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Functional Performance of Patients after Neurosurgery and Endovascular Treatment of Unruptured Intracranial Aneurysms

Sprawność funkcjonalna pacjentów po neurochirurgicznym i wewnątrznaczyniowym leczeniu niepękniętych tętniaków wewnątrzczaszkowych

Lucyna Ścisło[1], Judyta Pluta[1], Małgorzata Paplaczyk-Serednicka[1], Magdalena Staszkiewicz[1], Iwona Bodys-Cupak[2], Dorota Madej[1]

❶ Department of Clinical Nursing, Institute of Nursing and Midwifery, Faculty of Health Sciences, Jagiellonian University Collegium Medicum, Krakow, Poland

❷ Laboratory of Theory and Fundamentals of Nursing, Institute of Nursing and Midwifery, Faculty of Health Sciences, Jagiellonian University Medical College, Krakow, Poland

Abstract

Introduction. The methods of treating cerebral vascular aneurysms: neurosurgical clipping of the aneurysm and endovascular embolization are associated with the risk of complications that are difficult for the patient, including impaired functional capacity. Determining these disorders will allow for planning patient care and better quality of functioning after surgery.

Aim. Assessment and comparison of functional capacity of patients after classic neurosurgical and endovascular treatment of unruptured intracranial aneurysms.

Material and Methods. The study was conducted in the Clinical Department of Neurosurgery and Neurotraumatology with the participation of 94 patients (70.2% women and 29.8% men) after endovascular embolization of an intracranial aneurysm (75.5%) and traditional neurosurgical aneurysm clipping procedure (24.5%). The method of diagnostic survey, analysis of medical records and observation was used. Standardized tools were used in the form of scales: Functional Capacity Scale (FCS), Repty Functional Index (RFI), modified Rankin Scale (mRS), Numerical Rating Scale (NRS).

Results. In total, after the procedures, 75.5% of patients were self-sufficient according to the FCS scale, 73.4% were self-sufficient according to the RFI scale, and 80.9% were functional according to the mRS scale (for all scales, $p<0.001$). The average FCS value after the classic procedure was 35.8 points, after the endovascular procedure it was 43.7 points, ($p<0.001$). The deterioration of physical functioning was significantly dependent on pain ($p<0.005$), age ($p<0.05$) and complications ($p<0.05$).

Conclusions. Patients treated with the endovascular method experienced less pain, had fewer complications and had better physical functioning than patients treated with the neurosurgical method. **(JNNN 2024;13(3):112–118)**

Key Words: brain aneurysm, classic and endovascular neurosurgical procedure, physical functioning

Streszczenie

Wstęp. Podejmowane metody leczenia tętniaków naczyniowych mózgu: neurochirurgiczne klipsowanie tętniaka i wewnątrznaczyniowa embolizacja wiążą się z ryzykiem trudnych dla pacjenta powikłań, w tym zaburzeń wydolności funkcjonalnej. Określenie tych zaburzeń pozwoli na zaplanowanie opieki nad pacjentem i lepszą jakość funkcjonowania po operacji.

Cel. Ocena i porównanie sprawności funkcjonalnej pacjentów po klasycznym i wewnątrznaczyniowym leczeniu niepękniętych tętniaków wewnątrzczaszkowych.
Materiał i metody. Badanie przeprowadzono w Oddziale klinicznym Neurochirurgii i Neurotraumatologii z udziałem 94 chorych (70,2% kobiet; 29,8% mężczyzn) po wewnątrznaczyniowej embolizacji tętniaka wewnątrzczaszkowego (75,5%) oraz tradycyjnym zabiegu neurochirurgicznym klipsowania tętniaka (24,5%). Zastosowano metodę sondażu diagnostycznego, analizę dokumentacji medycznej, obserwację. Wykorzystano standaryzowane narzędzia w postaci skal: Skala Wydolności Funkcjonalnej (SWF), Wskaźnik Funkcjonalny „Repty" (WFR), modified Rankin Scale (mRS), Numerical Rating Scale (NRS).
Wyniki. Ogółem po zabiegach według skali SWF 75,5% chorych było samowystarczalnych, według wskaźnika WFR 73,4% samodzielnych oraz według skali mRS 80,9% sprawnych (dla wszystkich skal p<0,001). Średnia wartość SWF po zabiegu klasycznym wynosiła 35,8 pkt., po wewnątrznaczyniowym 43,7 pkt., (p<0,001). Pogorszenie funkcjonowania fizycznego było istotnie zależne od dolegliwości bólowych (p<0,005), wieku i powikłań (p<0,05).
Wnioski. Chorzy leczeni metodą wewnątrznaczyniową odczuwali lżejsze dolegliwości bólowe, występowało u nich mniej powikłań oraz charakteryzowali się lepszym funkcjonowaniem fizycznym, niż pacjenci leczeni metodą neurochirurgiczną. **(PNN 2024;13(3):112–118)**
Słowa kluczowe: tętniak mózgu, zabieg neurochirurgiczny klasyczny i wewnątrznaczyniowy, funkcjonowanie fizyczne

Introduction

Cerebral aneurysms are the most common cerebrovascular defect. According to many authors, this disease affects approximately 2 — 10.6% of the general population [1,2]. Most aneurysms are diagnosed only when they burst, which accounts for as many as 88% of all diagnosed brain aneurysms [3]. With better access to neuroimaging, in recent years there has been an increase in the number of detectable so-called silent (unruptured) brain aneurysms [4]. The incidence of aneurysms increases with the patient's age (between 40 and 60 years of age), and they may also occur as multiple aneurysms. The risk of hemorrhage from a silent aneurysm is estimated at 1.2 — 3% per year and cumulatively increases over time, so after 20 years it may range from 24 to 60% [5]. Most intracranial aneurysms (approximately 90%) do not cause any clinical symptoms and are revealed only when they rupture, resulting in subarachnoid hemorrhage (SAH). Approximately 7% of aneurysms increase in size and produce symptoms that depend on the location, vascular malformation and structures that compress. The remaining approximately 3% is detected accidentally [5,6]. Surgical treatment of intracranial aneurysms is associated with the possibility of many serious complications, the most dangerous being a life-threatening condition. Patient care after invasive treatment of an unruptured brain aneurysm is complex, and the need for it depends on the patient's general condition and functional capacity [2].

The aim of the study was to assess and compare the physical functioning of patients after neurosurgical and endovascular treatment of unruptured intracranial aneurysms.

Material and Methods

The study was conducted in the Department of Neurosurgery and Neurotraumatology of the University Hospital in Krakow among patients diagnosed with an unruptured intracranial aneurysm, qualified for planned surgical treatment. The study group included patients who underwent surgery using the classic aneurysm clipping method or intravascular embolization. The inclusion criteria for the study were: patients with good mobility, not using orthopedic equipment and giving informed consent to participate in the study. The following were excluded from the study: patients with mobility impairment, those who use assistive equipment, and comorbidities that reduce mobility. 102 patients were qualified for the study. Ultimately, a group of 94 patients remained (3 people excluded due to the use of orthopedic equipment, 5 people due to comorbidities that reduced their physical functioning). The examination was carried out on the 2nd day after surgery (according to the department's standard, patients can be started independently after surgery). The study included 28 men (29.8%) and 66 women (70.2%). The average age was 55.5 years. Taking into account the clinical diagnosis and the exact location of the cerebral aneurysm, the study group consisted of 21.3% of patients with multiple intracranial aneurysms and the following: 18.1% with an aneurysm of the anterior communicating artery of the brain, 14.9% with an aneurysm of the right internal carotid artery, 12.8% had an aneurysm of the left middle cerebral artery, 10.6% had an aneurysm of the left internal carotid artery, 7.4% had an aneurysm of the right middle cerebral artery, 4.3% had an aneurysm of the left posterior communicating artery of the brain. 3.2% of people were diagnosed with an aneurysm of the right posterior communicating artery, an aneurysm of the inferior posterior cerebellar artery or an aneurysm of the basilar cerebral artery. Only 1.1% are patients with an aneurysm

of the posterior communicating artery of the brain. The distribution of patients according to the method of invasive procedure was as follows: 75% of patients underwent endovascular embolization of an intracranial aneurysm, and the remaining 24.5% underwent a classic cerebral aneurysm clipping procedure.

The study was prospective. The diagnostic survey method and interview technique were used. The Functional Capacity Scale (FCS), the Modified Rankin Scale (mRS) and the Repty Functional Index (RFI) were used. Pain was assessed using the Numerical Rating Scale (NRS). Body Mass Index (BMI) was calculated. The collected data were statistically reviewed in SPSS Statistics 10. The following tests were used: chi-squared, Mann–Whitney U, Kruskal–Wallis, Rho-Spearman. The assumed level of statistical significance was $p<0.05$.

Consent was obtained from the Head of the Department and the Hospital Management. The respondents were informed about the purpose of the study, voluntary participation in it and the possibility of withdrawing at any stage. The research procedure was conducted in accordance with the Declaration of Helsinki of the World Medical Association [7] and the ethical codes of the Belmont Report [8].

Results

The functional fitness of patients after surgery was analyzed based on the FCS, mRS and RFI scales, the results of which are presented in Table 1.

Table 1. Functional fitness of patients based on the FCS, mRS and RFI scales (N=94)

Scale	Level	%	chi²	p-value
FCS	Group I	75.5	134.9	<0.001*
	Group II	19.2		
	Group III	3.2		
	Group IV	2.1		
mRS	0 points	80.9	281.2	<0.001*
	1 point	1.1		
	2 points	7.3		
	3 points	0.0		
	4 points	4.3		
	5 points	6.4		
RFI	Group I	7.4	118.9	<0.001*
	Group II	5.3		
	Group III	13.9		
	Group IV	73.4		

*p-value for the chi² test is statistically significant

The majority of respondents had no problems with physical fitness, were self-sufficient and independent or slightly dependent on the help of medical staff. Table 2 presents the results of the analysis of the relationship between the age and gender of patients and their physical functioning (FCS scale).

Table 2. Relationship between age, gender and physical functioning of patients

Variable	Group	Mean	Test U	p-value
FCS	Women	41.2	812	0.351
	Men	43.3		
Variable 1	Variable 2	rho	Test T	p-value
Age	FCS	–0.239	–3.342	0.05*

rho — Spearman correlation coefficient; Test U — Mann–Whitney U test; Test T — correlation coefficient test; *statistically significant p-value

Statistical tests (p-value <0.05) showed that the age of patients significantly affects their physical functioning, which decreases with increasing age.

The frequency of comorbidities and their correlation with physical functioning were also determined (Table 3).

Table 3. Frequency of comorbidities

Comorbidities	N	%	chi²	p-value
1	2	3	4	5
Hypertension	54	65.1	311.8	<0.001*
Type 2 diabetes	9	10.8		
Ischemic heart disease	11	13.3		
Degenerative spine disease	3	3.6		
Hypothyroidism	7	8.4		
Cervical/lumbar discopathy	4	4.8		
A brain tumor	5	6.0		
Hypercholesterolemia	7	8.4		
Kidney/gallstones	6	7.2		
Atherosclerosis	3	3.6		
Polycystic kidney disease	8	9.6		
Previous SAH	19	22.9		
Condition after embolization of a brain aneurysm	6	7.2		
Condition after clipping of a brain aneurysm	3	3.6		
Persistent atrial fibrillation	3	3.6		
Gastritis/esophagitis	3	3.6		
Microadenoma of the pituitary gland	4	4.8		
Previous ischemic stroke	4	4.8		

Table 3. Continued

Comorbidities	N	%	chi²	p-value
1	2	3	4	5
Glaucoma	2	2.4	311.8	<0.001*
Thyroid nodules	3	3.6		
Other	5	6.0		

*p-value for the chi² test is statistically significant

Statistically significant differences were found in the frequency of individual comorbidities. By far the most people suffered from hypertension or had undergone SAH. The statistical tests performed (p value for the chi² test=0.285; p >0.05) showed that there is no significant relationship between the occurrence of any comorbid disease and the physical functioning of patients. Also, in the analysis of the relationship between the location of the intracranial aneurysm in the examined patients and their physical functioning, there was no significant relationship (H test: 15.64; p=0.075). BMI was assessed and most patients were overweight (Table 4).

Table 4. Prevalence of BMI levels according to WHO (N=94)

BMI	%	chi²	p-value
Correct value	41.5	18.1	<0.001*
Overweight	45.7		
Grade I obesity	12.8		

*p-value for the chi² test is statistically significant

The statistical tests performed (chi2 0.48; p>0.05) showed that there is no statistically significant relationship between the nutritional status of patients based on the BMI index and their physical functioning determined on the basis of mRS.

The next analysis concerned the relationship between pain, the method of procedure performed and the physical functioning (FCS scale) of patients — Table 5.

The results showed that the physical functioning of the respondents significantly depended on the treatment method. Patients treated with the endovascular method are significantly more physically fit than those treated with the classical method. The pain experienced by patients also depends significantly on the treatment method. Patients treated with the endovascular method experience significantly less pain and demonstrate greater functional efficiency.

The relationship between complications and physical functioning was determined based on FCS — Table 6.

Table 6. Occurrence of complications and physical functioning of patients

FCS Scale	Complications have occurred		Without complications		chi²	p-value
	N	%	N	%		
Group I	6	6.4	65	69.1	42.6	<0.001*
Group II	12	12.8	6	6.4		
Group III	3	3.2	0	0		
Group IV	2	2.1	0	0		

*p-value for the chi² test is statistically significant

The majority of respondents (81.7%) did not experience any complications after surgery. In people treated with the classical method, complications after the procedure occurred in 43.5% of the respondents, while in patients treated with the endovascular method — in 18.3%. 5.3% of patients had a hematoma at the puncture site of the femoral artery, 4.3% had speech disorders and balance disorders, 3.2% had excessive sleepiness, and 2.1% of people required periodic oxygen therapy. One person (1.1%) experienced numbness of the left or right upper limb, poor vision in the right eye, nausea or vomiting).

A statistically significant relationship was demonstrated between the occurrence of complications after the procedure and the physical functioning of patients.

Table 5. The relationship between pain and the method of treatment of intracranial aneurysm and the physical functioning of patients

Variable	Treatment method	Mean	U Test	p-value
FCS	Neurosurgical clipping of an aneurysm	35.8	192	<0.001*
	Endovascular embolization of an aneurysm	43.7		
Variable	Treatment method	Mean	U Test	p-value
NRS	Neurosurgical clipping of an aneurysm	4.4	271.5	<0.001*
	Endovascular embolization of an aneurysm	2.5		
Variable 1	Variable 2	rho	T Test	p-value
NRS	FCS	–0.746	–10.612	<0.001*

rho — Spearman correlation coefficient; Test U — Mann–Whitney U test; Test T — correlation coefficient test; *statistically significant p-value

Patients who did not experience any complications had significantly better physical functioning.

Discussion

Assessment of the physical functioning of patients after neurosurgical and endovascular treatment of unruptured intracranial aneurysms is an important element of nursing care. Progress in diagnosing intracranial aneurysms and the increasing frequency of their detection contributes to an increase in the number of invasive procedures performed to treat vascular malformations. Therefore, unruptured brain aneurysms are becoming the subject of interest for researchers in terms of treatment and care [2,5,6,9]. In our study, women constituted the majority (70.2%), while there were fewer men (29.8%), which is consistent with reports from other studies that the female gender predisposes to the occurrence of intracranial aneurysms [2,6]. The age of the examined patients ranged from 27 to 75 years (average 55.5 years), which is also consistent with other observations that brain aneurysms are most often diagnosed between 40 and 60 years of age [5,6]. In our study, the most common comorbid disease among the respondents was hypertension — 65.1% and post-SAH in 22.9% of people. This is consistent with confirmed data in the literature that cerebral aneurysms are most often accompanied by arterial hypertension; moreover, they are often diagnosed only when another aneurysm ruptures, i.e. after the occurrence of SAH [1,6]. In our study, endovascular embolization was used in 75.5% of patients, and traditional neurosurgical aneurysm clipping was used in 24.5% of patients. Before treatment, all patients were physically fit, completely independent and independent of the help of other people. Thanks to the use of standardized tools in the study, such as the FCS, RFI and mRS scales, it was possible to objectively assess the physical functioning of patients on the 2nd day after the invasive procedure. The functional capacity of patients after treatment decreased based on observation, but most patients were physically fit, independent or partially dependent and required little assistance from medical staff. According to the FCS scale, only 2.1% of respondents were completely dependent and required comprehensive care. In turn, according to the RFI index, it was 7.4% of patients. When assessing disability according to the mRS scale, 6 people (6.5%) were included in the total disability group. A deterioration of physical functioning was also observed as the patient's age increased (p=0.05), which is consistent with the research of Ślusarz et al. [10]. A similar relationship was observed in the research of Piętkowska et al. [2]. In the studied patients, a large percentage of overweight (45.7%) and obese (12.8%) patients were observed, which is a risk factor for adverse events related to the cardiovascular system [5,6]. In our study, the majority of respondents (45.7%) experienced moderate pain. Only 2 people (2.1%) reported no pain, the rest reported pain of varying degrees of intensity. The studies of Ślusarz et al. [11] and other authors [2,12,13] in the area of surgical treatment of intracranial aneurysms prove that pain is a big problem, and what is more, it reduces their functional capacity. The author Dybciak [13] reports that in the studied group of 42 patients hospitalized for the treatment of brain aneurysm, 23 patients required the use of intensified analgesic therapy. This seems to be confirmed by our own results, which showed a statistically significant relationship (p=0.006) between the level of pain experienced and the patients' physical functioning. Moreover, our own results show that patients treated with endovascular embolization experience statistically significantly (p=0.002) less pain than those treated with traditional neurosurgical methods. The analysis of the results of our own study based on the FCS, RFI and mRS scales proves that the physical functioning of patients also depends on the method of treatment of unruptured intracranial aneurysm. Based on FCS, the functional capacity of patients treated endovascularly was on average 43.7 points, and in the case of the traditional aneurysm clipping method, the average was 35.8 points, so patients treated with embolization were characterized by better physical functioning after the procedure. This is also confirmed by the results of Jabłońska et al. [9]. Satisfactory results of functional assessment after endovascular embolization of an aneurysm were also observed in the study by Ślusarz et al. [14], where in a group of 118 patients treated with this method, 88% of the subjects on the day of discharge from the hospital were classified in group I according to FCS, which means that these were completely independent patients. Subsequently, research by Lorencowicz et al. [15] shows that on the day of discharge from the hospital, 82% of patients were independent in terms of self-care. This is also confirmed by the study of Acewicz and Richter [14], who report that endovascular treatment seems safer in the treatment of unruptured brain aneurysms, and patients are more functional in the early days after the procedure. The authors emphasize that the continuous development of endovascular techniques and materials used during these procedures contribute to improving the results of treatment with this method. Based on our own study, it was found that complications after invasive treatment of unruptured intracranial aneurysms occur in 24.5% of cases. The most frequently observed symptoms were: hematoma at the puncture site of the femoral artery (5.3%), speech disorders (4.3%), balance disorders (4.3%) and excessive sleepiness (3.2%). This is consistent with the analysis of the subject's literature [14], where the authors also mention neurological deficits in the

form of limb paresis among the most common complications after the procedure. Our own material also showed that patients without complications had a significantly better physical functioning (p=0.001). The tools used to assess patients' physical functioning correlate significantly with each other. Similar research results were obtained by other researchers [9,12,16], which indicates that the tools used can be successfully used in the practice of nursing care of patients treated in the neurosurgery department.

Implications for Nursing Practice

The results of our own research are of great importance in the nursing care of a patient after treatment of an unruptured intracranial aneurysm using classic or endovascular neurosurgical methods. The obtained results may be useful in determining patients' demand for nursing care, which will allow planning professional, appropriate and holistic care for the patient. Prevention and intervention in the event of complications as quickly and effectively as possible will also be possible.

Conclusions

Patients treated with the endovascular method experienced less pain, had fewer postoperative complications and had better physical functioning than patients treated with the neurosurgical method.

The deterioration of physical performance was significantly dependent on the severity of pain, the number of complications and the age of the patients. Knowledge about the patient's functional status after various types of surgery will allow for planning adequate patient care and will ensure a better quality of life in terms of functional fitness.

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Corresponding Author:
Lucyna Ścisło
Department of Clinical Nursing,
Institute of Nursing and Midwifery,
Faculty of Health Sciences,
Jagiellonian University Collegium Medicum, Krakow,
Kopernika 25 street, 31-501 Krakow, Poland
e-mail: lucyna.scislo@uj.edu.pl

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Author Contributions: Lucyna Ścisło[A, C, E, H], Judyta Pluta[D, F], Małgorzata Paplaczyk-Serednicka[D, F], Magdalena Staszkiewicz[B, G], Iwona Bodys-Cupak[D, F], Dorota Madej[B]

A — Concept and design of research, B — Collection and/or compilation of data, C — Analysis and interpretation of data, D — Statistical analysis, E — Writing an article, F — Search of the literature, G — Critical article analysis, H — Approval of the final version of the article

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