Intracranial or brain aneurysms as dilation of the intracranial blood vessels usually manifest clinically in middle age at around 50 years [1,2]. The incidence of intracranial aneurysms in patients younger than 18 years of age is very low and the percentage is 1 to 2 of the total number of all aneurysms [3,4]. The youngest patient with an intracranial aneurysm diagnosed was a seven-week-old infant [5,6]. The most frequent localization of aneurysms in adults is in the anterior part of the Circle of Willis, approximately 85%, or to be more specific, in the anterior communicating artery 30%, in the internal carotid artery (ICA), most frequently in the posterior communicative artery 25%, and in the middle cerebral artery 20%. In children the most frequent localization of brain aneurysms is in the vertebrobasilar circulation – posterior part of the Circle of Willis [7].

Systematic and vascular factors, such as the deficiency collagen of the type III and of reticular fibers, are of importance in the etiology of aneurysms in children [8]. The initial pathological-physiological mechanism is the damage to the internal elastic artery layer due to chemo-dynamic stress [9]. The occurrence of aneurysms is accompanied by congenital defects and degenerative changes of the tunica media of the blood vessels [10]. The histopathological examination of aneurysm wall has confirmed the absence of the elastic muscle layer in the neck area of the aneurysm which is substituted by the connective tissue. The aneurysm sack is formed as a result of this weakness of the arterial wall.

Intracranial aneurysms in children are more common in males and are predominantly localized in the posterior circulation. In addition, they are frequently of greater size and more complex architecture and they are associated with a lower incidence of clinically manifest vasospasm. According to previous experience, endovascular treatment of intracranial aneurysms in paediatric patients has proven to be a safe and efficient method with a small number of complications.

Key words: Intracranial Aneurysm; Aneurysm, Ruptured; Subarachnoid Hemorrhage; Adolescent; Male; Signs and Symptoms; Diagnosis; Endovascular Procedures
The surgical treatment of intracranial aneurysms can be surgical, endovascular or conservative combined with intensive monitoring of the patient.

The decision whether to undertake surgical, endovascular or conservative treatment is made by a team of experts including a cerebrovascular neurosurgeon, neuroradiologist and anesthesiologist. The kind of treatment depends on the patient’s objective factors (age, general and neurological state), factors of the aneurysm (size, configuration and localization of the aneurysm, the time passed between the rupture and hospitalization, the existence of vasospasms, hydrocephalus or other complications) as well as the technical possibilities for the treatment available at the medical institution.

The surgical treatment of intracranial aneurysms includes craniotomy, the imaging of arteries and the aneurysm itself, and its exclusion from the circulation by placing a metal clip on the neck of aneurysm. Due to the close relation between the vertebral and basilar artery with the structures of the brain stem, as well as to the difficult access to these anatomical elements, the surgical treatment of aneurysms located in these arteries is associated with a considerable risk.

The endovascular treatment means the filling of the aneurysmal sack with the particles of coils (Guglielmi coil). Embolization is performed by placing a catheter through the femoral artery, after which the tip of microcatheter is placed in the center of aneurysm and the aneurysm is filled with coils. During and after the procedure the angiograms are made to provide the data on the coil position and the level of embolization of the aneurysm sack [14,15]. Intracranial aneurysms are nowadays more frequently treated by endovascular treatment than by surgery due to advanced technical developments [16].

The conservative treatment of patients with SAH after aneurysm rupture is carried out in patients in a poor general and neurological condition or when it is not possible to perform the surgical or endovascular treatment. It is based on preventing intracranial and extracranial complications, which directly or indirectly contribute to the occurrence of secondary brain damage. The procedure most frequently performed is the "triple H" therapy (mild hypertension, hemodilution, hypervolemia). The aim of this treatment is to maintain the blood flow in referent values regardless of the SAH and SAH complications. In terms of prevention or as a treatment of already existing vasospasm, Ca antagonists are used, such as nimodipin, nicardipin or AT 877. Although its vasodilatory effect has not been confirmed, Nimodipin has been proven to be a medication which improves the outcome in patients after the SAH reducing the incidence of secondary brain damage and by acting as neuroprotection. In the field of neuroprotective medications, Tirilazad was tested in 4 randomized controlled studies in more than 3500 patients, but no improvement of the outcome was observed. The adequate usage of crystalloid solutions is important in these patients as the restriction of liquids increases the risk of secondary ischemia, whereas too much fluid may mean increasing the risk of cerebral edema in the situation of cerebral auto regulation collapse occurring in SAH [17,18].

Case report

A patient aged 16 was admitted to the Department of Pediatric Surgery of the Institute for Child and Youth Health Care of Vojvodina in Novi Sad, because of a sudden strong headache followed by sickness, vomiting, vertigo and loss of consciousness lasting for several minutes. On admission the boy was somnolent, oriented in all three directions, communicative, TA 130/85 mmHg, pulse 68/min, respiration 16/min. His neurological status was dominated by somnolence, his pupils were isochoric, symmetrically reactive, bulbs were normally positioned with the preserved motoric functions. Meningeal signs were negative.

The computed tomography (CT) scan of the head was performed immediately on admission and a massive SAH was diagnosed, present mostly in the sub-
arachnoid cisterns in posterior cranial fossa with the presence of blood in the IV ventricle. The Fisher grade was 4 (Figure 1).

During the first day of hospitalization the patient was somnolent, the Glasgow Coma Scale Score (GCS) was 14. His pupils were isochoric, round, reacting to light. His skin was pale; he was afebrile, hypertensive, normocardiac, eupnoic and auscultatory heart and lungs test negative. The antiedematous therapy was administered (20% Manitol 0.5 g/kg/12h), as well as the anti-convulsive therapy and crystalloid compensation. Due to persistent hypertension (artery pressure reached 170 mmHg) the bolus therapy of antihypertensives was included (Ebrantil 25 mg) together with the continuous sedation (Flormidal 3 mg). The laboratory results showed the presence of hyperglycemia and leukocytosis.

The day after the hemorrhage, CT angiography was performed (CTA) as well as the digital subtraction angiography (DSA) (figures 2, 3). The CTA and DSA revealed a saccular aneurysm of the size of 5x3mm in the left vertebral artery (VA) on the place of origin of the posterior inferior cerebellar artery (PICA).

The patient was transferred to the nearby Department for Neurosurgery of the Clinical Centre of Vojvodina for further treatment. On admission the patient was conscious, communicative, oriented in three directions, with positive meningeal signs, the GCS was 15 and World Federation of Neurological Surgeons Scale (WFNS) grade was I. Further modality of treatment was decided by the team of medical specialists in terms of endovascular treatment and the coiling of the aneurysm. The patient was under total anesthesia and the coiling of the lumen of the aneurysm was performed preserving the flow in VA and PICA. During the procedure the patient was administered 3000IJ of heparin. Immediately after the intervention, angiography showed that the coils were in the adequate position and the aneurysm was no longer filled (Figure 4).

After the endovascular treatment, the „triple-H“ therapy was administered in order to increase the cerebral perfusion and prevent vasospasms and the resulting delayed cerebral ischemia. The patient was conscious, communicative and oriented; he obeyed the commands,
the GCS was 15 with a discreet paresis of the left abducent nerve and diplopia. The patient was included in the program of early rehabilitation.

On the fifth postoperative day the control CT scan of the brain showed the state after the endovascular treatment, a gradual resorption of the subarachnoid and intraventricular hemorrhage without any signs of ischemic lesions or hydrocephalus (Figure 5). Later on the signs of paresis of the left abducent nerve and diplopia gradually disappeared. On the tenth day after the endovascular treatment the boy was sent home for bed rest, in good general condition and without any neurological deficiency.

Six months after intervention the patient was without symptoms and the control DSA showed complete occlusion of the aneurysm.

Discussion

Intracranial aneurysms are very infrequent in pediatric neurosurgical practice. The first description of the rupture of intracranial aneurysm was given by Biuni in 1778 [19]. One of the earliest descriptions was given in 1871 by the German pathologist Eppinger, who presented a case of a fifteen year old boy who collapsed after exhausting gymnastic exercises. His state gradually deteriorated in the next three days. Postmortal examination revealed a stenosis of the aorta orifice, with an extraordinary finding of free blood on the brain base, originating from the ruptured saccular aneurysm of the right anterior cerebral artery [20]. Several years later, Edward Bull described a case of a seventeen year old girl clinically presented with a severe headache and the paralysis of oculomotor nerve. The clinical diagnosis of the rupture of aneurysm in the posterior communicative artery was later confirmed by the autopsy [21].

The most frequent aneurysm localization in children is in the vertebro-basilar system and in the internal carotid artery bifurcation. They are also more frequently in boys. Aneurysms are frequently accompanied by: aorta coarctation, fibro-muscular dysplasia, arteriovenous malformation, polycystic kidney disease, Marfan’s syndrome, sickle-cell disease, Ehlers-Danlos syndrome [22].

The procedure and timing of the treatment (surgical, endovascular or just conservative) are determined by taking into consideration the patient condition, the factors from aneurysms and the technical possibilities for the treatment available at the medical institution. The treatment of intracranial aneurysms can be urgent when it is performed immediately after the diagnosis, early – within three days after the rupture – or delayed/usually from 14 to 21 days after the aneurysm rupture.

An urgent surgery is needed in case of ruptured intracranial aneurysms accompanied with a compressive intracranial hematoma when the expansive lesion is urgently removed together with the aneurysm occlusion, if possible.

An early treatment, surgery or endovascular coiling is advisable in patients in good clinical condition (WFNS scale grade of I, II, III) and who have no signs of SAH complications. An early treatment accompanied with the occlusion of aneurysm significantly improves the outcome in this group of patients.
In patients with a more severely disturbed clinical condition (WFNS grade IV and V) it is advisable to perform either the endovascular treatment immediately after angiography (if there are no signs of vasospasm) or to postpone the treatment until their condition is improved and stabilized.

The endovascular treatment is the most frequent procedure of treating the asymptomatic and symptomatic non-ruptured aneurysms. The Italian neuroradiologist Guglielmi introduced a new technique for the embolization of aneurysm which improved the success rate of the treatment. During this intervention the incidence of aneurysm rupture was 2.5% and mortality was 1% [15]. However, there are no sufficient data and experience regarding the safety of this technique in pediatric patients [14].

The age of patients with intracranial aneurysms is also one of the factors affecting the clinical procedure and outcome, as well as the choice of treatment. The data suggest that children and adolescents can cope with the consequences of subarachnoid hemorrhage and especially the potential vasospasm much better than adults. The reason for this is their better cerebral functional capacity, the developed collateral circulation and the absence of degenerative vascular processes, all of which increase their resilience to vasospasm [18,23].

Ischemic infarction of the brain in children rarely occurs even in cases of a severe form of vasospasm, whereas in adults the incidence of ischemic infarction caused by angiospasm is 7% to 15%. In pediatric patients the ruptured intracranial aneurysms have a much better outcome compared to older patients.

In patients of older age the type of treatment, surgical or endovascular, does not affect the outcome in a statistically significant manner, but the endovascular treatment is a less invasive treatment [24–26].

Conclusion

The incidence of intracranial aneurysms in patients under 18 years of age accounts for only 1% – 2% of all aneurysms. The percentage of children in the total number of patients operated on is 0.5% to 5%. Intracranial aneurysms are especially rarely diagnosed in the first decade of life.

Among children, intracranial aneurysms are more frequent in male children and are predominantly localized in the posterior, vertebrobasilar circulation. The data also suggest that intracranial aneurysms in children are of larger dimensions, of complex structure and are followed by a lower incidence of clinically manifested vasospasm after the rupture and with milder consequences in terms of ischemic lesions.

According to the present findings the endovascular treatment for intracranial aneurysms in pediatric patients has proven to be a safe, efficient method with a small number of complications, which is confirmed by our case report of a 16 year old patient with a ruptured aneurysm.

References

Sažetak

Uvod

Uprkos savremenoj dijagnostici intrakranijalnih aneurizmi, nji-

hov tretman i dalje predstavlja veliki izazov. Odluku o tome kada

i da li primeniti hirurški ili endovaskularni tretman intrakranij-

alnih aneurizmi treba da donese tim medicinskih specijalista

formiran od cerebrovaskularnog neurohirurga, neuroradiologa

i neuroanesteziologa.

Prikaz slučaja

U našem radu prikazujemo slučaj pacijenta starog 16 godina

koji je primljen zbog naglo nastale intenzivne glavobolje praćene

mučninom, povraćanjem i gubitkom svesti. Na prijemu pacijent je

bio svestan ali pospan. Glasgow Coma Scale skore bio je

14, World Federation of Neurological Surgeons Scale gradus I.

Snimak kompjuterizovane tomografske angiografije pokazao je

masivnu subarahnoidnu hemoragiju najviše izraženu u zadnjoj

lobanjskoj jami. Nalazi kompjuterizovane tomografske angiogra-

fije i digitalne suptrakcijske angiografije pokazali su ruptu-

riranu sakularnu aneurizmu na levoj vertebralnoj arteriji na me-

stu ishodišta zadnje donje arterije malog mozga. U opštoj aneste-

ziji sproveden je rani endovaskularni tretman sa ispunjavanjem

lumena aneurizme coilima uz očuvanje prohodnosti okolnih arte-

rijia. Desetog dana nakon tretmana dečaka smo otpustili na dalje

kućno lečenje u dobrom opštem stanju, bez neurološkog deficit.

Šest meseci nakon intervencije pacijent je bio u dobrom opštem

stanju bez tegoba a kontrolna digitalna suptrakcijska angiografi-

ja pokazala je kompletnu okluziju aneurizme.

Zaključak

Intrakranijalne aneurizme kod dece se češće javljuju kod dečaka

i češće su locirane na zadnjoj moždanoj cirkulaciji. One su tako-

de češće veće i kompleksnije arhitekture i praćene su nižom inci-

dencijom klinički manifestnog vazospazma. Prema dosadašnjim

nalazima, endovaskularni tretman intrakranijalnih aneurizmi

kod pedijatrizkih pacijenata pokazao se kao sigurna i efikasna

metoda sa malim brojem komplikacija.

Ključne reči: Intrakranijalna aneurizma; Ruptura aneurizme; Subarahnoidno krvarenje; Adolescent; Muško; Znaci i simptomi; Dijagnostički testovi; Endovaskularne procedure

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