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**Kliniczne, biomechaniczne i radiologiczne aspekty oceny
funkcjonowania stawu biodrowego po operacjach
endoprotezoplastyki stawu biodrowego**

**Rozprawa na stopień doktora nauk medycznych i nauk o zdrowiu
w dyscyplinie nauki medyczne**

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Obrona rozprawy doktorskiej przed Radą Dyscypliny Nauk Medycznych
Warszawskiego Uniwersytetu Medycznego

Warszawa 2024 r.

Słowa kluczowe

Staw biodrowy, endoprotezoplastyka, choroba zwyrodnieniowa, koksartroza, alloplastyka, biomechanika, skostnienia pozaszkieletowe, dostępy operacyjne, analiza radiologiczna

Keywords

Hip, joint replacement, osteoarthritis, coxarthrosis, alloplasty, biomechanics, heterotopic ossification, surgical approaches, radiological analysis

Streszczenie w języku angielskim

Clinical, biomechanical and radiological aspects of assessing the functioning of the hip joint after total hip replacement surgery

Degenerative hip joint disease is one of the most common problems affecting various social groups, with a global count of over 500 million people, mainly over the age of 55. The main feature of the disease is the degradation of the joint cartilage and surrounding soft tissues, leading to sclerosis of the subchondral layer, formation of bone spurs (osteophytes), synovial membrane hypertrophy, and overall joint degeneration. Patients experience pain, joint movement restriction, limb shortening, and gait disturbances. Managing hip osteoarthritis poses a challenge for healthcare systems worldwide, especially when about 10% of men and 13% of women over the age of 60 suffer from this condition, and the numbers increase with age. Projections indicate a rise in the number of cases in developed countries due to obesity, lack of physical activity, and rising patient expectations. Initially, treatment is usually conservative, including oral analgesics, rehabilitation, and joint injections. In advanced cases, where complete cartilage degeneration occurs, total hip arthroplasty (THA) may be necessary, although despite the development of alternative treatment methods, THA remains the gold standard.

In this series of publications included in the doctoral dissertation, radiological, biomechanical, and clinical factors influencing the outcome of surgical treatment are discussed. The impact of using minimally invasive surgical approaches on the radiological result of components placement is presented. Additionally, the influence of spinal and pelvic alignment on hip acetabulum positioning techniques is analyzed. Differences in gait biomechanics between patients with different prosthetic head sizes are demonstrated. The risk of falls in

individuals who developed heterotopic ossification is estimated, and the possibility of restoring normal biomechanical conditions in individuals undergoing hemiarthroplasty of the hip joint using standard implants is assessed.

In the study "The Direct Anterior Approach to Primary Total Hip Replacement: Radiological Analysis in Comparison to Other Approaches," which is part of the doctoral thesis, the authors reviewed publications analyzing the parameters of implant fixation depending on the surgical approach used, such as DAA, PLA, and ALA. The analysis focused on the influence of the surgical approach on the position of the acetabular cup, the axiality of the stem implant, and limb length discrepancy. Nine studies were included in the analysis, and the results indicate differences between the DAA approach and other approaches regarding implant fixation parameters. Eight studies showed differences in stem implantation, although not all were statistically significant. Regarding acetabular inclination, the analysis of 9 studies showed a significant difference between DAA and ALA, although not all studies demonstrated statistically significant differences. Acetabular anteversion also differed significantly between DAA and other approaches, indicating a potential impact of the surgical approach on surgical outcomes. However, limb length discrepancy was not statistically significant in the analysis of three studies. In summary, the use of the DAA approach may affect the fixation of implant components, especially concerning parameters such as anteversion and inclination of the acetabular cup. Surgeons should be aware of potential differences in implant fixation depending on the chosen surgical approach.

In the work "Spinopelvic Alignment and Its Use in Total Hip Replacement Preoperative Planning—Decision Making Guide and Literature Review," a part of the doctoral dissertation, the authors conducted the world's first systematic literature review and developed guidelines for placing hip implants depending on the stiffness of the lumbar-sacral spine segment and secondary pelvic settings. To precisely determine the proper implant placement, it is necessary to assess pelvic mobility through several parameters measured on lateral pelvic radiographs, considering half of the femoral shaft and the lumbar-sacral segment. This includes measuring sacral slope (SS), pelvic tilt (PT), pelvic incidence (PI), pelvic femoral angle (PFA), lumbar lordosis (LL), femoral inclination (FI), and angle between the S1 endplate and a line perpendicular to the ground (SSA).

The authors of the work "Spinopelvic Alignment and Its Use in Total Hip Replacement Preoperative Planning—Decision Making Guide and Literature Review" proposed guidelines based on available literature regarding the appropriate placement of the acetabular cup during THR depending on the above classification. To properly assess spinal mobility, the above-described angle values should be measured on radiographs in standing and sitting positions with 90 degrees of hip flexion.

In the study "Analysis of biomechanical gait parameters in patients after total hip replacement operated via anterolateral approach depending on size of the femoral head implant: retrospective matched-cohort study," which is part of the doctoral thesis, the authors analyzed gait parameters between two groups of patients operated on at the Orthopedics and Rehabilitation Clinic of the Medical University of Warsaw and a control group of healthy volunteers. One group of patients had implants with a 36mm head diameter, and the other had a 28 or 32mm diameter, matched by age, sex, and operated side. Each participant underwent radiological analysis of hip joints, functional assessment using WOMAC and VAS scales, and gait parameter analysis. It was shown that patients with small head implants had longer stance time and pelvic drop compared to healthy individuals, and shorter swing time, shorter step length, slower walking speed, and cadence. However, patients with large heads had gait parameters more similar to healthy individuals, albeit with reduced pain and high patient satisfaction. Choosing the appropriate implant seems to be a crucial decision in the preoperative planning stage, and the results of the study may influence post-THA rehabilitation, focusing on developing a proper gait model.

In the study "Posture stability and risk of fall test in the objective assessment of balance in patients with ectopic bone tissue after total hip replacement," part of the doctoral dissertation, heterotopic ossifications were identified in 46 out of 312 patients after total hip arthroplasty. A control group of 39 patients without extra-skeletal ossifications was matched. Patients underwent radiological and biomechanical evaluation and completed WOMAC and Oxford questionnaires for hip function assessment.

In the study "Hip hemiprosthesis due to femoral neck fracture in the elderly population - are we doing it right?" a part of this doctoral thesis, the authors analyzed the effectiveness of reproducing parameters using standard stem prostheses depending on the neck-shaft angle. The analysis included 100 consecutive patients undergoing hemiarthroplasty due to femoral neck

fracture. A correlation was demonstrated between the neck-shaft angle and change in FO, and a significant difference in the change in this angle and change in FO. The use of standard stem implants, designed to replicate a neck-shaft angle of about 130 degrees, may lead to incorrect FO reproduction, requiring thoughtful decision-making before surgery.