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Balance and lower limb loads distribution after Ilizarov corticotomy

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ABSTRACT

Introduction: Normal balance and symmetric distribution of lower limb loads are associated with adequate muscle strength, joint mobility and proprioception. The aim of this study was to analyze the distribution of lower limb loads and balance prior to and after axis correction and lengthening with Ilizarov method.

Materials and methods: The prospective analysis included 20 patients from our clinic, who have been subjected to distraction-corrective lower limb corticotomies with the Ilizarov method in 2014–2015. Balance and distribution of lower limb loads were determined with a pedobarographic platform.

Results: Prior to the surgery, mean loads on affected and non-affected limbs corresponded to42%and58% of body weight, respectively. Mean loads on affected and non-affected limbs during the postoperative examination did not differ significantly. Mean path length of the center of gravity prior to and after the surgery amounted to143.27 cm and 125.11 cm, respectively. Mean area of the center of gravity was 7.81 cm^2prior to the surgery and 5.81 cm^2after the procedure.

Discussion: Our present study showed that distraction-corrective Ilizarov corticotomy may provide more symmetric distribution of lower limb loads and improvement of balance. This outcome should be considered satisfactory from the perspective of the locomotor system statics. Corticotomies with Ilizarov method provide symmetric distribution of loads between non-affected and operated limb.

Introduction

Shortening and deformity of lower limb result in limping, pain and reduced mobility [1–142,3,15,16,18,19,21]. Lower limb lengthening and axial deformity correction can be achieved with Ilizarov method [8–13,15].

Axis correction and limb lengthening may result in the improvement of locomotor function [1,2,8–10,12]. However, these procedures may pose a risk of complications, such as a decrease in muscle strength, reduced joint mobility, and sometimes also nerve injury and joint subluxation [11,13]. These complications may impair lower limb function [11,13]. An effective treatment for limb shortening and axial deformity should improve the function of lower extremities, producing more benefits than risks [11,16,17]. Normal balance and symmetric distribution of lower limb loads are associated with adequate muscle strength, joint mobility and proprioception [9,10,18,19]. An important determinant of therapeutic decisions is lower limb load distribution and balance, which can be determined with a pedobarographic platform [9,10,15,18,20]. This test provides an objective information if limb lengthening and axis correction have contributed to improvement of lower extremity function.

Both gait disorders present in patients with lower extremity shortening and their compensatory mechanisms are well understood [11,12,14]. However, published evidence from prospective studies evaluating statics of the locomotor system after limb lengthening and axis correction is limited. Previous studies dealing with the problem in question centered around the evaluation of gait prior to and after lower limb elongation [11,12]. Bhave [11] and Koczewski [12] reported an improvement of various gait parameters after lower limb lengthening procedure, and Rongies observed that after rehabilitation, patients with coxarthrosis presented with better balance, which correlated with reduction of pain [18].

Authors of previous retrospective studies [9,10] analyzed lower limb load distribution and balance after Ilizarov corticotomies of various types [9], or compared the outcomes of Ilizarov corticotomies with the results of healthy volunteers [10].

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We hypothesized that axis correction and lengthening with Ilizarov method may improve biomechanics of lower limbs due to normalization of their balance and distribution of loads.

The aim of this study was to analyze the distribution of lower limb loads and balance prior to and after axis correction and lengthening with Ilizarov method.

Materials and methods

The prospective analysis included 20 patients from our clinic, who have been subjected to distraction-corrective lower limb corticotomies with the Ilizarov method in 2014–2015.

To be eligible for the study, patients needed to satisfy the following inclusion criteria: a history of Ilizarov corticotomy involving the femur or lower leg with more than 2-year follow-up, availability of demographic data, information about the etiology of lower limb deformity and pre- and postoperative pedobarographic findings. Patients with no history of Ilizarov corticotomy involving the femur or lower leg, or with follow-up shorter than 2 years, persons with incomplete demographic data, missing information about the etiology of primary disease and/or lacking pre- or post-operative pedobarographic documentation, individuals who received other surgeries on lower extremities, and subjects with lower limb comorbidities were excluded from the analysis.

Patients were qualified to the study based on an interview, analysis of pre- and post-treatment medical records, and physical examination. Protocol of the study was approved by the Local Bioethics Committee, and written informed consent was sought from each of the study subjects.

A total of 43 distraction corrective Ilizarov corticotomies involving the femur or lower leg have been performed in our clinic in 2014–2015. However, 23 patients were excluded from the analysis due to too short follow-up time (n = 10), presence of other lower limb comorbidities (n = 3), history of other surgeries on lower extremities (n = 3), and incompleteness of pedobarographic documentation (n = 3). Thus, 20 patients (11 women and 9 men) with mean age of 27 years 3 months (SD 8 years, 4 months) were eventually eligible for the study.

The list of outcome measures included the results of pre- and postoperative examination, as well as pedobarographic findings recorded before the treatment and during the last control visit post-surgery.

Balance and distribution of lower limb loads were determined with a pedobarographic platform from Zebris Medical GmbH (Fig. 1) [9,10]. The platform (320 mm × 470 mm) is equipped with 1504 sensors, and connected via a USB cable to a computer installed with FootPrint software (version 1.2.4.9). The software was used for processing and recording of pedobarographic parameters that were later subjected to statistical analysis. Patients were examined barefoot, with their eyes open. Before calibration of the platform, each subject was familiarized with the testing procedure. Pedobarographic examination lasted for 90 s and was carried out in a two-legged stance. Each parameter was measured on triplicate and mean value from three measurements was subjected to further analysis [9,10].

Distribution of loads between the operated and non-operated limb was expressed in percent. Balance was measured as the area of the center of gravity in square centimeters (cm^2). The length of the path of the center of gravity was given in centimeters (cm) [9,10].

Statistical significance of intergroup and intragroup differences in the study variables was examined with Student *t*-test and Mann-Whitney *U* test. All calculations were carried out with Statistica 10 software, with the threshold of statistical significance set at $\alpha = 0.05$ [9,10].

Fig. 1. Patient on pedobarographic platform.

Results

The study included 20 patients (11 women and 9 men) (Fig. 2). Lower limb shortening and axial deformity resulted from trauma (n = 8), inflammation (n = 7) or congenital defect (n = 5). Leg length discrepancy was 3.8 cm on average (range 2.5–7.5 cm). Twelve patients presented with axial deformity of the lower limb in coronal (mean 12°, range 6–31°) and sagittal plane (mean 10°, range 6–21°). None of the study subjects showed axial deformity in horizontal plane. Mean postoperative follow-up time was 29 months (range 24–40 months). Mean postoperative limb lengthening equaled 3.8 cm (range 2.5–7.5 cm). Mean elongation index was 40.68 days/cm (range 33,01–52,2 days/cm). Mean healing time was 154,5 days (range 88–277 days). Axis correction was performed in 12 patients. Mean correction in coronal and sagittal plane equaled 12° (range 6–31°) and 10° (6–21°), respectively; none of the study subjects required axis correction in horizontal plane. In all cases, surgical treatment resulted in complete correction of limb axis and length equalization. In 12 patients, corticotomy involved the femur, and in 8 lower leg. Total number of complications was 8, which corresponded to 0.4 complications per patient on average (range 0–2). Infections around implants appeared 6 times (75% of adverse events). In 6 cases the infection was controlled with local and systemic administration of antibiotics. Joint stiffness occurred two times (25% of adverse events) and subsided after intensive rehabilitation.