Acta of Bioengineering and Biomechanics
Vol. 22, No. 1, 2020

Original paper
DOI: 10.37190/ABB-01480-2019-02

Body balance a few years after total hip replacement

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Purpose: These aim of the study was to conduct a long-term evaluation of whether total hip replacement permanently affects the dynamic body balance. *Methods*: Twenty-five patients after the unilateral total hip replacement (mean age: 69.9 ± 6.2) and 25 subjects without the total hip replacement (mean age: 68.4 ± 4.8) who matched the age and overall health participated in this study. The force platform and functional tests such as Timed Up and Go, 3m walk test, Functional Reach Test, 30s Chair Stand Test, Step Test and Berg Balance Scale were used to assess dynamic balance. The results obtained in individual trials were compared using the Student's *t*-test for independent variables, the Welch test or the non-parametric Mann–Whitney *U*-test. *Results*: Subjects from the THR group exhibited significantly increased time and distance in the tests performed on the force platform, compared to the control group. We also observed worse balance and functional test scores in the THR group: Timed Up and Go test ($p < 0.001$), 3 m walk test ($p < 0.001$), Functional Reach Test ($p < 0.001$), 30 s Chair Stand Test ($p = 0.001$) and Step Test (operated leg: $p < 0.001$, non-operated leg: $p < 0.001$). The results obtained in the Berg Balance Scale tests were not significantly different between the groups ($p = 0.218$). *Conclusions*: We observed significant differences in postural stability and dynamic balance between patients after THR and subjects in the same age without endoprosthesis. Our research shows that total hip replacement permanently impairs patients' dynamic balance and their functionality in certain lower-extremity activities.

Key words: *balance, total hip replacement, gait, muscle strength*

1. Introduction

Hip osteoarthritis leads to the destruction of the joint, which results in chronic pain, asymmetrical loading of the lower extremities and gait disorders. Some research also suggests the worsening of static and dynamic balance in these patients [1]. Patients in end-stage of osteoarthritis have deficits in muscle strength, function and physical activity and have a higher incidence of falls compared to the healthy adults [2]. Total hip replacement (THR) is generally recommended for patients with advanced degenerative changes. Some studies indicate that performing surgery in the later natural history of deterioration was associated with poorer results [3].

The procedure may lead to temporarily decreased amounts of proprioceptors located in the articular capsule and muscles, while postoperative pain impedes patient functionality [4]. The activities that require the involvement of the lower limbs are temporarily limited. It is associated with a postoperative reduction of the range of motion in the hip (mainly due to pain) and a decrease in muscle strength. One consequence might be deteriorating postural control and dynamic balance, which determine proper gait quality. Therefore, it is important to apply targeted exercise as fast as possible in order to limit the degree of lower limb dysfunctions, improve performance of tasks such as stair climbing, fast walking, and balance and return patients to full daily activity [5]. Patients often enjoy decrease in pain, improved range of movement and the level of function recovery after surgery [2], [6]. However, many reports reveal patients' dissatisfaction with their ability to perform social and domestic activities and the persistence of functional limitations [7].

In our research, we want to assess whether balance deficits in patients after THR tend to subside over

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Received: October 17th, 2019
Accepted for publication: January 24th, 2020

time. Some researchers provided evidence for improvements in THR patients with regard to some functions (gait, rising from a chair, improved life quality) [8]. Nonetheless, few projects have focused on the quantitative dimension of postural control examination [9], [10].

The balance assessment can be performed in static and dynamic conditions. In numerous studies, both static and dynamic balance are examined, especially one year post-surgery [6], [11]. In many cases, such assessment concentrates on static balance and on gait, because gait instability has been identified as a relatively consistent risk factor for falls. Test results of THR patients are often compared to their pre-operative results and not against results of a control group consisting of age-matched people without prosthetic implants [11]. Additionally, literature review shows that there is little research regarding the assessment of dynamic balance over one year after surgery [12], [13]. Some researchers observed that after THR many patients continue to show abnormal gait patterns compared to preoperative levels and healthy subjects. Reduced walking ability and muscle weakness may be a reason for decreased mobility [7]. Also balance and proprioceptive deficits are often persistent after THR. Balance impairments limit functionality, hinder activities of daily living (such as self-care) and lead to altered movement patterns and difficulties in walking and maintaining postural control [14]. It is also associated with an increased incidence of falls.

The aim of the study was to assess the quality of postural control in dynamic conditions in THR patients a long time after surgery compared to patients with not advanced radiological changes of hip-joint and other joints resulting in nonsignificant restrictions of the range of movement in the joint and nonsignificant level of the pain provoked by physical activity. The hypothesis of the study was that the elderly after THR demonstrated worse dynamic balance than subjects who were age- and overall health matched.

2. Materials and methods

Participants

The observational, case-control study included 50 subjects (69.1 ± 5.6 years, aged 60.0–83.0) treated at the Outpatient Rehabilitation Ward of Wiktor Dega's Orthopaedic and Rehabilitation Clinical Hospital at Poznan University of Medical Sciences (Fig. 1). The research was conducted from July 2016 to October 2018. Patients from both groups were treated in the Ward for four weeks and were recruited concurrently to the THR group and the control group according to the inclusion and exclusion criteria by the same physiotherapist working in the Ward. The reason for the rehabilitation of patients from both groups were musculoskeletal dysfunctions, which, according to literature data and the results of the subjective and physical examination, did not affect body balance. The assessment of balance was performed only once at the beginning of the rehabilitation process to avoid the potential impact of the actual rehabilitation process on the balance ability of patients.

The THR group (the study group) included 25 individuals (21 women and 4 men) who had undergone unilateral total hip replacement following advanced osteoarthritis. The patients had unilateral anterolateral THR. The THR group consisted of 11 patients with right endoprosthesis and 14 patients with right endoprosthesis. The average time of the postoperative period was 5.1 ± 2.6 years. Information from individual medical histories show that patients after THR did not have postoperative complications. All patients qualified for the study group participated in postoperative rehabilitation on an inpatient rehabilitation ward and gained independence during gait and daily activities.

The control group was comprised of 25 healthy people (21 women and 4 men) without hip endoprosthesis, who did not report any pain or limited range of motion in joints. The THR group and the control group were age- and sex matched. Overall health was similar in both groups. In both groups, the right limb was the dominant lower limb.

We recruited patients with unilateral hip endoprosthesis (left or right), and patients who recovered after surgery without serious complications to THR group. The inclusion criteria for both groups were as follows: moving without any orthopedic aids (canes, walkers, crutches), age range of 60–85 years and scoring at least 9 points on the AMTS scale (Abbreviated Mental Test Score). The criteria for exclusion for both groups were diseases affecting the balance, such as: vestibular problems, neurological conditions (hemiplegia, peripheral neuropathy, stroke, Parkinson's disease, SM), muscle diseases, rheumatic diseases (rheumatoid arthritis, ankylosing spondylitis, psoriatic arthritis), sciatica, operations in the area of the spine and lower limbs (knee arthroscopy with ACL reconstruction or meniscectomy, total knee replacement, total hip replacement in both extremities, osteotomy or arthrodesis), feet deformities, taking medications that might affect balance. To exclude the effect of gender, age, general health on the results of the study, the control group was matched to the study group in terms of these characteristics.

All subjects expressed written consent to participate in the study. The study was conducted in compliance with the Declaration of Helsinki and with the approval of the Bioethics Committee of Poznan University of Medical Sciences (reference number 949/14). Data were anonymised before analysis.

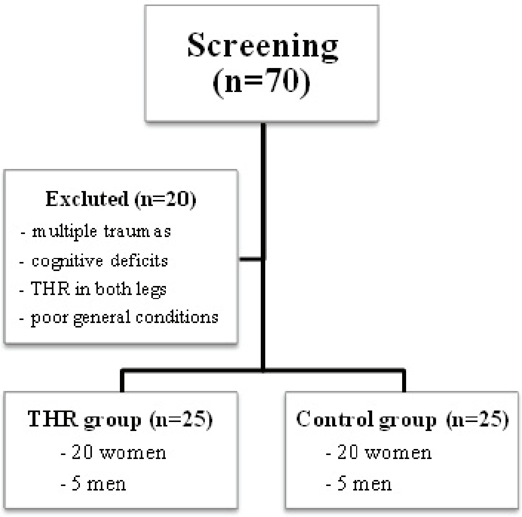

Fig. 1. Flowchart of the study.
Seventy patients were screened for this pilot study.
Fifty patients participated, and divided into two groups

Experimental procedures and instruments

Dynamic balance and functional mobility were assessed using force platform and the following tests: Timed Up and Go test, 3 m walk test, Functional Reach Test, 30 s Chair Stand Test, Step Test and Berg Balance Scale (Fig. 2).

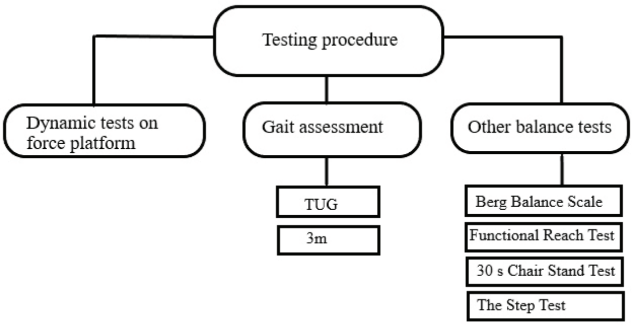

Fig. 2. Testing procedures

Dynamic test on force platform

The dynamic test was performed on the Metitur's Good Balance force platform. The subject's position was upright with feet placed parallel and 20 cm apart. During the test, the subjects received visual biofeedback from the monitor, enabling them to localize the position the centre of feet pressure (COP) and its displacement (Fig. 3). It was visualized as a cursor. The participant's task was to shift weight forward to a target and back to the central target without move the feet [15]. Two protocols with the same "path" to COP displacement (B screen) were used to assess the dynamic balance. The protocols differed only as far as the sensitivity of the platform and distance from targets (B100 and B60 scale) was concerned. The B100 scale was characterized by a greater distance to designated targets than the B60 scale.

In both cases, we analyzed the following parameters (Fig. 4):

– time [s] – time in which the participant completed the task
– distance [mm] – distance of COP displacement
– distance Y [mm] – distance of COP displacement in the sagittal plane (anteroposterior direction)
– distance X [mm] – COP displacement distance in the frontal plane (mediolateral direction)

Before evaluation, the participants were acquainted with the testing method. The measurement was made once for B100 and B60 screen. Dynamic tests on a balance platform were carried out to assess the control of body movements of people after THR while performing specific tasks quickly (B100 screen) or precisely (B60 screen).

Fig. 3. Position during the test on the balance platform

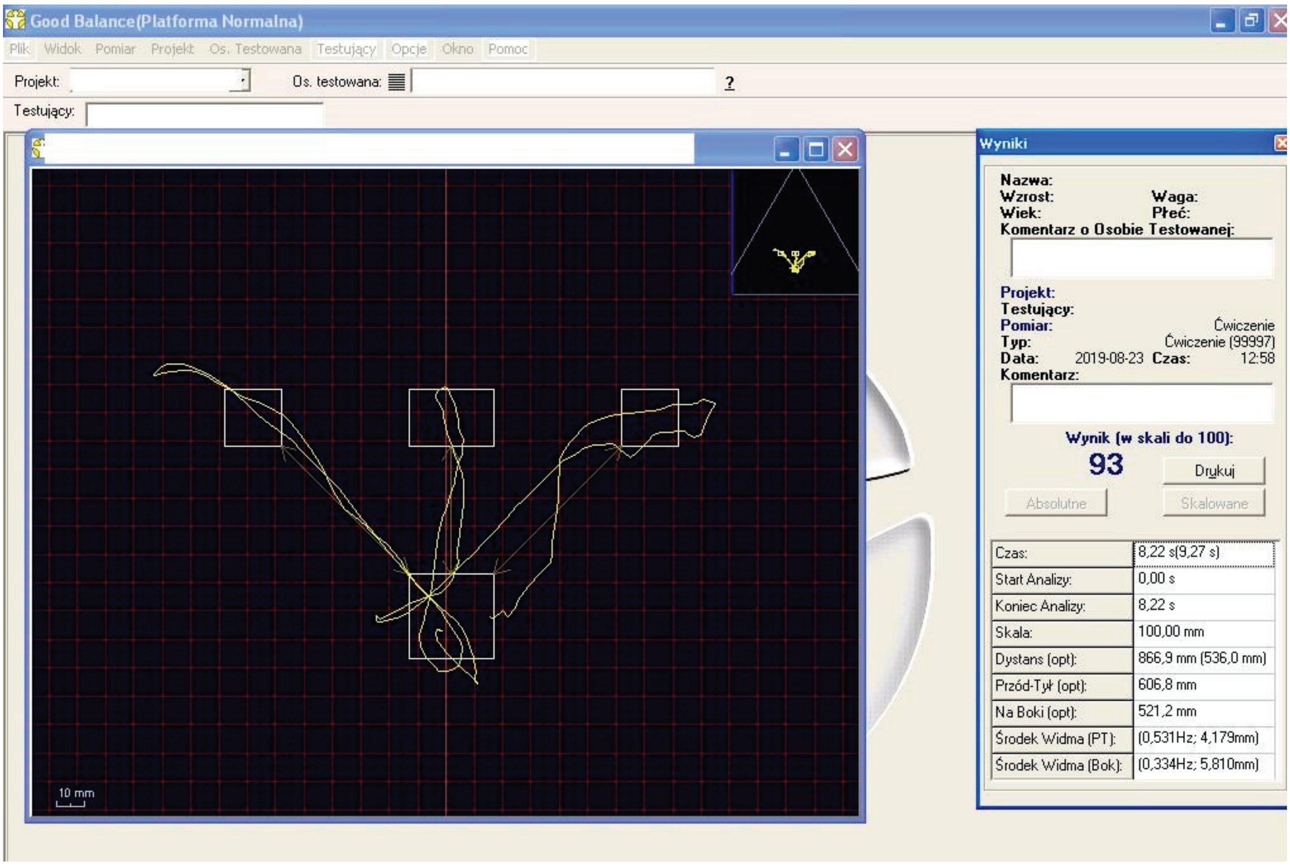

Fig. 4. Results obtained in the dynamic test

Timed Up and Go (TUG)

During the test, patients were to rise from a chair, walk a distance of 3 meters, make a turn of 180° having crossed a designated line and return to the chair. Recording the time of performing the task was initiated by the "start" command and stopped the moment a patient returned to the sitting position with the back resting against the chair. Patients were instructed to do the task as quickly as possible, but at the maximum speed at which the patient could walk safely without running [16]. Each participant completed three trials. An average value from all three trials was recorded as study data for further analyses.

3 m walk test (3 m)

The test was conducted to asses gait speed. Patients were instructed to stand with their toes touching the start line and walk fast beyond the taped finish line. The time from the moment their foot crossed the start line to the moment their both feet crossed the stop line was measured [17]. Each participant completed three trials. An average result from all three trials was recorded as study data for further analyses.

Functional Reach Test (FRT)

During the test, the patient was standing by the wall with their feet shoulder-width apart, one shoulder flexed at 90° and the other arm on the side. A ruler was attached to the wall. Patients were instructed to reach their maximal distance (in centimetres) without moving their feet or losing balance and come back to the standing position. If subjects raised a heel or took a step during testing, the trial was repeated [18]. Each participant completed three trials. An average distance for all three trials was recorded as study data for further analyses.

30 s Chair Stand Test (CST)

The test consists of standing up and sitting down from a chair as many times as possible within 30 seconds. Initially, subjects were seated on the chair with their arms folded across the chest and with a back in an upright position. They performed only one trial and started it after a command. A standard chair with armrests was used. All patients performed the test using the same chair [19].

The Step Test (ST)

The subjects were instructed to place one foot onto a 7.5 cm high step and then take it back down to the floor repeatedly as fast as possible. The score is the number of steps completed in the 15-second period for each lower extremity [20]. Both sides were tested two times, with the THR group completing the test first with the operated leg (ST O) and then the non-operated leg (ST N). Scores for each lower extremity were recorded separately. Better results were recorded as study data for further analyses. We calculated a reference value in the control group (ST C), which is a mean representing tasks conducted with the left and right limb.

Berg Balance Scale (BBS)

The Berg Balance Scale (BBS) is currently the most commonly used clinical test for assessment of functional balance in older adults. Subjects did 14 different tasks including static tests with different feet positions and functional balance control tasks, including transfer, getting up and sitting on a chair, reach, turning and stepping. The BBS tests performance on levels from 0 (can't perform) to 4 (normal perform) and can give a total score of 56. Higher scores on the BBS indicate better balance. A total score obtained in 14 trials was recorded for further analyses [21].

Statistical analysis

Data were analysed with the Statistica version 13.1. Demographic data and clinical characteristics are presented as means, standard deviations (SD), median, minimum (min) and maximum (max). The Shapiro–Wilk test was used to assess the normality of the distributions in the test score. To compare the differences between the THR group and the control group, we applied the Student's *t*-test for independent variables, the Welch test or the non-parametric Mann–Whitney *U*-test depending on which test assumptions were made. *P*-values less than 0.05 were considered statistically significant.

3. Results

Average age of a person with endoprosthesis was 69.9 ± 6.2 (60.0–83.0), whereas for healthy individuals it was 68.4 ± 4.8 (62.0–83.0). No statistically significant differences in age, height, weight and the BMI index were found between the study and the control group (Table 1). There was also no significant difference in abductor muscle strength measured with the Manual Muscle Test between the two groups ($p = 0.649$).

Dynamic tests on the force platform

There were statistically significant differences in the time and distance of COP displacement in sagittal planes between the study and the control groups in B60 board tests. The values for both of these parameters were found to be higher in the study group (Table 2). Subjects from the research group performed the task slower and demonstrated greater COP displacement. Also distance in the frontal plane on B100 board was significantly worse in the THR group. All values are presented in Table 2.

Functional test results

There was significant difference in TUG, 3 m, FRT and CST between groups (Table 3). Both tests assessing gait in patients after total hip replacement showed that they completed the task slower than members of the control group. Completing the TUG test by an individual from the study group took on average 1.8 seconds longer than in the control group ($p < 0.001$), whereas the walking time over the distance of 3 meters was 0.6 seconds longer. In the FRT trial, the reach distance of THR patients was, on average, by 4.9 cm shorter than that of the control group

Table 1. Demographic data of participants

	THR group			control group				
variable	mean ± SD	min–max	median	mean ± SD	min–max	median	*t*/*Z*	*p*
Age [years]	69.9 ± 6.2	60– 83	68.0	68.4 ± 4.8	62.0–83.0	67.0	0.902	0.367
weight [kg]	74.6 ± 15.3	56–115	72.0	69.4 ± 11.4	50.0–92.5.0	70.0	0.902	0.367
height [cm]	163.1 ± 7.1	152–182	163.0	164 ± 7.2	152.0–182.0	163.0	–0.435	0.666[a]
BMI	27.9 ± 4.5	20.8–41.2	27.1	25.7 ± 3.2	18.8–31.2	26.3	1.948	0.057[a]

Student's *t*-test for independent variables[a] or Mann–Whitney *U*-test.

Table 2. Results of the dynamic test from the B100 and B60 boards obtained by the THR and the control group

Parameter		Group	Mean ± SD	Min–max	Median	t/Z	p
B100	time [s]	THR control	16.7 ± 6.2 14.9 ± 3.2	8.3–35,7 9.8–21,9	14.5 14.3	0.650	0.516
	distance [mm]	THR control	1244.2 ± 293.1 1126.8 ± 177.8	840.4–1876.7 859.4–1683.4	1181.8 1098.3	1.713	0.095[b]
	distance *Y* [mm]	THR control	775.0 ± 150.0 739.3 ± 126.9	548.4–1112.9 574.0–1117.2	788.3 703.5	0.757	0.449
	distance *X* [mm]	THR control	791.9 ± 237.9 682.8 ± 126.7	451.4–1248.2 464.1–1043.9	692.4 682.3	2.024	0.050[b]
B60	time [s]	THR control	17.8 ± 4.7 14.7 ± 2.6	10.8–30.0 11.3–21.3	16.4 13.8	2.522	0,012
	distance [mm]	THR control	1033.9 ± 296.6 867.7 ± 215.3	601.3–1768.7 563.9–1325.4	1001.0 859.6	2.267	0.028[a]
	distance *Y* [mm]	THR control	625.2 ± 132.7 538.6 ± 118.1	386.3–886.6 346.6–823.0	611.4 522.0	2.244	0,019[a]
	distance *X* [mm]	THR control	669.9 ± 257.3 549.4 ± 182.0	291.1–1312.2 289.9–889.0	632.6 505.4	1.911	0.062[a]

Student's *t*-test for independent variables[a], Welch test[b] or Mann–Whitney *U*-test.

Table 3. Results of functional tests obtained by the THR and the control group

Test	Group	Mean ± SD	Min–max	Median	t/Z	p
TUG [s]	THR control	9.8 ± 1.8 7.9 ± 0.7	7.2–13.5 6.8–9.7	9.4 7.9	4.191	<0.001
3 m	THR control	3.2 ± 0.5 2.6 ± 0.2	2.3–4.3 2.2–3.1	3.3 2.6	5.758	<0.001[b]
FRT [cm]	THR control	32.9 ± 4.4 37.8 ± 3.5	24.3–40.0 31.0–45.0	34.0 38.3	–4.246	<0.001[a]
CST	THR control	10.8 ± 3.4 14.0 ± 3.9	5.0–19.0 9.0–30.0	11.0 13.0	–3.409	0.001[a]
BBS	THR control	54.8 ± 2.0 55.8 ± 0.4	48.0–56.0 55.0–56.0	56.0 56.0	–1.232	0.218

Student's *t*-test for independent variables[a], Welch test[b] or Mann–Whitney *U*–test.

Table 4. Results of Step Tests obtained by the THR and the control group

Test	Group	Mean ± SD	Min–max	Median	Z	p
ST	THR ST O THR ST N	12.9–3.2 13.1–3.5	7.0–22.0 8.0–22.0	13.0 13.0	–4.686 –3.871	**<0.001** **<0.001**
	control ST C	16.3–0.9	14.0–17.0	16.5		–

Mann–Whitney *U*-test.

($p < 0.001$). Furthermore, considerable differences were observed in the CST, where members of the control group did more repetitions than subjects in the study groups ($p = 0.001$). We did not find statistically significant differences in the results of the BBS test between the study and the control group.

Step Test results of individuals with prosthetic implants differed significantly from results in the control group. The differences were present when comparing to the control group (average 16.3 ± 0.9) both the operated limb (mean 12.9 ± 3.2; $p < 0.001$) and the limb without a prosthetic implant (mean 13.1 ± 3.5; $p < 0.001$); in both cases, people with total hip replacement conducted fewer repetitions (Table 4). To summarize, task performance by THR patients was worse, compared to the control group.

4. Discussion

Our study on the quality of dynamic balance used single-board force platform [15] as well as functional tests recommended by other researchers [12], [16]–[21] for evaluating the quality of dynamic postural control or assessing the risk of falling. The force platform test showed that people with THR had significantly worse dynamic balance control compared to healthy individuals. Generally, the subject from THR group performed the task slower and demonstrated greater COP displacement on the B60 board (the task required small and precise COP displacement). There were no studies on dynamic balance and THR found in relevant subject literature that would use a test method similar to ours. The prevailing test used such clinical cases is computerized dynamic posturography. Among others, the method tests a patient's ability to maintain balance under different conditions of sensory system stimulation (Sensory Organisation Test-SOT) as well as reflexive abilities of postural control in response to sudden changes in the positioning of a supporting surface (Motor Control Test-MCT) [9]. Calò et al. [9] did not find significantly worse results in THR patients, compared to the control group, both in SOT and MCT four months after THR. They suggested normal postural control, symmetrical responses in THR patients and irrelevant role of intrascapular proprioceptors in maintaining balance [9]. Similar studies were conducted by Nallegowda et al. [10]. They proved, however, that dynamic balance and gait differed significantly between THR group and healthy subjects of comparable age and sex. In the SOT with difficult tasks, the THR group needed more sensory input from vision and vestibular sense, and there was a delayed motor response. They also did not observe any proprioceptive deficits in patients after THR, compared to the healthy group.

The force platform tests are complemented with measurements of dynamic balance conducted with simple and commonly used clinical tests. The first test applied was the FRT. The FRT is a popular method of measuring the dynamic balance of the elderly and is useful as a predictor of the risk of falling and a decline in function of the elderly. It includes an essential motion often performed in daily life. The FRT test results show that people after THR achieve a reach distance that is on average by 4.9 cm shorter than in the control group. Lavigne et al. [13] saw similar results when assessing patients before surgery and then 3, 6 and 12 months after. The THA group was not able to reach control subjects' values for the functional reach test in any follow-up evaluations. Chang et al. [12] also used FRT and similar intervals to measure patients' abilities, but there was no control group to compare the results. They suggested that functional reach distance tended to improve gradually after surgery, reached the maximum distance, and decreased 1 year postoperatively, indicating that the somatosensory and neuromuscular function around the hip joint did not recover progressively or completely within 1 year.

The literature suggest that low levels of body strength are the primary cause of both balance problems and falls in the elderly population. The CST measures lower body strength and relates it to the most demanding daily life activities (e.g., climbing stairs, getting out of a chair or bath tub or rising from a horizontal position) [19]. It is an important metric of biomechanical recovery after THA. This task requires greater muscle strength and produces higher joint forces than walking and stair climbing. It is a fundamental daily activity performed approximately 60 times per day by healthy adults [22]. In our study, people after THR did fewer repetitions compared with the control group, which may indicate a decrease in muscle strength in lower limbs in THR patients, compared to the age-matched subjects. Vissers et al. [8] observed that six months post-THA patients rose from a chair faster, compared to baseline, but they needed more time compared to the control group. These authors, however, based their study on a different, more complex measurement method. Patients and control group were tested at home with an accelerometry-based Activity Monitor, and for each patient, 20 chair rising movements during the measurement period were randomly selected by a computer program and analysed [8]. The results obtained in both studies suggest that deficiencies in strength may occur even several months or years after surgery, which may contribute to impaired balance in these patients.

The Step Test (ST) shows evidence of validity, since the ST scores correlate with other clinical tests of balance and mobility. Until now, the test was used, among others, in assessments of post-stroke patients [20]. Literature review did not find any studies that would apply the ST for assessing balance in THR patients with the use of study method analogous to ours. According to Mercer et al., the ST, besides requiring balance during lower limb movement in standing, reflects lower limb motor control and coordination [20]. From the biomechanical and clinical point of view, when the individual steps with the "operated foot", the operated lower extremity must move quickly in flexion and reverse movement direction. When the individual steps with the non-operated foot, the operated lower extremity must be stable in extension, supporting full body weight. In our tests, patients after THR did fewer repetitions, on both the operated and non-operated limb, compared to the control group. The ST results may indicate deficits in dynamic balance and coordination in subject after THR.

To determine the quality of balance, we also used the BBS test, which comprises both static (maintaining position) and dynamic tasks. It is the only test where we did not find significant differences between the groups. Ellison et al. [23] also did not find significant differences in a group of patients approximately 6 months post-THA, compared to a group of age- and gender-matched healthy subjects with no hip replacement. However, scores on a subset of 4 more difficult tasks from the BBS were significantly lower in the group of subjects with THA (turning to look behind while standing, turning 360°, placing each foot alternately on a step while standing unsupported and standing unsupported with one foot in front). Chang et al. [12] also based his balance assessments on this testing method. The authors, however, applied the test to evaluate progress in functional abilities of patients by comparing their result prior and post operation. Authors suggested that BBS decreased significantly at 2 weeks and improved gradually, reaching the highest score of 53.2 ± 1.9 at 6 months after surgery [12].

Gait assessment is an important measure of postoperative outcomes after THA because gait is an important indicator of functional recovery [24]. Slow gait is associated with risk of falling. As mentioned above, correct dynamic balance is a major factor in THR patients' gait quality. Analysis of subject literature showed that gait assessment in patients after THR was performed using different tools and tests such as: TUG, Dynamic Gait Index, the GAITRite® system, 6 minute walk test, gait laboratory, three-dimensional gait analysis [2], [13], [24]. Abnormal gait was found both in the period following surgery as well as a few years later. It is important that in the latter case, the condition was not associated with pain, limited motion or loss of muscle strength in the operated extremity [24]. For instance, Kolk et al. [25] performed a systematic review and reported that walking speed and step length were reduced in the THR group compared to controls at longer-term follow-up, but not at the short-term follow-up. These findings are consistent with those reported by Agostini et al. [26], who observed some gait abnormalities one year after surgery such as a higher percentage of atypical cycles, a prolonged heel contact, a shortened flat foot contact, a reduced hip dynamic range of motion and abnormal timing in the muscle activation patterns (tibialis anterior, gastrocnemius lateralis, biceps femoris, gluteus medius). Bahl et al. [27] reached similar conclusions. At 12 months after surgery, the patients demonstrated deficits, compared to healthy individuals, in walking speed, stride length, single limb support time and sagittal plane hip ROM. Importantly, Vissers et al. [8] observed that six months after surgery patients walked faster compared to baseline and walked as fast as healthy controls. In our tests, gait assessment was an indispensable supplement of dynamic balance diagnostics and was performed using the TUG test and the 3 m test. The TUG test is a reliable and valid test for quantifying functional mobility and is quick to perform, requires no special equipment or training and is easily incorporated into medical practice routine [16]. It is also used to assess increased risk of falls in elderly people. In both tests, people after THR showed worse results than healthy controls, which means that abnormal gait patterns are present even a few years after being operated, and indirectly shows that these people suffer from dynamic balance deficiencies. Similarly to our study, Guedes et al. [24] evaluated patients a few years after surgery and observed that elderly subjects with a history of THR had changes in gait parameters and lower performance in TUG test even 2.6 ± 1.3 years after surgery, which suggests functional impairment. These results indicate the need to include exercises that would improve the quality of gait in patients after surgery to reduce the risk of falls.

It is worth mentioning that changes in other parts of the musculoskeletal system, as well as changes in sensory systems, can affect balance, especially in people over 60 years of age. For example, Puszczałowska-Lizis et al. [28] suggested that there is a significant association between foot characteristics and performance in balance in the elderly over 75 years. In another study, gender-related differences affecting postural stability were found in the elderly [29]. Numerous studies indicate an age-related decrease in the ability to maintain a stable standing position [29]. In people over 60 years of age, changes in the eye, proprioceptors, and vestibular organ may affect stability. We cannot completely rule out the impact of these changes on the results obtained in the studies. However, we wanted to limit the impact of these factors by setting specific inclusion and exclusion criteria and by matching groups in terms of gender and age.

5. Conclusions

Our results demonstrate that even a few years after operation THR patients exhibit balance deficiencies compared with people of the same age without a prosthetic implant. We think that short functional tests such as TUG, 3 m walk test, Functional Reach Test, 30 s Chair Stand Test and Step Test may be used in functional assessments of patients a few years after they underwent total hip replacement. We suggest that it is important to use targeted exercises not only immediately after THR, but also several months or years after surgery to improve the performance of tasks requiring a good balance and to restore THR patients to full daily activity.

Limitation

We did not perform the calculation of the sample size before the start of the test so it can be considered as a pilot study.

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