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The Role of Neurosurgeons in Neurointerventional Surgery

Nöro-Girişimsel İşlemlerde Beyin Cerrahlarının Rolü

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Abstract

Objective: Although the endovascular technique represents an important, minimally invasive approach to cerebrovascular diseases, only a few neurosurgeons are trained in both endovascular and surgical management of intracranial vascular pathologies. Our aim was to emphasize the importance of the endovascular approach in neurosurgery by analysing the cerebral digital subtraction angiography findings in our patients.

Materials and Methods: We analysed 207 patients who underwent cerebral angiography between February 2011 and June 2014. They had previously been diagnosed with cerebral vascular pathology including aneurysm, arteriovenous malformation (AVM), carotid cavernous fistula, vasculitis and Moyamoya disease according to computed tomographic angiography/magnetic resonance angiography findings. Demographic data, indications for cerebral angiography, endovascular and surgical treatments, complications and results were analyzed.

Results: This study included a total of 207 patients (108 males and 99 females) with a mean age of 57.43±11.14 (17-83) years. A total of 234 selective angiographies were performed. The indications for procedures were as follows: cerebral aneurysm (n=118, 57%), Moyamoya disease (n=3, 1.4%), AVM (n=13, 6.3%), carotid cavernous fistula (n=2, 1%), and intracranial vascular stenosis (n=2, 1%). No pathology was found in 69 patients (33.3%).

Conclusion: Cerebral angiography is important not only in the diagnosis but also in the treatment of cerebrovascular diseases. Neurointerventional surgery is a safe and minimally invasive treatment option based on meticulous protocols, however, it has not been included in the neurosurgery residency program yet. Developing training programs for endovascular neurosurgeons provididing comprehensive patient care should be considered.

Öz

Amaç: Endovasküler teknik serebrovasküler hastalıklara yaklaşımda önemli, minimal girişimsel bir yol olmasına karşın, sadece birkaç beyin cerrahı intrakraniyal vasküler patolojilerde hem endovasküler hem cerrahi yöntemde eğitildi. Amacımız hastalarımızdaki serebral dijital çıkarma anjiyografisi bulgularını analiz ederek, beyin cerrahide endovasküler yaklaşımın önemini vurgulamaktır.

Gereç ve Yöntemler: Şubat 2011-Haziran 2014 arası üniversitemiz nöroşirurji ve nöroloji ünitelerinde serebral anjiyo olmuş 207 hastayı analiz ettik. Hastalar önceden bilgisayarlı tomografi/manyetik rezonans bulgularına göre anevrizma, arteriovenöz

malformasyon (AVM), karatiko kavernöz fistül, vaskülit ve Moyamoya hastalığı gibi serebrovasküler hastalık tanısı almıştı. Demografik bulgular, serebral anjiografi endikasyonları, endovasküler ve cerrahi tedaviler, komplikasyonlar ve sonuçlar analiz edildi.
Bulgular: Bu çalışma 57,43±11,14 (17-83) yaş aralığında 108 erkek ve 99 kadın içerir. Toplam 234 selektif anjiyografi yapıldı. Prosedürlerin endikasyonları; serebral anevrizma (n=118, %57), Moyamoya hastalığı (n=3, %1,4), AVM (n=13, %6,3), karatiko kavernöz fistül (n=2, %1) ve intrakraniyal vasküler stenozdu (n=2, %1). Altmış dokuz hastada (%33,3) hiçbir patoloji bulunmadı.
Sonuç: Serebral anjiografi serebrovasküler hastalıkların sadece tanısında değil tedavisinde de önemlidir. Nörogirişimsel cerrahi, henüz beyin cerrahi eğitim programında olmamasına rağmen, titiz güvenli prosedürlere dayanan minimal girişimsel bir tedavi yöntemidir.

Introduction

Despite recent advances in noninvasive diagnostic neuroimaging, cerebral angiography is still the gold standard in the evaluation of cerebrovascular pathologies (1,2). The treatment choices for such diseases are also widening, and the cerebrovascular discipline has undergone dramatic changes in recent years. Although many conventional and traditional vascular operations are performed during neurosurgery, endovascular treatment is still a separate, alternative procedure. Vascular neurosurgery must evolve toward both endovascular and surgical management of cerebrovascular diseases (3-5). In many countries, neurosurgeons have both open surgical as well as endovascular techniques in their armamentarium. However, only a few neurosurgeons are trained in endovascular neurosurgery. The need for endovascular neurosurgeons in this area will be greater as the new endovascular techniques improve over time. We believe that endovascular training must be an integral part of a neurosurgical curriculum which has yet to be planned in most of the countries. Here, we aimed to emphasize the importance of and need for an endovascular approach in cerebrovascular diseases by analysing the angiography findings in our patients with cerebrovascular pathologies.

Materials and Methods

This is a retrospective study of 207 consecutive patients with cerebrovascular pathologies who were admitted to our university Neurology and Neurosurgery deparments between Februrary 2011 and June 2014. The patients had been previously diagnosed with cerebrovascular pathology, including aneurysm, arteriovenous malformation (AVM), carotid cavernous fistula, vasculitis, and Moyamoya disease according to noninvasive neuroimaging studies including computed tomography (CT), magnetic resonance imaging (MRI), CT angiography (CTA) and MR angiography (MRA). All subjects had neurological examinations by a neurosurgeon or a neurologist. Cerebral digital subtraction angiography (DSA) procedures were performed in the angiography suite by an endovascular specialist within 2-36 hours (mean: 2.5±0.96 hour). Selective catheterization of the carotids (internal, external), vertebral, or subclavian arteries was usually performed. Patients with hemorrhagic diathesis, renal insufficiency and contrast allergy were excluded since cerebral DSA could not be performed. The cerebrovascular pathologies detected by cerebral DSA were as follows: cerebral aneurysm, AVM, carotid cavernous fistula, vasculitides, and Moyamoya disease. The cerebral aneuryms were divided into six subgroups according to their localisations, including anterior communicating, middle cerebral, internal carotid and anterior cerebral arteries, posterior circulation aneuryms and multiple aneuryms. The symptomatic aneuryms with subarachnoid hemorrhage (SAH) were also analysed according to their World Federation of Neurological Surgeons (WFNS) and Fisher scores. Additionally, 27 cerebral DSAs were performed again in patients with vasospasm due to SAH and also for coiling cerebral aneurysm. Demographic data, indications for cerebral DSA, endovascular and surgical treatments, complications, and results were analyzed.

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) 14.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis and a p value of less than 0.05 was considered statistically significant. The results were given as mean±standard deviation. Comparisons of numeric values of all variables were performed using the Mann-Whitney U-test or Student's t-test. Chi-square tests were used for analyzing categorical variables. We tested whether or not the variables which were detected in numeric scales in both groups had normal distribution by using the Kolmogorov-Smirnov test. WFNS and Fischer scores showed

no normally distribution and, therefore, the Mann Whitney U test was used. However, score values were so closed to each other and, in order to emphasize the difference, mean± standard deviation was used in the tables.

Results

A total of 207 patients (108 males, 99 females) with a mean age of 57.43±11.14 (17-83) years underwent cerebral DSA. The pathologies detected were as follows: cerebral aneurysm (n=118, 57%), Moyamoya disease (n=3, 1.4%), AVM (n=13, 6.3%), caroticocavernous fistula (n=2, 1%), and intracranial vascular stenosis (n=2, 1%); there was no pathology in 69 patients (33.3%). The cerebral aneuryms were divided into six subgroups according to their localisations: anterior communicating artery (n=39, 18.8%), middle cerebral artery (MCA) (n=28, 13.5%), internal carotid artery (n=23, 11.1%), anterior cerebral artery (n=4, 1.9%), posterior circulation aneuryms (n=13, 6.3%), and multiple aneuryms (n=11, 5.3%). In our study, 170 patients with SAH had vascular pathologies diagnosed by cerebral DSA. The other 22 patients had SAH without cerebrovascular pathology. Fourteen patients underwent cerebral DSA with a suspicion of cerebral infarction due to vasculitis, but only two of them had atherosclerotic intracranial stenosis which was followed up with medical treatment and no vasculitis was diagnosed. We also compared the patients with SAH according to the presence of vascular pathology (Table 1). The WFNS (3.7±1.44 vs. 2.59±1.14, p=0.001) and Fisher scores (2.9±0.9 vs. 2.5±0.67, p=0.02) were higher in patients with a vascular pathology than in patients with normal cerebral DSA. A total of 234 selective angiographies were performed. In order to evaluate aneurysms which could not be detected due to vasospasm, in 22 patients, cerebral DSA was performed twice. After the second cerebral angiography, new cerebral aneurysms were detected in two patients who had previously been shown to have a normal cerebral DSA. One of our patients had a minor stroke due to thromboembolism and one patient had aortic dissection after cerebral angiography as a complication. Five patients with aneurysm (anterior communicating artery (n=2), internal carotid artery (n=1), anterior cerebral artery (n=1) and basillar artery (n=1)) were successfully treated in our clinic with endovascular coil embolisation. The patient with anterior cerebral artery aneurysm had AVM as well which was treated afterwards by embolisation. Patients having MCA aneurysms with a space-occupying hematoma, aneurysms with a high dome-to-neck ratio for coiling and patients with vascular anatomy unfavorable for endovascular navigaton due to severe proximal vessel tortuosity or carotid stenosis were not considered for coiling. Such patients (n=86) were operated on and 60 patients recovered without any deficits, however, 26 patients died during follow-up. Thirty-eight patients refused any kind of treatment and seven patients died during medical treatment in the intensive care unit.

Table 1. The demographic and clinical data of the patients with subarachnoid hemorrhage

	Patients without cerebrovascular pathology (n=22)	Patients with cerebrovascular pathology (n=170)	p
Age	58.07±9.6	58.67±10.1	NS
Gender male (%)	12 (54.5%)	89 (52.4%)	NS
WFNS	2.59±1.14	3.7±1.44	0.001
Fisher score	2.5±0.67	2.9±0.9	0.02

WFNS: World Federation of Neurosurgery Scale, NS: Not significant

Discussion

This retrospective study demonstrated that the diagnosis and treatment of cerebrovascular pathologies can be done safely and effectively by endovascular specialist neurosurgeons who perform both endovascular and surgical treatments. We analysed the data of 207 patients who underwent cerebral DSA with indications of vascular pathologies, including aneurysm, AVM, carotid cavernous fistula, vasculitis and Moyamoya disease. One hundred ninety-two patients had SAH and 88.54% of them (n=170) had vascular pathology which was detected by cerebral DSA. The WFNS and Fischer scores were significantly higher in patients with vascular pathology (Table 1). One hundred eighteen patients had cerebral aneurysms which were evaluated by neurosurgeons for either surgical or endovascular treatment. Aneurysm endovascular coil embolisation was performed successfully in five patients. Eighty-six patients with SAH and vascular pathology were operated on and 69.77% (n=60) of them recovered

without any deficits, however, 26 patients (30.23%) died. Although we did not investigate the long-term outcome, it has been previously reported that there was a significant correlation between both Fisher grading scale and WFNS scores and the outcome (6,7). Our data suggested that patients with SAH due to vascular pathologies had a worse clinical status with regard to Fisher and WFNS scores (8). Today, neurointerventional procedures are continuing to become more prevalent (9). There has been a statistically significant increase in the number of endovascular interventions in the management of ruptured cerebral aneurysms, rising from 17.28% to 57.59% of cases (9). However, there is still a debate as to whether this is really superior to microsurgical management (10). It is unclear which treatment modality is definitively better since cerebral aneurysm represents a complex and multifactorial clinical situation. The localisation, size and morphology of aneurysm and the patient's age, previous medical history and comorbid pathology, such as hydrocephalus and massive parenchymal hematoma, may affect the success of the treatment (11). The International Subarachnoid Hemorrhage Trial was a randomized controlled trial to assess coiling versus clipping in 2143 patients (12). At one year, clinical outcomes based on the modified Rankin Scale score were better in the endovascular treatment group than in those who had undergone surgical treatment. Furthermore, 23.7% of endovascular patients were dependent or dead at one year as compared with 30.6% of patients randomized to open surgical treatment, and this was statistically significant. Additionally, the risk of death in patients randomized to coiling continued to remain lower than the risk of death in patients in the surgical cohort (r=0.77, p=0.03) (13). It has been reported in the literature that in several randomised controlled studies, endovascular treatment was a viable treatment option that rivaled surgical clipping in aneurysms (14,15). There are also studies suggesting that there was no statistically significant difference in angiographic occlusion or clinical outcome between the two procedures in MCA aneurysms. However, it should be noted that both retreatment and procedural complication rates have been found to be higher in endovascular group of patients (16). These conflicting results mainly depend on the selection of patients for endovascular treatment. In addition to localisation of cerebral aneurysm, it is well known that aneurysm size, patient age and medical comorbidities are important risk factors that can affect the patient's ultimate outcome (11,17). Many authors feel that surgical clipping offers "select patients" with ruptured aneurysms the best long-term clinical outcome (14,18). Therefore, endovascular coil embolization should be considered for patients with serious medical problems, or where there is the risk of damaging blood circulation during surgery which should be taken care of by a clinician. In our study, we had 14 patients with cerebral ischemic lesions concominant with cerebral vasculitis detected on MRI. Technological progress in neuroradiology brings out easier detection of brain lesions. In cerebral vasculitis, angiographic investigation is still the gold standard for evaluation and should be performed in symptomatic patients for differential diagnosis (19). Although we were unable to detect any vasculitis, two of our patients had atherosclerotic intracranial stenosis that was followed up with medical treatment. In neuroradiology, there has been a great improvement in the evolution of endovascular techniques, and many new techniques have been developed by neuroradiologists in the last two decades (20,21). Building on their experience, neurosurgeons should work to broaden the use of neurointerventional methods in neurosurgery. In 2012, the Stroke Council of the American Heart Association published an update to the 2009 Guidelines for the Management of Aneurysmal Subarachnoid Hemorrhage recommending that determination of aneurysm treatment should be a multidiciplinary decision of both experienced cerebrovascular surgeons and endovascular specialists based on the characteristics of the patient and the aneurysm (17). Some authors have begun to discuss the future of cerebrovascular neurosurgery (3-5,22-24). Almost all vascular pathologies are now treated with endovascular techniques and this brings out the need for training endovascular neurosurgeons. Therefore, endovascular training must necessarily be a part of a neurosurgical curriculum which has yet to be planned in many countries. As mentioned above, the endovascular treatment option is continuing to become more prevalent. We believe that evaluating the aneurysm together with the neurological clinical status of the patient should lower the possible complications of endovascular treatments, and this should be done by a clinician. As clinicians, neurosurgeons should be able to follow a course that trains them in both surgical and endovascular aspects. Therefore, it is important for neurosurgeons to be

trained and gain experience in neurointerventional surgery.

Ethics

Ethics Committee Approval: This is a retrospective study therefore no ethics committee approval was taken.

Peer-review: External and internal peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: Ali Yılmaz, Abdullah Topçu, Ayça Özkul, Concept: Bayram Çırak, Feridun Acar, Erdal Coşkun, Design: Feridun Acar, Erdal Coşkun, Data Collection or Processing: Ayça Özkul, Analysis or Interpretation: Ayça Özkul, Literature Search: Mücahit Avcil, Writing: Ayça Özkul.

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