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Mechanisms of Improvement of Biomechanical Parameters as a Result of Hip Replacement

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Abstract Total arthroplasty is the most reliable and cost-effective method from the modern arsenal of surgical treatment of severe degenerative and dystrophic diseases of the hip joint. It is no coincidence that in developed countries it has entered everyday life as a priority method of helping large populations of patients and has long moved from the category of unique to the category of routine surgical interventions. It is estimated that at the end of the 20th century, the medical device market offered over 300 different hip replacements.

Keywords Hip joint, Joint pathologies, Functional status of the joint, Norms and pathologies

1. Introduction

The high rehabilitation effect of endoprosthetics, the long-term and successful functioning of the artificial joint in the body lead to a revision of the age limit of this intervention, if there are indications to reduce it. However, despite the constant improvement of structures and techniques of their implantation, the functional outcomes of endoprosthetics do not always satisfy the patient and the surgeon. The reasons for this lie in the fact that the development of the degenerative-dystrophic process leads to significant violations of statics and locomotion, the severity of which depends on the prescription and severity of the disease. The strength of the hip joint muscles, especially the abductors, is sharply reduced. Due to the duration of the disease, other parts of the musculoskeletal system are involved in this process, with the formation of complex adaptive and compensatory rearrangements of not only functions, but also anatomical relationships. The changes that have occurred are estimated to limit the fulfillment of the requirements of daily life by 36%, professional activity by 67%, and social functions by 25%. So, by the time of the operation, the patient has a long-existing complex of musculoskeletal pathology. The situation is further complicated by the fact that the majority of endoprostheses are not created individually, but as a universal serial product. Thus, rehabilitation of a patient who has undergone total hip replacement surgery becomes a difficult task. It is not for nothing that, despite the elimination of pain and an increase in the amplitude of movements in the affected joint, a certain part of patients cannot walk without additional means of support, the biomechanics of walking remains impaired, and the indicators of static-dynamic function, in general, change relatively little [1,3,5,7,9,11].

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2. Results and Analyzes

Therefore, the range of problems requiring further scientific development should include improving the rehabilitation provision of operated patients. The level of rehabilitation potential implies not only a statement of the damage caused to the joint by the pathological process, but also a broader comprehensive assessment of the condition of the musculoskeletal system. The biomechanics of locomotion in coxarthrosis has been studied in sufficient detail. At the same time, hip replacement surgery is planned without taking into account specific biomechanical conditions, i.e. by simply transferring the template to an X-ray instead of solving the problem of compensating for a complex of pathological changes by implanting an endoprosthesis. The study of biomechanical aspects of hip arthroplasty is clearly not receiving enough attention both in our country and abroad. In this regard, it is advisable to recall the statement of a well-known Swiss orthopedist, chairman of the European Federation of National Associations of Orthopedic Traumatologists, that biomechanics is the basis of orthopedics, without which further development of the specialty is impossible. Due to the advent of modern reliable endoprostheses of domestic and foreign production with a large number of anatomically adapted standard sizes, which makes it possible to choose the best option for each clinical situation, there is an urgent need for a comparative study of statics and locomotion before and after total hip replacement. At the same time, it is advisable to study the biomechanical results of endoprosthetics with a single, well-proven model. The

main clinical and biomechanical indicators have been identified, which make it possible to compare the status of a patient with severe degenerative-dystrophic hip joint damage before and after its total replacement. It is shown that endoprosthetics with a modern model has a high rehabilitation effect, eliminating pain syndrome, a vicious position of the limb, restoring mobility in the joint, which provides a significant improvement in all the studied parameters of statics and kinematics. The data obtained indicate the expediency of revising approaches to the medical and social examination of patients and the disabled after hip replacement with modern designs. An algorithm for creating an individual rehabilitation program has been developed. Recommendations for patients with an artificial hip joint on the mode of "operation" of the musculoskeletal system are formulated. The most significant static parameters are the asymmetry of the weight load distribution on the limbs (the coefficient of toe-heel support and diagonal misalignment of the support) and the indicators of standing stress (tremor, amplitude and structure of spontaneous and induced waves of the stabilogram before the support breaks under load). The most significant parameters of kinematics should be considered the full amplitude of active angular movements in the three large joints of the lower limb and the index of angulometric asymmetry in various walking modes. The main clinical characteristics that are inextricably linked to biomechanical parameters and must be evaluated to assess the effect of surgical treatment are the intensity of pain, the amount of movement restriction in the joint in the sagittal plane, the severity of contracture, and the severity of lameness. Hip replacement with a modern design leads to the complete disappearance of pain syndrome in 90.9% of the operated patients and its transition from moderate or severe to minimal in 9.1%. Movements in the joint in the sagittal plane are fully restored in 69.7% of patients, in the remaining 30.3% the mobility restriction becomes slightly pronounced. Lameness disappears in 69.7% of cases and turns from moderate or severe to mild in 30.3%. A clear improvement in both the static and kinematic parameters of walking is achieved. The stability of the vertical orthogonal stance pose, its stability, and its ability to withstand functional tests are increased. The gait approaches the stereotype of normal walking. Normalization of the distribution of the weight load on the feet and the tension of the muscles that ensure standing and walking; an increase (almost to normal) in the length and width of the step and the angle of rotation of the feet on both sides to achieve optimal values of the dynamic area of support; the effectiveness of iso- and stenolocomotor rearrangements of movements in the joints of the operated limb in various walking modes; reduction or complete elimination lameness in the form of normalization of the coefficients of rhythmic phases and dynamic support; sufficiency of mechanisms for compensation of residual disorders of standing and walking [2,4,6,8,10].

Hip replacement with a cement-free endoprosthesis from the Swiss company PLUS Endoprothetik provides full-fledged rehabilitation of patients with severe degenerative and dystrophic lesions. Kocher's posterior access is less traumatic than the anterior external one. It avoids cutting off the gluteal muscles, guarantees good visualization of the acetabulum and the proximal femur; there are no large blood vessels along the line of its implementation; there is no danger of crossing the sciatic nerve. It is desirable to implant the acetabular component at an angle of 4045 ° relative to the horizontal plane and 10-15 ° of the anteversion, resection of the neck is performed at an angle of 45 ° to the axis of the femoral diaphysis. Efforts should be made to ensure that the new biomechanical center coincides with the center of rotation of the joint.

3. Conclusions

The success of hip replacement largely depends on full-fledged physio-functional treatment, the main component of which is physical therapy aimed at restoring muscle function. An individual rehabilitation program helps to preserve and strengthen the rehabilitation effect of the operation. The mild instability, instability and tension of standing and walking remaining after surgery require prescribing a regime of careful "operation" of the musculoskeletal system. Patients should especially pay attention to the need to avoid sudden movements and shock loads on the lower extremities, as well as to the caution required when walking on uneven surfaces.

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