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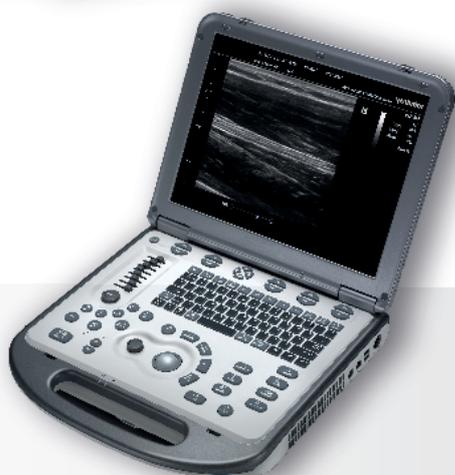
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Comparison of early and late surgical outcomes of patients after total hip arthroplasty in terms of the type of surgical approach and assessment of the level of fitness

Porównanie wczesnych i późnych wyników operacyjnych pacjentów po alloplastyce stawu biodrowego pod względem rodzaju dostępu operacyjnego i oceny poziomu sprawności

**Paweł Zieliński^{1(A,B,D,E,F)}, Rafał Trąbka^{2(A,B,C,D,E)}, Jarosław Amarowicz^{2(A,D,E,F)},
Mateusz Curyło^{3(D,E,F)}, Paweł Kamiński^{1(A,B,E,F)}, Magdalena Wilk-Frańczuk^{1,2(D,E,F)},
Tomasz Maicki^{2(D,E,F)}**

¹Małopolski Szpital Ortopedyczno-Rehabilitacyjny, Kraków / Lesser Poland Orthopaedic and Rehabilitation Hospital, Poland

²Klinika Rehabilitacji, Wydział Nauk o Zdrowiu, Uniwersytet Jagielloński Collegium Medicum, Kraków /
Rehabilitation Clinic, Faculty of Health Sciences, Jagiellonian University Collegium Medicum, Krakow, Poland

³Uniwersytet Medyczny w Łodzi / Medical University of Lodz, Poland

Abstract

Osteoarthritis is the most common form of human joint pathology. It is estimated that it affects about 6% of the world's population. In addition to the hand and knee joints, the hip joint is one of the most common joints affected by OA. The study included 59 randomly selected patients (from a group of over 600 people operated in a similar period) of the Orthopaedics and Rehabilitation Department of the Centre for Rehabilitation and Orthopaedics in Krakow, who underwent THA due to advanced degenerative changes using a cementless prosthesis.

The objective of the study was to compare the early and late outcomes of the procedure (patient's fitness level and subjective assessment) using the anterolateral (according to Watson-Jones) and lateral (McFarland and Osborne as modified by Hardinge) approach.

The obtained results confirm better outcomes in terms of the abduction strength scale (SO_{0%}), HHS, VAS, frequency of the Trendelenburg sign and partially mobility (external rotation) in relation to short-term follow-up (especially after 6 and 12 weeks), but not long-term follow-up (after 24 weeks and 11-12 years).

It was found that people who underwent surgery using the lateral approach (according to Hardinge) recover faster than people who underwent surgery with the use of the anterolateral approach (according to Watson-Jones).

Key words:

arthroplasty, osteoarthritis, hip joint

Streszczenie

Choroba zwyrodnieniowa to najczęściej spotykana forma patologii stawów człowieka. Szacuje się, że dotyka ona ok. 6% światowej populacji. Obok stawów dłoni oraz stawu kolanowego, staw biodrowy należy do najpowszechniejszych typów OA. Badaniem objęto wybranych w sposób losowy 59 pacjentów (z grupy ponad 600 osób operowanych w podobnym okresie) Oddziału Ortopedii i Rehabilitacji Krakowskiego Centrum Rehabilitacji i Ortopedii w Krakowie, poddanych zabiegowi THA na skutek zaawansowanych zmian zwyrodnieniowych, z wykorzystaniem protezy bezcementowej. Celem pracy było porównanie wczesnych i późnych efektów zabiegów (poziom sprawności pacjenta oraz subiektywna ocena) z dostępu przednio-bocznego (wg Watson-Jonesa) oraz bocznego (McFarlanda i Osborne'a w modyfikacji Hardinga).

Uzyskane wyniki badań własnych potwierdzają lepsze rezultaty w zakresie skali siły odwodzenia (SO_{0%}), HHS, VAS, częstości objawu Trendelenburga oraz częściowo ruchomości (rotacja zewnętrzna) w odniesieniu do obserwacji krótkoterminowej (szczególnie po 6 i 12 tygodniach), lecz nie długoterminowej (po 24 tygodniach i 11-12 latach). Stwierdzono, że osoby, u których zabieg był wykonywany z dojścia bocznego (wg Hardinga) szybciej dochodzą do sprawności niż osoby po operacji z dojścia przednio-bocznego (wg Watson-Jonesa).

Słowa kluczowe:

alloplastyka, choroba zwyrodnieniowa, staw biodrowy

Introduction

Osteoarthritis (OA) is the most common form of human joint pathology. It is estimated that it affects about 6% of the world's population [1]. In addition to the hand and knee joints, the hip joint is one of the most common joints affected by OA [2]. Despite numerous theories explaining its aetiology, it is currently believed that the cause of the disease is multifactorial [3]. Due to the aging of the population and the growing percentage of obese people, the number of people suffering from osteoarthritis of the hip and knee has increased significantly in recent years [4]. It is estimated that the incidence of OA increases rapidly between the age of 40 and 50, reaching 50% after the age of 60. According to the available data, every fourth patient who turns 85 experiences symptoms of OA of the hip joint. At the same time, the probability that the patient will undergo total hip arthroplasty is 10% [3]. Conservative treatment in combination with pharmacotherapy (NSAIDs) constitute the basis of the treatment of osteoarthritis of the hip joint. In the case of ineffective conservative treatment or no positive prognosis, surgery is recommended (in the absence of other contraindications) [5–7]. Due to the advanced age of patients with OA of the hip joint, early activation and return to activities of daily living (ADL) after surgery constitute a measurable effect, proving its effectiveness.

Total Hip Arthroplasty (THA) remains one of the most effective and cost-effective surgical procedures in orthopaedics [8–10]. In Poland, approximately 160 THA procedures per 100,000 inhabitants are performed every year [11]. Since the introduction of hip arthroplasty in the second half of the nineteenth century, this procedure has been subject to constant changes, both in terms of the technique of the procedure and the materials used [12]. These changes relate to the growing diversity of surgical approach used. This differentiation is the result of a compromise between the desire to obtain the best possible insight into the operated joint and the smallest possible traumatization of tissues as a result of the procedure, as well as its duration [13]. Due to the wide variety of surgical approaches, there are only a few comparative studies of the therapeutic outcomes of the procedures with their use.

All surgical procedures were performed by the same operating team. The pre-, intra- and postoperative management was the same for all patients in both groups, excluding the surgical approach. During surgery in the first group, the anterolateral approach according to Watson-Jones (Müller) was used, while the lateral approach of McFarland and Osborne was used in the second group.

Approach according to Watson-Jones (Müller)

Arcuate incision, starting 2 cm distal and rearward from the anterior superior iliac spine, carried over the top of the greater trochanter and further 8–10 cm distally along the limb axis, depending on the patient's size. The fascia was cut in the line of the cutaneous incision, revealing the tensor muscle of broad fascia, bordering on the upper part with the gluteus medius, and in the lower part with the gluteus maximus. The muscles were bluntly dissected, the gluteus medius was cut in the anterior part from the greater trochanter for a better view into the joint,

and after the gluteal muscles were moved back, and the tensor muscle of broad fascia forward, the anterior surface of the articular capsule covering the head and neck of the femur was visualized.

Approach according to Hardinge

Incision is made in the lateral line above the greater trochanter through its top from the height of the anterior superior iliac spine to about 8 cm below the top of the greater trochanter. The subcutaneous tissue and fascia were cut in the line of the cutaneous incision. The flexor of broad fascia was moved to the front, and the gluteus medius to the back. After incision of the greater trochanteric bursa, the anterior and posterior parts of the distal connection of the tendon of the gluteus medius and the proximal vastus lateralis attachment were visualized. According to Hardinge, both of these muscles form a functional whole. The incision made using an electric blade was then led along the gluteus medius fibres towards the top of the greater trochanter and then directed with a line bent forward through the vastus lateralis near the anterior surface of the femoral shaft. After adduction of the thigh, the gluteus medius was moved anteriorly, revealing the articular capsule on the anterior surface of the femoral neck.

From then on, the surgical technique for both approaches did not differ. The exposed articular capsule was excised from the anterior side, and after an anterior dislocation of the femoral head, the neck was resected at its base at an angle of 45° from the top and side, down and medially. After the exposure using hooks, the socket was processed with a spherical cutter, and after obtaining a properly prepared bed with an exposed spongy layer of the bone, the acetabular component of the endoprosthesis of the appropriate size was implanted using the press-fit method. An anti-luxation UHWMPE polyethylene insert with an offset of 10° was placed in the acetabular shell. Then, with the help of successive rasps, the bed for the endoprosthesis pin was prepared. The femoral element was implanted in the generated bed according to the corresponding size of the rasp. Finally, the joint was restored to its position with a head with a 28 mm diameter, the length of the neck was chosen so as to obtain a compromise between the greatest possible stability of the artificial joint and equal length of the limbs. The wound was closed after the placement of suction drainage in the subfascial and supra-fascial layers according to Redon, with the use of absorbable sutures up to the subcutaneous layer. The skin was sutured with a non-absorbable monofilament.

All patients underwent total hip arthroplasty using the Ceraver CERAFIT endoprosthesis. A metal acetabulum, covered with hydroxyapatite, was implanted using the press-fit technique.

The objective of the study was to compare the early and late outcomes of surgery (patient's fitness level and subjective assessment) using the anterolateral (Watson-Jones) and lateral (McFarland and Osborne as modified by Hardinge) approach [13, 14].

Material and methods

The study included 59 randomly selected patients (from a group of over 600 people operated in a similar period) of the Orthopaedics and Rehabilitation Department of the Centre for Rehabilitation and Orthopaedics in Krakow, who underwent THA due to advanced degenerative changes using a cementless prosthesis. Qualification was made on the basis of medical history, clinical and radiological examination according to Kellgren and Lawrence. The diagnosis of the degenerative disease was based on the guidelines of the American College of Rheumatology (ACR) [15]. The patients were divided into two equal groups: people operated on using the Watson-Jones anterolateral method (group 1 - 30 people - mean age 58.9 years, 49-69, SD 5.23) and the Hardinge lateral approach (group 2 - 29 people - mean age 59, 46-74, SD 6.69). Group 2 was slightly smaller due to a patient's late withdrawal from the study. In all patients, the procedure was performed with the use of the Ceraver CERAFIT endoprosthesis. A metal acetabulum, covered with hydroxyapatite, was implanted using the press-fit technique. Attempts were made to maintain the acetabular orientation with an inclination of 30-45° and an anteversion of 10° [16]. Individual components were selected on the basis of pre-operative planning (templates were applied directly to the X-ray film) and verified intra-operatively on the basis of the acetabular anatomy and the hip bone shaft anatomy (taking into account patient-specific factors).

Only patients with unilateral degenerative disease were randomized for the study, which allowed for a comparative study with the healthy side. The exclusion criteria included a secondary form of degenerative disease resulting from trauma, inflammation, dysplasia, as well as cases where it was not the first procedure on this joint. Moreover, people with coexisting osteoarthritis of other joints of the lower extremities, neurological diseases that impair the functionality of the locomotor system and people with symptomatic degenerative disease of the lumbar spine were excluded. After surgery, patients with confirmed, intraoperatively and radiologically, correct location and positioning of the elements of the artificial joint were qualified to participate in the study.

The distribution of gender and comorbidities of the studied patients in each group is presented in Table 1.

Table 1. Characteristics of the studied patients

| | Group 1 (PB)* | | Group 2 (B)* | |
|-----------------------|---------------|----|--------------|----|
| | K | M | K | M |
| Gender | | | | |
| N | 15 | 15 | 15 | 14 |
| Comorbidities: | | | | |
| Hypertension | 2 | 1 | 3 | 1 |
| Diabetes | - | 2 | 1 | 3 |
| Bronchial asthma | 1 | - | - | - |

* PB – anterolateral approach, B – lateral approach; F – female, M – male

In order to assess the differences in the obtained outcomes, the following research tools were used: measuring the muscle strength of abductors (Imada Inc. Japan electronic dynamometer), range of motion (analogue goniometer), measuring pain using the VAS scale (10-degree Visual Analog Scale, where 0 is no pain, and 10 – maximum perceptible pain), the HHS scale (Harris Hip Score 0-100 points, bad result below 70 points) and the WOMAC questionnaire (Western Ontario and McMaster Osteoarthritis Index – 0-96 points, the more points, the smaller the limitation). Pain was assessed during the abductor strength test, during the greatest force applied to the dynamometer before surgery, and during follow-up examinations.

The value of the moment of force was used to calculate muscle strength, i.e. the product of the average of 3 measurements of the maximum force generated during thigh abduction (SO – abduction force) and thigh length (expressed in newton meters – Nm). Due to the fact that SO is an individual feature for individual patients, and there are no reference values, it was necessary to perform standardization. The influence of individual characteristics was eliminated by replacing the absolute value of SO with the relative value of SO_%, taking SO for the healthy limb of a given patient ($SO_{\%} = SO_{\text{affected}}/SO_{\text{healthy}} \times 100$) as the reference point (100%).

The assessment with the use of the above research tools was planned for 4 sessions: immediately before the procedure, after 6, 12 and 24 weeks. As the actual dates of the tests differed from the planned scheme, the raw data was verified by interpolation to the average time for a given examination (1st examination – the day before the procedure, 2nd examination – $t_{6_{sr}} = 6.36$, 3rd examination – $t_{12_{sr}} = 12.81$, 4th examination – $t_{24_{sr}} = 25.28$). In addition, after 11–12 years, in 2015, a re-evaluation was carried out among patients with whom we maintained contact after this period ($n = 23$; 13 people from group 1 and 10 people from group 2).

The research results were analysed with the use of Statistica 9, using, Student's t-test and multivariate analysis of variance ANOVA with repeated measures. Throughout the study, the significance threshold was set at $p = 0.05$.

Results

Full characteristics of the individual groups, including perioperative factors, are presented in Table 2. Both groups were comparable in terms of age (G1: average age 58.9, 49–69, SD = 5.23 vs. G2: average age 59, 46–74, SD = 6.69) and BMI (G1: average BMI 28.5 kg/m², 20.5–35, SD = 3.5 vs. G2: 28.9 kg/m², 20.2–34, SD = 3.6). Statistically significant differences were observed in the context of the procedure time (G1: average time 77 min, 45–125, SD = 23.5 vs. G2: average time 67 min, 45–85, SD = 10.6) and the length of the scar (G1: average length 17.3, 13–25, SD = 2.5 vs. G2: average length 16.5, 13–20, SD = 3.5). No other significant changes in perioperative factors were observed. Two patients operated on from the anterolateral approach (group 1) developed complications in the form of surgical site infection (antibiotic therapy) and dislocation of the anterior endoprosthesis (revision was performed in the 7th month after the primary surgery).

Table 2. Characteristics of the studied groups

| Group | Group 1 | | | | Group 2 | | | | p |
|---|---------|-------|-------|-------|---------|------|------|-------|------|
| | Mean | Min | Max | SD | Mean | Min | Max | SD | |
| Age [years] | 58.9 | 49 | 69 | 5.23 | 59 | 46 | 74 | 6.69 | 0.95 |
| BMI [kg/m ²] | 28.45 | 20.45 | 35.00 | 3.53 | 28.86 | 20.2 | 33.9 | 3.57 | 0.66 |
| Time of the procedure [min] | 77 | 45 | 125 | 23.54 | 67 | 45 | 85 | 10.6 | 0.04 |
| Intraoperative bleeding [ml] | 486 | 250 | 1000 | 197 | 447 | 160 | 1100 | 209 | 0.47 |
| Postoperative bleeding [ml] | 1172 | 400 | 1970 | 415 | 1118 | 480 | 2170 | 359 | 0.59 |
| Change in Hb level | 3.259 | -0.2 | 6.1 | 1.436 | 3.087 | 0.3 | 7.1 | 1.325 | 0.63 |
| Change in Hb [%] | 23.1 | -1.9 | 43 | 9.7 | 21.8 | 2.2 | 49.3 | 9.3 | 0.62 |
| Volume of red blood cell transfusion [ml] | 490 | 440 | 540 | 115 | 460 | 440 | 490 | 95 | 0.64 |
| Volume of red blood cell transfusion [ml] | 9.3 | 7 | 14 | 1.5 | 9.1 | 7 | 12 | 1.2 | 0.59 |
| Day of verticalization | 3.5 | 2 | 5 | 0.6 | 3.8 | 3 | 5 | 0.65 | 0.08 |
| Limb extension [mm] | 10 | -20 | 30 | 011 | 1 | 0 | 50 | 13 | 0.20 |
| Scar length [cm] | 17.25 | 13 | 25 | 2.5 | 16.50 | 13 | 20 | 3.47 | 0.04 |
| POWIKLANIA / COMPLICATIONS | | | | | | | | | |
| Dislocation | 1 | - | - | - | - | - | - | - | - |
| Wound infection | 1 | - | - | - | - | - | - | - | - |
| Venous thrombosis | - | - | - | - | - | - | - | - | - |

MIN – minimum; MAX – maximum; SD – standard deviation; p – level of significance

The results of the muscle strength test (expressed in SO%) showed statistically significant differences between the groups (in favour of group 2 – surgery using the lateral approach). The analysis with the use of contrast analysis showed that in the follow-up period after 6 and 12 weeks, patients in group 2 had significantly greater abductor strength (32.5 and 10.7%, respectively). At the same time, the result for both groups before the procedure was comparable, as in the follow-up after 24 weeks ($p > 0.05$) – Figure 1.

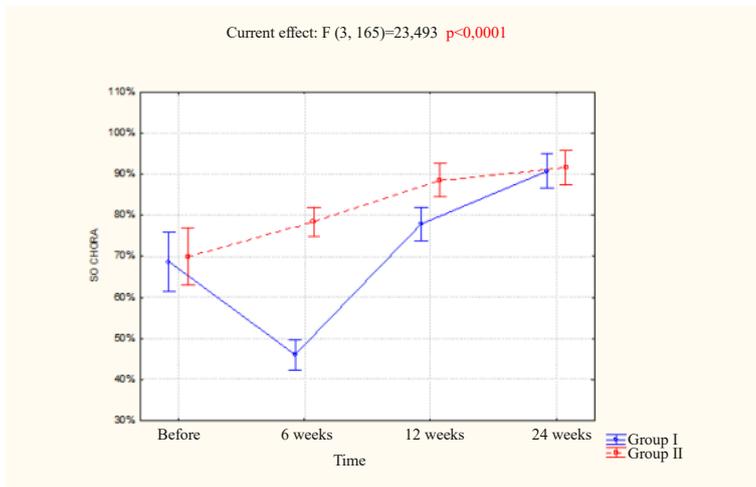


Fig. 1. Change in the moment of abductor strength (SO%) depending on approach and time. Vertical bars represent the 0.95 confidence interval

Similar results were obtained for the HHS. Contrast analysis showed, however, that a statistically significant difference was only observed in the 6-week follow-up period (mean HHS G1: 40.2 vs. G2: 56.5; $p < 0.001$). In both groups, a satisfactory result according to HHS was noticed during the follow-up at week 12 (Figure 2).

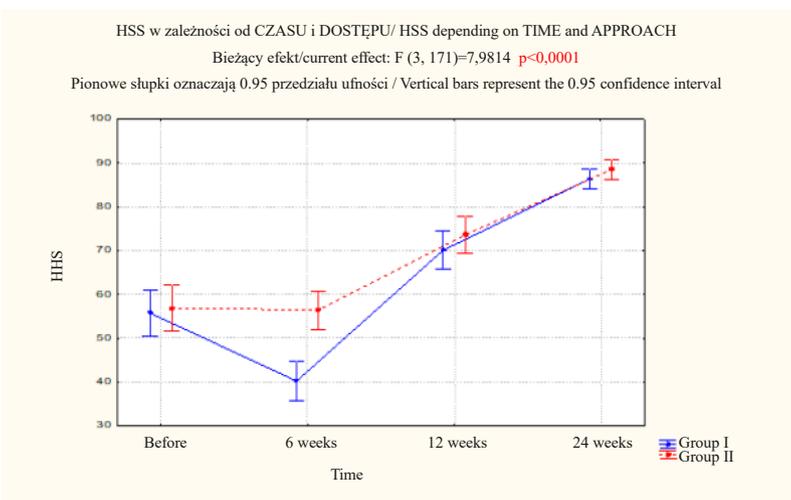


Fig. 2. Change in the Harris Hip Score at individual time levels by study groups

The results obtained using the WOMAC scale showed differences at each stage of the study. However, again, as in the case of SO% and HHS, the most clearly outlined difference was noticed during the follow-up after 6 weeks (average WOMAC G1: 47.8 vs G2: 61.8; $p < 0.0001$). A less visible difference was noted after 12 weeks (Gr. 1: 73.5 vs G2: 78.5; $p = 0.004$). Although the differences were also visible between the groups before the procedure and after 24 weeks, they were small (6 points in favour of G1 and 2.5 points in favour of G2, respectively; $p = 0.039$).

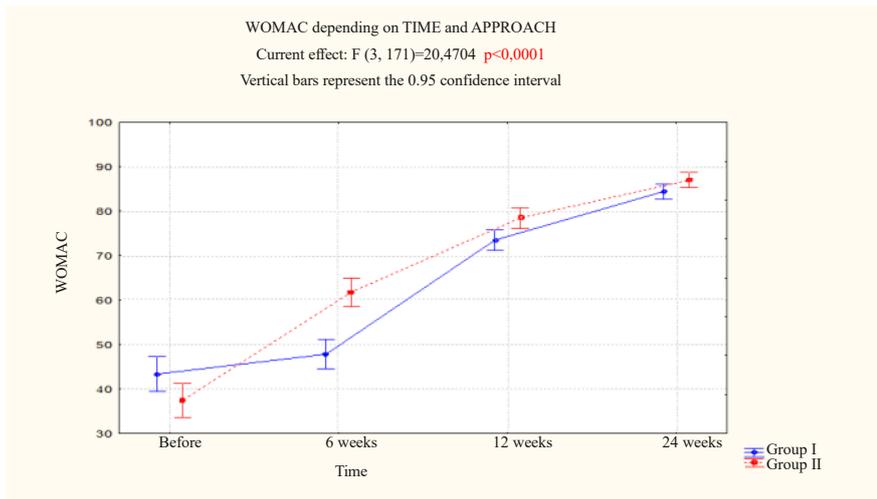


Fig. 3. Assessment according to the WOMAC scale at individual time levels

Differences in pain between the two groups were observed using the VAS scale. The results significantly differed between the groups at each stage of the follow-up (except for the measurement before the procedure), taking into account the additional measurement obtained on the 2nd day after the procedure ($p = 0.008$). Although the differences were small (within the range of 0.91–1.79 between the groups at individual stages of the follow-up), they were statistically significant throughout the follow-up period (Table 3).

Table 3. Assessment of pain intensity in the operated hip joint on the VAS scale

| Time | VAS mean | VAS SD | Confidence limits for VAS 95% | |
|----------------------|----------|--------|-------------------------------|------|
| Group I | | | | |
| Before the procedure | 7.52 | 0.24 | 7.05 | 8.00 |
| Day 2 | 8.84 | 0.15 | 8.54 | 9.15 |
| Week 6 | 5.47 | 0.26 | 4.95 | 5.99 |
| Week 12 | 2.82 | 0.24 | 2.35 | 3.29 |
| Week 24 | 1.43 | 0.19 | 1.05 | 1.81 |
| Group II | | | | |
| Before the procedure | 6.96 | 0.23 | 6.49 | 7.43 |
| Day 2 | 7.05 | 0.15 | 6.75 | 7.35 |
| Week 6 | 4.21 | 0.25 | 3.70 | 4.72 |
| Week 12 | 1.91 | 0.23 | 1.44 | 2.38 |
| Week 24 | 0.43 | 0.19 | 0.06 | 0.80 |

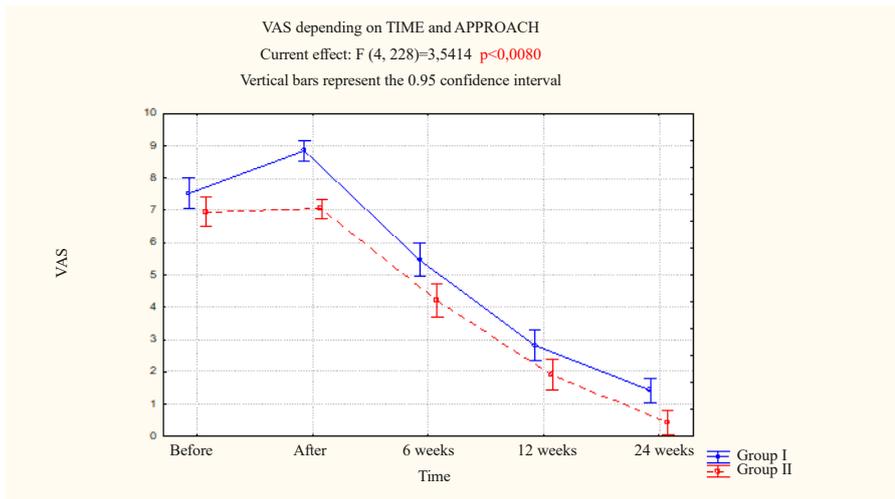


Figure 4. Assessment of pain intensity in the operated hip joint on the VAS scale

During the follow-up during the study, a much more frequent occurrence of the Trendelenburg sign (characteristic of thigh abduction muscle failure) was found in group 1, especially after 6 weeks (TR G1: 97% vs. G2: 53%; $p < 0.0001$) and 12 weeks (TR G1: 41% vs. G2: 3%; $p < 0.0001$) (Figure 5).

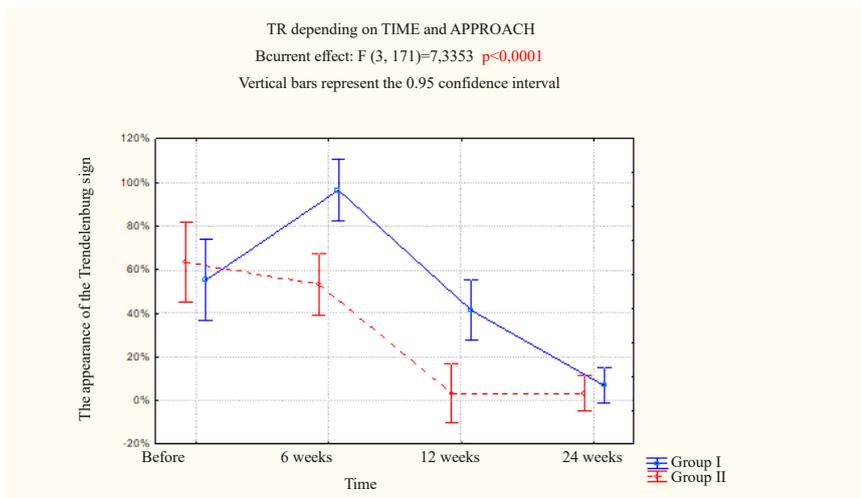


Figure 5. Change in the occurrence of the Trendelenburg sign in groups 1 and 2 at individual time levels

Measurements with the use of an analogue goniometer showed no significant differences in extension, flexion, abduction and internal rotation of the hip joint on the operated side. The only difference was noted in external rotation, in the follow-up period after 6 weeks, in favour of lateral approach patients (group 2) – although the difference was not large (7.4°), it was statistically significant ($p = 0,0014$).

Re-evaluation after 11-12 years

Re-evaluation after more than a decade in patients operated between 2003–2004, with whom we managed to keep in touch (23 patients),

showed no statistically significant changes between the groups in the scope of the HHS or WOMAC scales (Table 4). The only significant difference concerned the WOMAC scale between the follow-up period after 24 weeks and 11 years in favour of the anterolateral approach. The difference, although slight, was statistically significant ($p = 0.0074$). Due to the small significance and reduction of the study group, this has not been investigated in detail.

During the 12-year follow-up period, 9 patients in the group did not require a similar procedure on the opposite side (8 men and 1 woman) or revision of the original endoprosthesis. 5 women underwent arthroplasty on the opposite side in 2008–2012 (on average after 6.5 years). Among men, a similar procedure was required in 3 patients between 2007–2012 (on average after 7 years). Additionally, 3 patients required revision of the operated hip joint between 2014–2015 (on average after 11 years) for various reasons: loosening of the pin, acetabulum and periprosthetic fracture of the femur (Figure 1, 2). No cases indicating the necessity of revision were observed in the group of men. Moreover, in 3 women and 1 man, it was necessary to perform hip arthroplasty on the opposite side due to degenerative changes.

Table 4. Comparison of the results of the studied groups with the group of patients in the control study after 11 years

| Group Sex Scale [points] | Group 1 | | | | Group 2 | | | |
|--------------------------------|---------|-------|-------|-------|---------|-------|-------|-------|
| | Women | | Men | | Women | | Men | |
| | HSS | WOMAC | HSS | WOMAC | HSS | WOMAC | HSS | WOMAC |
| 24 weeks after the procedure | 83.17 | 88.50 | 88.47 | 81.25 | 85.74 | 81.20 | 93.80 | 79.00 |
| 11 years after the procedure | 85.00 | 90.00 | 86.75 | 84.75 | 81.40 | 86.20 | 92.60 | 84.50 |

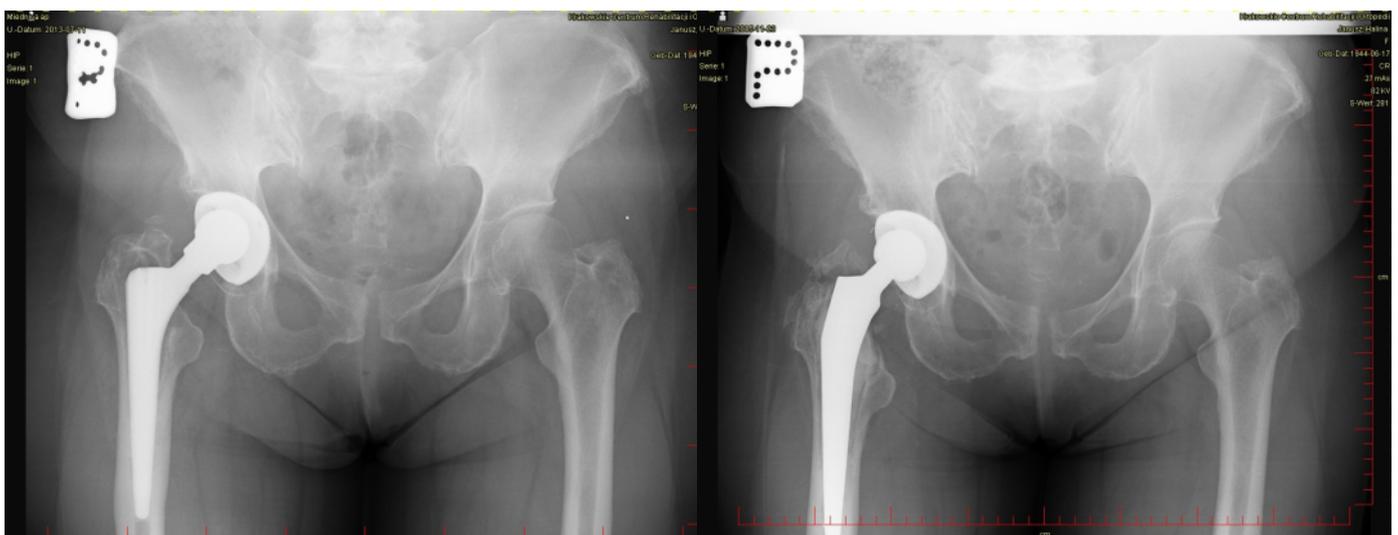


Figure 6. A) Hip joint prosthesis implant with wear features of the PE insert and loosening of the pin after 12 years; B) replacement of the damaged PE insert and the loose pin (from photo 6) with a cemented pin



Figure 7. A) Postoperative X-ray immediately after primary right hip arthroplasty in 2003; B) the patient in 2015 after the fixation of the periprosthetic fracture of the right thigh

Discussion

As part of preliminary observations of patients undergoing cementless arthroplasty at the Department of Orthopaedics and Rehabilitation of the Centre for Rehabilitation and Orthopaedics in Krakow, it was found that people who underwent the procedure using the lateral approach (according to Hardinge) recover faster than people in whom the procedure was conducted using the anterior approach (according to Watson-Jones). The obtained results of our own research confirm better results in terms of the abductor strength scale (SO₁₀), HHS, VAS, frequency of the Trendelenburg sign and partially mobility (external rotation) in relation to short-term follow-up (especially after 6 and 12 weeks), but not long-term (after 24 weeks and 11-12 years).

Due to the average age of the operated patients (~ 60 during the study), early activation and quick recovery of functionality constitute the basis for effective rehabilitation. Especially that, according to epidemiological studies, the vast majority of hip arthroplasty is performed in elderly people (2/3 of the procedures are people over 65) [17]. Patients in the older age group (after 60–65 years of age) are much more susceptible to possible postoperative complications than younger age groups, i.e. the risk of respiratory complications is twice as high in people over 60 as compared to younger people: 3 times higher in the group aged 70–79 [18]. The risk factors include the physiological reduction in muscle mass (approx. 0.7–0.8% for the lower limb after the age of 70, regardless of gender), associated with aging and the result of the degenerative disease itself [19]. Muscle changes resulting from degenerative disease are associated with type II muscle fibre atrophy (the effect of reduced physical activity). Additional surgical intervention in the muscle tissue causes further qualitative changes. The use of the lateral approach according to Hardinge (group 2) is associated with the longitudinal dissection of the musculotendinous unit (the gluteus medius and the lateral head of the quadriceps femoris), which allows for the continuity of the force lines of the abductors muscles to be maintained. At the same time, the Watson-Jones (Müller)

approach is associated with cutting off the tendons of the gluteus medius and gluteus minimus from the greater trochanter of the femur (which results in their temporary failure). The healing process of the connective tissue forming the tendon may take from 6 to 12 weeks [20]. Taking into account the possibility of incomplete healing of the cut tendons in the gluteal muscles and sometimes their secondary detachment from the greater trochanter, it may lead to the weakening of the muscle strength of abductors in patients operated on from the anterolateral approach – group 1 [21]. The differences in abductor muscle strength between the groups in the study below were most pronounced at 6 and 12 weeks after the follow-up in favour of the lateral approach group (the difference was over 32% at 6 weeks, $p < 0.0001$). This suggests that the recovery of muscle strength is faster in the group operated using the approach according to Hardinge. Consequently, the surgical approach seems to directly translate into the recovery of the abductor muscle strength.

The use of HHS and WOMAC scales showed significant differences depending on the approach used. The results obtained on the above-mentioned scales confirm the legitimacy of performing the surgical procedure with an indication of those operated using the lateral approach. On the WOMAC scale, significant differences were visible at week 6 and week 12 of follow-up (in the second case, a much smaller difference – about 5 points, $p = 0.004$), and HHS only at week 6. It should be emphasized that before surgery, the results in both groups were comparable in both HHS and WOMAC. The results clearly show the advantage of the lateral approach according to Hardinge (group 2) in relation to short-term results, while pointing to its lack in relation to long-term results. Contrary to the results obtained by the authors, Restrepo et al. showed that better short-term results (WOMAC, SF-36) are observed in the iliac-femoral approach according to Smith-Petersen. However, these differences disappeared within 2 years of the procedure [22]. No significant differences (in HHS, WOMAC and SF-36) between the groups operated using the lateral and posterior approach were shown by Witzleb et al. during 12 weeks of follow-up [23]. Also, Mjaaland et al., in the same follow-up period as in this study, did not observe a difference (HHS, 6 minutes walking distance, Oxford Hip Score, EQ-5D) between the immediate lateral and anterior approach [24].

The advantages of minimally invasive surgical (MIS) approach was not confirmed after one-year follow-up conducted by Goosen et al [25]. The advantage of the lateral approach over the anterior approach was challenged by Wang et al. In their review, the authors included five randomized studies, concluding that the anterior approach reduces pain and blood loss to a greater extent, and increases the frequency of walking and stride length. However, they did not find significant differences in HHS, duration of surgery, duration of hospitalization or frequency of operations [26]. Similar doubts were expressed by Amlie et al., referring to the quality of life of patients depending on the THA approach used. The authors of this study proved that patients operated on using the lateral approach had worse results on the HOOS (Hip Disability Osteoarthritis Outcome Score), WOMAC, VAS and health-related quality of life scales – EQ-5D-3L [27].

Our own research did not show significant differences in terms of perioperative factors, except for the time of surgery (77 vs. 67 min on average, $p = 0.04$) and the length of the postoperative scar (17.25 vs. 16.5 cm on average, $p = 0, 04$) – in both cases in favour of group 2 operated using the lateral approach. Group 2 also had

statistically significantly better results in the VAS scale at each stage of postoperative follow-up, especially visible immediately after the procedure (a difference of 1.79 points between the groups on average, $p < 0.0001$). Kristensen et al. obtained different results in the group of patients after hip fractures, where more favourable VAS-related quality of life values were obtained in the group undergoing the procedure using the posterior approach than the lateral approach, but only after 12 months the difference was statistically significant [28].

The authors' own research showed that the patients operated on using the anterolateral approach (group 1) were much more prone to the Trendelenburg sign during weeks 6 and 12 of follow-up, after which the frequency of its occurrence between the groups became equal. Its occurrence, which indicates failure of the thigh abductor muscles, can significantly affect the recovery process of the operated patient. Authors do not agree on the issue of its occurrence depending on the approach used. According to Pai, regardless of the form of the lateral approach, the percentage of Trendelenburg sign frequency will be similar [29]. In their study Ugland et al. prove that direct lateral approach is characterized by a greater percentage of its occurrence than the anterolateral approach [30]. A similar observation was made by Mjaaland et al., where the Trendelenburg sign occurred much more frequently in patients undergoing the procedure using the lateral rather than the anterior approach (16% vs. 1%, OR 15, $p = 0.001$). The occurrence of the Trendelenburg sign significantly decreased the functional abilities of these patients, however, it did not significantly affect the differences between the groups studied by Mjaaland et al. [24].

Follow-up examinations 11–12 years after the primary surgery were significantly reduced due to the high proportion of patients with whom contact was lost. From the original group of 59 people, the re-evaluation was successfully carried out in 23 patients. Based on the available results, the authors did not observe any significant differences in the studied variables between the groups after 11–12 years. In the remaining group, 3 patients (13%) required revision of the operated hip joint, which was a slightly higher percentage than in other studies [31, 32]. Complications were incidental (2 cases, only in the anterolateral approach) and did not translate much into the rehabilitation process in relation to the results of the entire group.

Conclusions

Scientific literature provides abundant evidence that hip arthroplasty is an effective procedure, resulting in a small number of complications and allowing for a quick recovery of the patient's functioning [33]. Various surgical approaches have their advantages and disadvantages, and the choice of the appropriate procedure should always be adapted to a given patient, taking into account his/her functional capabilities and health [34]. Taking into account the results of this study, as well as the average age of patients undergoing THA due to hip OA, we can conclude that the lateral approach according to Hardinge enables faster recovery than the Watson-Jones anterolateral approach. This is particularly important in the case of elderly patients who are at higher risk of vascular, respiratory or orthostatic complications. Greater functional abilities after surgery translate into their less frequent occurrence, and hence, improvement of the quality of life, which is an important factor in assessing the effectiveness of therapy from the patient's point of view.

Our study had several limitations that could have influenced

its outcome. The most important limitation was a significant reduction in the number of people in the follow-up study conducted after 11–12 years (by 61%), which makes it difficult to draw conclusions from this part of the study. This is largely due to the small size of the group at the start of the study (59 patients). In our study, we did not take into account the potential impact of comorbidities and pharmacotherapy used by patients, which could also translate into the rehabilitation process and possible complications.

Adres do korespondencji / Corresponding author

Tomasz Maicki

e-mail: tomasz.maicki@uj.edu.pl

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