Effects of brace treatment on stabilometric and kinetic parameters in adolescents with idiopathic scoliosis

Introduction: Idiopathic scoliosis (IS) is defined as a three-plane deformity of the spine with its lateral deviation from the midline ≥ 10° in the frontal plane. This pathology causes a significant asymmetry of the body, which can affect the general vertical posture and postural fluctuations resulting from a change in the center of gravity of the body. A number of significant differences in the biomechanical parameters of gait were identified in patients diagnosed with scoliosis compared to healthy subjects. Both the morphology of the trunk and the type of curvature of the spine are related to the imbalance in adolescent idiopathic scoliosis (AIS), hence it can be assumed that the use of Chêneau brace, which additionally stiffens a torso, can change the postural balance in a standing position, as well as during free movement. So far not only the effect of orthopedic corset on the progression of scoliotic curvature, but also on postural stability and locomotion in this population has been studied. Nevertheless, reports are still inconclusive.

Objective: The aim of the study was to assess the impact of Chêneau brace treatment on gait and stabilometric parameters in patients with AIS and to analyze the postural stability of the study group in correlation with the stage and topography of scoliosis.

Material: The research group consisted of patients of the Rehabilitation Clinic and the Department of Rehabilitation and Orthopedics, Faculty of Medicine, Collegium Medicum, University of Warmia and Mazury in Olsztyn, diagnosed with AIS, qualified for treatment with a Chêneau brace. 61 patients with AIS, who met the inclusion criteria, were tested using a full protocol, from April 2019 to September 2021.

Methods: Initially, patients were presented with the study methodology, interviewed. Anthropometric measurements were made and X-rays of the spine were analyzed. In the main part of the study, stabilometric measurements with eyes open (EO) and eyes closed (EC), as well as baropodometric measurements during a standing position and gait, were carried out. The main measuring tool was the FreeMED Base, consisting of a baropodometry platform, two passive paths and a computer with compatible software that records measurement data. Patients were examined on the day of first application of a Chêneau brace, without an orthosis and in an orthosis, 30 minutes after its first application, approximately 1 month after the start of brace therapy and approximately 6 months after the start of brace therapy. During each visit, patients filled out a questionnaire regarding the frequency of individual kinesitherapy and, in the case of follow-up examinations, also a questionnaire regarding brace

therapy compliance. In order to verify the research hypotheses, statistical analyses were carried out using the IBM SPSS Statistics 25 package. An analysis of descriptive statistics was performed along with the Shapiro-Wolf test, Student t tests for dependent trials and Mann-Whitney U tests. The level of significance was considered to be the classic threshold of $\alpha = 0.05$.

Results: In the stabilometric study, immediately after the first brace application, compared to the study without an orthosis, a significantly greater length, area and velocity of center of pressure (COP) sway and a lower L/S coefficient value in the study with EO and EC, higher values of maximum COP sway and lower values of the ellipse eccentricities in the study with EO were noted. In the stabilometric study performed in Chêneau brace, after 1 month of therapy, compared to the study without an orthosis, a larger COP sway area at both EO and EC, a lower L/S coefficient value at EC and higher Romberg coefficient values for the length and average velocity of COP. In the stabilometric study, performed in brace condition, after 6 months of therapy, compared to the initial examination, a significantly higher length, area, average velocity of COP sway and a lower L/S ratio at EC, as well as higher values of maximum COP sway for EO were found. According to the analysis, there was no significant correlation of the posturographic parameters, measured immediately after the application of the Chêneau brace, with the degree of correction of scoliosis in the orthosis or the topographic type of scoliosis. Significantly larger COP area and lower values of the L/S coefficient were found in the scoliosis group, in which the brace corrected the upper arch of scoliosis, compared to the group of scoliosis only stabilized under the influence of the orthosis. In a static baropodometric study conducted in a brace, immediately after its application, compared to the study without the orthosis, a larger contact area of the right hindfoot was shown, while the total percentage distribution of the load between lower limbs were comparable and significantly unchanged. Baropodometric parameters in statics did not change significantly after 1-month brace therapy. In the study after 6 months of therapy, performed in brace, in comparison to the non brace conditions, higher values of the average and maximum load of both left and right foot, a smaller area of right foot contact, as well as a smaller contact area of the front and hindfoot of the right foot were noted. In the baropodometric study, during free walking, immediately after first brace application, a significantly greater percentage load on the back of the right foot was observed. After 1 month of orthosis therapy, compared to the study without an orthosis, the measurements for the left lower limb recorded a significantly shorter duration of both midstance and stance phase, while the measurements for the right lower limb showed only a shorter stance phase.

After 6 months of brace therapy, in baropodometric measurements carried out in orthosis, higher values of average load, maximum foot load, higher step rate and shorter stance phase were noted for both right and left lower limbs. In addition, measurements for the right lower extremity showed a higher step speed and shorter duration of total and mean foot contact, while the measurements for the left lower limb showed a higher percentage load on the medial part of the left foot.

Conclusions: 1. Direct application of the Chêneau brace in adolescents with AIS causes a deterioration in the postural stability parameters, which partially normalize after 1 month of orthosis use. Long-term corset therapy causes re-destabilization of stabilometric parameters under the conditions of closed eyes. The use of the brace has no significant effect on the gait symmetry in AIS patients. 2. Postural stability disturbances noted immediately after the first application of the Chêneau brace are observed in patients with AIS regardless of the topographic type of scoliosis, the degree of angular advancement of curvature of the spine or the degree of correction of scoliosis in brace. AIS patients whose braces provide a stronger correction of spinal curvature have poorer postural stability than those whose braces only stabilized the spine curvature. 3. The results suggest that exercises aiming at improving postural stability should be administered to all patients with AIS in whom brace therapy has been implied, regardless of topography and degree of spinal curvature. In the diagnostic-therapeutic process of AIS patients treated with an orthopedic brace, both postural stability tests and baropodometric elements in statics and dynamics should be considered in order to comprehensively assess functional deficits and to plan an individualized kinesiotherapy.