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Assessment of Functional and Gait Efficiency in Patients after Knee Endoprosthesis

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Abstract

Background: *Osteoarthritis is a perennial and progressive disease, and its progression can only be slowed down. The disease incidences increase with age and are a large problem of the elderly. Women and people doing physical work are more often ill. Knee arthroplasty is the procedure carried out most often for advanced degenerative changes. The disease causes severe pain and limits joint movement, thus impairing professional and social life and hindering everyday activities. Replacing the knee joint reduces pain, improves the biomechanical conditions of the joint and gait, and allows to undertake physical activity, and thus positively impacts on the quality of life of patients. The aim of the research was to determine the functional and gait capabilities of patients rehabilitated after knee arthroplasty.*

Material and Method: *The research involved 60 patients, including 30 women and 30 men, who were subject to two researches: before and after surgery followed by rehabilitation. The author's questionnaire, Laitinen scale was used for the research. The range of flexion and extension in the knee joint was assessed, and the "Up & Go" test was carried out. Statistical analysis of the collected data was carried out in the Statistica 13.0 program.*

Summary and Conclusions: *The research revealed that rehabilitation treatment positively impacts on improving functionality and gait in patients' daily lives. The rehabilitation applied after knee arthroplasty significantly improved the range of flexion and extension movements in the knee joint. Moreover, a statistically significant increase in the level of balance and a decrease in the risk of falls in the researched persons was observed. In terms of all pain indicators assessed in the Laitinen questionnaire, statistically significant improvement was noted after the use of surgical treatment supplemented with rehabilitation.*

Key words: *knee, grthrosis, physiotherapy*

Introduction

Functional efficiency is the ability to independently carry out basic everyday activities in a controlled and safe way as well as without excessive effort [1]. Due to the individual ageing process, the assessment of functional efficiency is often a very difficult element of diagnostics, which should be multi-faceted and should include careful observation [2].

Gait assessment as the basic form of human mobility is one of the best indicators of the patient's functional status. Gait is largely individual, primarily influenced by age and pathologies associated with the musculoskeletal system.

Functional efficiency and gait function assessment are basic determinants in the overall assessment of the patient and significantly impact on the level of his/her quality of life.

Degenerative changes in the musculoskeletal system progress with age and increased multi-morbidity. The most common cause of these changes is developing osteoarthritis that destroys anatomical structures such as articular cartilage, the subchondral layer of the bone, meniscus, ligaments, synovium, and joint capsule. The disease process is often accompanied by severe pain, muscle weakness and reduced range of motion in the joints. In addition, there can be distortions within the joint itself (e.g. valgus, varus formation) and fixation of contractures [3]. All these irregularities adversely impact on the function of gait.

Osteoarthritis is a perennial and progressive disease, and its progression can only be slowed down. The disease occurs most often in the age range from 40 to 60 years old. It concerns both men and women; however, epidemiological data show that the more severe forms of this disease concern women. It arises as a result of both mechanical and biological degenerative changes, and recently, the influence of genetic factors is also being considered [4].

Depending on the severity of the disease, as clinical symptoms increase, conservative management of osteoarthritis is not effective enough, as it only slows down the progression of disease changes. Currently, the only effective method of treating people with advanced knee osteoarthritis is

knee arthroplasty, which, supplemented with rehabilitation, restores the correct range of motion parameters and enables re-education of the correct gait pattern [5].

The main purpose of surgery is to improve the quality of life of patients by reducing pain, correcting the disturbed axis of the limb – if it occurs, restoring joint stability and improving the range of mobility [3].

The effectiveness of knee endoprosthesis implantation in patients with advanced degenerative joint changes in reducing pain intensity, improving joint function and quality of life has been confirmed in scientific publications [3]. The improvement of the functional condition of patients after total knee replacement surgery depends on many factors, including appropriate physiotherapy. Relieving pain and improving functional efficiency, including restoring the appropriate range of motion in the knee joint necessary to achieve independent gait are important goals for rehabilitation.

Nowadays, medicine has extensive treatment options. The selection of rehabilitation procedures depends on the type of pain, experience gained from previous rehabilitation and the tolerance of treatments by the patient.

Intensive functional rehabilitation carried out already in the early postoperative period reduces pain, improves gait efficiency and functioning of patients in everyday life, which results in an increase in patients' quality of life [6, 7].

Material and Methods

Respondents

The research consisted of 60 patients, including 30 women and 30 men. They were patients with osteoarthritis of the knee who qualified for an endoprostheoplasty (31 researched people – right knee joint, 29 – left knee joint).

The research was carried out twice: for the first time before the surgery, for the second time after the endoprosthesis and rehabilitation. Rehabilitation was carried out from Monday to Friday, once a day for 5 weeks. The researched group consisted of 11 people (18.3%) aged 35–50 and 49 people

(81.7%) aged 51–75. The average BMI in the researched group was 26.3 ± 2.1. The BMI value was within the normal range for only 28% of the researched group (Table 1).

Research tool

All patients were subjected to the research using the author's own questionnaire. An additional Laitinen scale test was carried out twice, the range of flexion and extension movement in the knee joint was assessed, and the 'Up & Go' test was carried out. The first research was carried out before knee arthroplasty; the second research took place in the postoperative period on the day of completion of the rehabilitation procedure.

Statistical analysis was carried out using the Statistica 13.0 PL program. The Wilcoxon pair order test was used for the analysis of dependent variables, the dependence of quantitative variables was assessed using Sperman rank correlation, whilst the analysis of independent variables was carried out using the ANOVA test. The distribution normality assumptions were checked using the Shapiro-Wolf test, and the variance using the Levene test. Statistical dependences were significant if their level of significance was $p < 0.05$.

Results

The research showed that in all the analysed cases there was pain in the knee, which the subjects classified in three ranges, with almost 75% of people reporting the presence of pain for at least 2 years (Table 2). In the analysed group, almost all respondents (98.3%) had joint pain while carrying out basic daily activities and while walking (Table 2).

Among the methods of dealing with pain, 65% of respondents indicated the use of pharmacological agents, and less than 30%, physical therapy procedures.

In the group of patients, 96.7% had used physiotherapeutic procedures in the past, and on average every fifth respondent definitely confirmed that the applied treatments improved his/her comfort of life. Patients most often

indicated the TENS procedures, iontophoresis and cryotherapy as those that impacted on reducing pain experienced during conservative treatment (Figure 1). In addition, all respondents declared their willingness to use physiotherapeutic procedures in the postoperative period.

The treatment effect obtained during previous rehabilitation was maintained for all patients for no more than half a year. Most often from two weeks – 46.6%, to approximately a month – 43.1%.

Analysis of the obtained results showed a relationship between the duration of the treatment effect and the BMI index. The treatment effect lasted the longest in patients with the lowest body mass index (Figure 2).

The research assessed the range of motion in the knee joint and the level of balance and gait of the patients, using the 'Up & Go' test. Analysis of the researched variables showed statistically significant differences in the scope of all parameters ($p < 0.001$). The range of flexion movement in the knee after treatment increased on average from 81 to 113.42 degrees, and the effect of the therapy was determined at 32.42 degrees ± 10.52 (Table 3).

In the first measurement of extension in the knee joint, prior to the treatment, a limited range of motion was pointed out, an average of 9.38 degrees, which meant the lack of full extension in the knee joint. After the treatment, the range of limitation of joint mobility decreased to an average of 1.83 degrees ± 3.44 degrees (Table 3).

The assessment of dynamic balance and gait was carried out using the 'Up & Go' test, where the duration of the motor task was determined. Patients carried out the pre-treatment test at an average time of 18.92 seconds, and after treatment at an average time of 10.92. In the next two measurements, the subjects improved the test time by an average of 8 seconds (Table 3).

The intensity of pain, the frequency of pain occurrence, the frequency and amount of painkillers taken, as well as the level of physical activity limitation due to pain were determined in the study group with the Laitinen pain index questionnaire. The listed categories of the questionnaire were rated on a five-point scale, from 0 to 4 points, where a higher number of points meant a greater severity of the problem. The intensity of pain sensations was assessed by the subjects in the measurement taken before treatment at an

average level of 2.8 ± 0.94 points. After treatment, the intensity of pain decreased to an average of 0.85 points. The difference between the assessment of pain intensity in two subsequent measurements was 1.95 ± 0.79 points on average. The observed change was statistically significant ($p < 0.001$) (Table 4).

Discussion

Knee osteoarthritis is a growing socio-economic-social problem, which is also a major medical challenge. It applies mainly to the elderly, in whom, due to multiple diseases, therapeutic management and improvement of the quality of life may be difficult. As the recognition of the disease increases, younger and younger patients are undergoing joint endoprosthesis surgery, which aims to improve the quality of life. Therefore, research on the quality of life and assessment of the functional state of patients before and after endoprosthesis surgery is widely used in assessing the effectiveness of medical activities [8, 9].

Osteoarthritis of the knee is the source of a number of local and systemic lesions with varied dynamics and clinical images. It results not only in pain and limitation of mobility, increasing contractures, deformation of the axis of the limb, impairment of gait performance and aesthetics, but also changes in body posture resulting from disturbances in the spatial orientation of individual elements of the osteoarticular system.

Osteoarthritis is the result of overlapping diseases that, despite different aetiologies, lead to similar biological, morphological and clinical effects. Clinically, osteoarthritis is manifested by joint pain, pressure soreness, restricted mobility, crackling, occasional exudate and inflammation of varying severity without systemic symptoms.

Knee arthroplasty for the treatment of advanced degenerative changes is currently the most common method, because its main goal is to restore functional independence in daily activities of the patient by reducing the intensity of pain and increasing mobility in the knee joint.

Our conducted research proved that in patients after arthroplasty the range of motion in knee joints significantly increased ($p < 0.05$). The flexion improved by an average of over 30°, while the extension by 8°. In the research

of Majewska et al., the passive range of the operated joint in the control research improved by an average of 10.7°. Researchers noted that an important factor affecting the size of the postoperative range of motion was the range of motion of the operated knee joint prior to joint replacement surgery. In patients with significantly reduced joint flexion (below 90°) before surgery, the postoperative results were significantly worse than in those patients whose knee flexion before surgery was above 90° [5].

The carried-out 'Up & Go' test for able-bodied persons should last approximately 10 seconds, and an increased risk of falls occurs for persons with a score over 14 seconds [10]. The research has shown that the time of 'Up & Go' test was significantly shortened from an average of 18.9 seconds before treatment to 10.8 after surgery. The obtained improvement indicates good functional efficiency of the subjects and a significantly reduced risk of falls in the postoperative period [11, 12].

Respondents in the research of Gajewski et al. reported almost daily pain in the osteoarticular system. The score was on a scale of 1 to 5, where 1 corresponded to very weak or weak ailments, and 5 described the pain as very strong. Approximately 11% of respondents felt low pain, approximately 35% medium, and 48.5% suffered large pain [13]. In our research, the patients complained of pain every day. The pain usually occurred during the day during the basic activities of everyday life – in 40.0% of respondents, and while walking – in 58.3%. In addition, our research showed that in all pain indicators assessed in the ***Laitinen questionnaire, statistically significant improvement was observed after the use of surgical treatment supplemented with rehabilitation.*** The largest difference was observed in reducing the frequency of pain and in reducing the need to take painkillers.

One of the risk factors for developing knee osteoarthritis is excessive body weight, which can contribute to accelerating the destruction of articular cartilage and the occurrence of degenerative changes. Still, the results of the research on the effects of obesity on the development of osteoarthritis and the results of total joint replacement surgery are not always unambiguous. In the research on the assessment of the functional state of patients with gonarthrosis, Jastrzębiec-Święcicka and co-authors showed that 80%

of respondents had a BMI above the accepted norm, i.e. > 25, and the average value of the indicator was 28.55. This indicates a relatively frequent occurrence of excess weight or obesity of various types [14]. In the research of Kiełbasa et al. the BMI value was at a similar level, also indicating the existence of excess weight and obesity among people diagnosed with osteoarthritis of the knee [15]. Similar average values were obtained in the research of Krekor et al., where the majority of the subjects had abnormal body weight (73%) compared to those with normal BMI (27%) [16].

The carried-out research proved the existence of a relationship between the duration of the therapeutic effect after physiotherapeutic procedures and the body mass index. ***The lower the BMI value, the longer the therapeutic effect experienced by the patient. Similar conclusions were reached by*** Bugała-Szpak et al. who demonstrated a significant influence of patients' BMI on the results of treatment [17].

In the research of Jastrzębiec-Święcicka and co-authors, respondents mentioned physiotherapeutic procedures (98%), followed by the use of analgesic and anti-inflammatory drugs and ointments as a method of coping with symptoms of knee osteoarthritis the most often [14]. In our research, ***most respondents cope with pain by using painkillers – 65.1%.*** Far fewer respondents applied physiotherapy procedures – only 28.3%. ***However***, out of all respondents, 96.7% had physiotherapeutic procedures in the past, and on average every fifth respondent definitely confirmed that the physiotherapeutic procedures applied in his/her case contributed to the improvement of his/her life comfort.

Conclusions

Surgical treatment of osteoarthritis of the knee combined with physiotherapeutic treatment positively impact on improving gait and functioning in everyday life, thus improving the quality of life of patients.

Rehabilitation applied after knee arthroplasty had a beneficial impact on increasing the range of flexion and extension movements in the knee joint, increasing the level of balance and reducing the risk of falls in the subjects.

In terms of all pain indicators assessed in the Laitinen questionnaire, statistically significant improvement was noted after the use of surgical treatment supplemented with rehabilitation.

Rehabilitation after knee arthroplasty impacted on reducing the incidence of pain and the need to apply painkillers.

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Table 1. General characteristics of the research group of the respondents

Characteristics		n		%
Gender (n – 60) **– female/male**		30 / 30		50.0 / 50.0
Age (n – 60) [years] **– 35–50 / 50–75**		11 / 49		18.3 / 81.7
Place of residence (n – 60) – village / city		18 / 42		30 / 70
Professional status (n – 60) **– professionally active / professionally inactive / pensioners**		34 / 2 / 22 / 2		56.7 / 3.3 / 36.7 / 3.3
Type of performed work (n – 34) **– intellectual work / light physical work / hard physical work**		14 / 11 / 9		41.1 / 32.4 / 26.5
Variable	$\bar{x}$	**SD**	**Reference**	**Me**
Age (n – 60) [years]	67.4	5.2	35–75	67.0
BMI (n – 60)	26.30	2.1	21.3–30.5	26.1

* $\bar{x}$ – mean; SD – standard deviation; Reference – minimum to maximum; Me – median

Table 2. Parameters of pain in patients

	n	%
Occurrence of pain (n – 60) [months] **– over 12 months / 24 months / over 24 months**	16 / 20 / 24	26.7 / 33.3 / 40.0
Activities that intensify pain (n – 60) **– walking / everyday activities / sleep**	35 / 24 / 1	58.3 / 40.0 / 1.7
Methods to relief pain **– pharmacology / physical therapy / relief positions / not used**	39 / 17 / 2 / 2	65.1 / 28.3 / 3.3 / 3.3
Impact of physical therapy on the patient's condition **– improvement / partial improvement / no improvement**	12 / 35 / 13	20.0 / 58.3 / 21.7
Duration of the effect of the applied rehabilitation (n – 58) **– two weeks / month / half year**	27 / 25 / 6	46.6 / 43.1 / 10.3

n – number of observations; % – percent

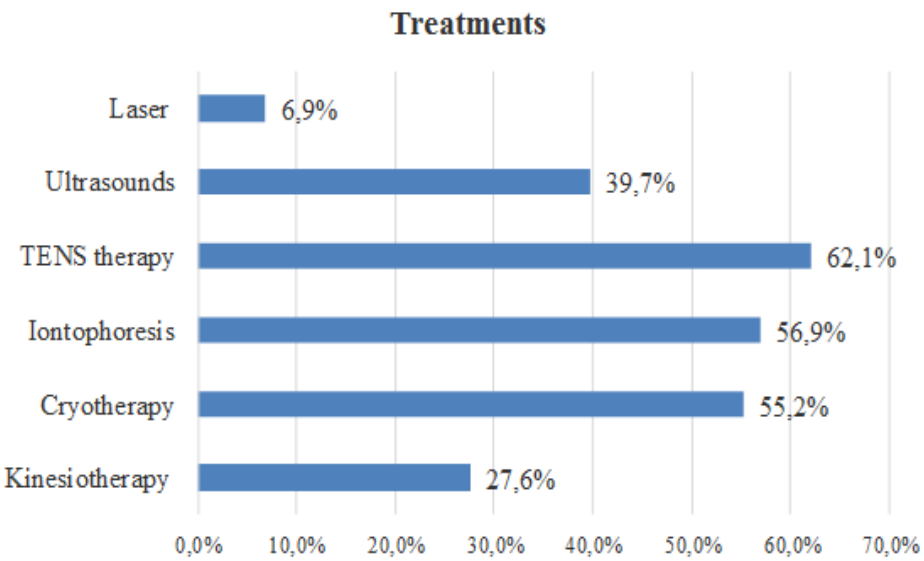
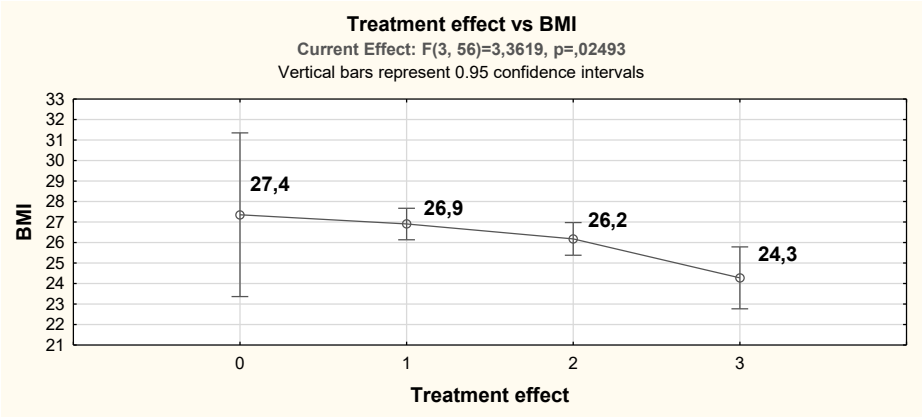


Figure 1. Treatments regarded as significantly impacting on reducing pain

* possibility of indicating several answers



** Treatment effect: 0–2 weeks; 1 month; 2 – half a year; 3 – a year*

Figure 2. The duration of the lasting treatment effect of the applied rehabilitation, considering the BMI of the researched patients

Table 3. Changes in the range of motion and assessment of the level of balance

Variable	$\bar{x}$	SD	Reference	Me	Q1	Q3
The range of bending movement in the knee joint [degrees] n = 60	p < 0.001					
Before treatment	81.00	12.78	55–100	80.00	70.00	90.00
After treatment	113.42	11.29	90–135	115.00	102.50	120.00
Difference	32.42	10.52	15–55	32.50	25.00	40.00
The range of extension in the knee joint [degrees] n = 60	p < 0.001					
Before treatment	-9.83	9.83	-40–0	-10.00	-15.00	0.00
After treatment	-1.83	3.44	-10–0	0.00	-2.50	0.00
Difference	8.00	8.50	0–40	5.00	0.00	10.00
'Up&Go' [sec.]	p < 0.001					
Before treatment	18.92	3.04	14–27	19.00	16.50	21.00
After treatment	10.92	1.88	8–16	10.00	10.00	12.00
Difference	-8.00	1.66	-12–(-5)	-8.00	-9.00	-7.00

n – number of observations; $\bar{x}$ – mean; SD – standard deviation; Reference – minimum to maximum; Me – median; Q1 – lower quartile; Q3 – upper quartile

Table 4. Laitinen pain index questionnaire

Laitinen Pain Indicator Questionnaire [0–4 points]	Descriptive statistics			
	n	$\overline{x}$	Me	SD
pain intensity				
Before treatment	60	2.80	3.00	0.94
After treatment	60	0.85	1.00	0.63
Difference	60	-1.95	-2.00	0.79
frequency of pain occurrence				
Before treatment	60	2.88	3.00	1.04
After treatment	60	0.88	1.00	0.67
Difference	60	-2.00	-2.00	0.82
taken painkillers				
Before treatment	60	2.85	3.00	1.07
After treatment	60	0.85	1.00	0.71
Difference	60	-2.00	-2.00	0.86
limitation of physical activity				
Before treatment	60	2.45	3.00	0.79
After treatment	60	0.78	1.00	0.69
Difference	60	-1.67	-2.00	0.71

N – number of observations; $\overline{x}$ – arithmetic average; Me – median; SD – standard deviation