SD 8.09. The difference in the results is statistically significant at p=0.05.

Results of subjective evaluation of vertigo severity before and after rehabilitation in groups with pathological findings

In the group of patients after vestibular neuritis the severity of vertigo, in evaluation of improvement from 0 to 3, decreased after both types of rehabilitation. The subjective improvement was from grade 3 to grade 0, significantly better results were observed after rehabilitation using sensory conflict method.

In the group of patients after vestibular neurectomy the severity of vertigo, in evaluation of improvement from 0 to 3, also decreased after both types of rehabilitation. The subjective improvement was from grade 3 to grade 1, however, a decrease in symptom severity after both types of rehabilitation was similar.

DISCUSSION

Nowadays vestibular rehabilitation is one of the key elements of treatment in patients with vertigo and balance disorders of various etiology as it significantly shortens the duration of treatment and facilitates patient recovery to social and professional activity. Vertigo causes fear and anxiety, therefore rehabilitation requires cooperation of the whole team and is associated with an aspect of psychotherapy. Therapy can be conducted individually or in groups [12,13]. However, therapy conducted under the supervision of a physiotherapist gives best results [14]. Appropriately planned and conducted vestibular rehabilitation with the use of available techniques and thanks to CNS plasticity may improve the process of central compensation. Yet a correct diagnosis of the location, severity, and the mechanism of injury of the balance system and proper choice of motor exercises are important factors deciding about the success of rehabilitation. Vertigo is a subjective sensation of movement most often accompanied by balance and spatial orientation disorders. It has been proven that early initiation of motor activity in a patient with acute labyrinth injury positively influences the course of compensation and pace of patient's recovery to the state of physical equilibrium, therefore it is recommended to introduce motor exercises already in the period when the patient still remains in the bed. After rehabilitation (with habituation training) conducted for a period of 4 to 20 weeks Jaczewska et al. [1] observed an overall balance improvement in Sensory Organization Test in 90% of patients. Stoyan [15] found an improvement in 14 patients after vestibular neuritis who were rehabilitated during one month using Cawthorne-Cooksey method. In the examination before rehabilitation the result of general equilibrium score of Sensory Organization Test was 66.8 and after rehabilitation 78.1. Gottschal [16] divided the group of patients after neurectomy into two groups. The group rehabilitated with the use of habituation training achieved a better result of general equilibrium score of Sensory Organization Test after rehabilitation 68.5 than before rehabilitation 51.1. In Poland and worldwide, habituation training is a recognized method of therapy in patients with vertigo and balance disorders and postural training is a method that is innovative and effective. Constant supervision of a physiotherapist translates into an increased motivation of the patient for training than it would be in a traditional method of rehabilitation. In the study of Corn et al. [2003] in a group of 32 patients with unilateral vestibular injury better results of postural stability were found both in the group of 17 patients after Cawthorne-Cooksey exercises and in the group of 15 patients after posturographic training. Instrumental rehabilitation was conducted 2 times per day for 30 minutes for 5 days. From these two methods training on the dynamic posturographic platform turned out to be more effective [17]. Similar results were obtained by Strupp et al. [1998] in a group of 19 patients after vestibular neuritis treated with a postural training method in comparison to a group of 20 patients without rehabilitation [18]. In the studies of Corn and Strupp better results were achieved by the patients treated with the postural training method, but also the results of these studies confirm better results in the group of patients treated with sensory conflict method. Meldrum (2012) in a group of 80 patients with unilateral peripheral injury compared the results of vestibular rehabilitation with the rehabilitation based on virtual reality training in the period of 6 weeks. Rehabilitation effects were measured with the results of SOT and IN VISION. In 82% patients the results of rehabilitation with the use of virtual reality technique were better than the results of rehabilitation with the use of a traditional method [19]. Vestibular rehabilitation accelerates the process of compensation and improves the clinical aspect of the patients. Early initiation of rehabilitation is of major importance. The role of a physiotherapist, who supervises and educates the patient about the therapy, is vital. In the evaluation of the level of vertigo severity in patients in the respective groups before rehabilitation the vertigo severity was highest in the group after vestibular neuritis treated with sensory conflict method. In the remaining groups of patients with pathological findings the results were similar. To recapitulate, in the subjective assessment done by the patients, better results were obtained after rehabilitation in the group of patients after vestibular neuritis treated with sensory conflict method. In the group of patients after vestibular neurectomy the results are similar Better results were obtained in the group of patients after vestibular neuritis because

unilateral injuries compensate faster and after vestibular neurectomy the patients need a longer compensation period. The role of physiotherapist in the treatment of patients with acute vestibular syndrome is essential. Appropriate education of the physiotherapist conducting rehabilitation treatment and education of the patient as well as motivation of the patient who is included in the process of treatment decides about the success of rehabilitation. Rehabilitation is effective at every stage of the disease. The advantage of the traditional vestibular rehabilitation is its simplicity and effectiveness, yet better effects are achieved when the rehabilitation is supervised by a physiotherapist [20]. In the treatment of patients with vertigo and balance disorders cooperation between a doctor specializing in otoneurology and a physiotherapist educated in physiology of vestibular organ injury and physiological bases of vestibular rehabilitation is of key importance.

CONCLUSIONS

1. Rehabilitation using habituation training method and sensory conflict method result in a significant improvement of general equilibrium score of Sensory Organization Test and score of subjective vertigo evaluation scale independently of the level of vestibular organ injury.

2. Better results were obtained in the group of patients after vestibular neuritis treated with a sensory conflict method.

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