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THE INFLUENCE OF EARLY CRANIECTOMY AND MICROSURGICAL TREATMENT OF RUPTURED MCA ANEURYSM ON NEUROLOGICAL RECOVERY ACCOMPAINED WITH EXTRACRANIAL COMPLICATION

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ABSTRACT:

AIM: To emphasize the importance of early recognition, diagnostic processing and emergent surgical treatment of spontaneous rupture of intracranial aneurysms (aSAH)

METHODS: A 41-year-old female presented with sudden impaired state of consciousness up to coma. "A golden hour" native computed tomography (CT) scan showed signs of voluminous subarachnoidal hemorrhage (SAH) into basal cisterns filled with hemorrhagic content (Fisher grade III) and patient was sent to referral neurovascular centre due suspicious right MCA aneurysmatic rupture.

RESULTS: Repeted native CT scan showed signs of subarachnoidal hemorrhage (SAH) into basal cisterns, intracerebral hematoma into right temporal lobe accompanied with a cloak of right subdural haemathoma (Fisher grade IV). CT angiography scans (CTA) confirmed aneurysmatic rupture at bifurcation of right MCA. The patient underwent emergent decompressive craniectomy and clipping of ruptured aneurysm within 6 hours of symptoms onset.

CONCLUSION: Aneurysmal subarachnoid haemorrhage (aSAH) is a devastating condition that we should to think about in patients presenting with sudden impaired state of consciousness up to coma like it was in our case. Computed tomography (CT) and CT angiography (CTA) present a gold standard and should be routinely performed in order to exlude or confirm the presence of ruptured intracranial aneurysm. Prompt surgical decompression and occlusion of ruptured aneurysm is an absolute surgical indication.

INTRODUCTION

Spontaneous rupture of intracranial aneurysms leads to subarachnoid hemorrhage (SAH), a subtype of hemorrhagic stroke with a high fatality rate (1). As a devastating neurological disorder it occurs in 5 to 10 per 100,000 people annually (2), mostly in young patients (3). Prevalence of intracranial aneurysms is 2% in those without any known risk factors (4). Annual risk of rupture has been reported to be between 0.1 and 8%, depending on variable lesional characteristics such as location, size of the aneurysmal dome, aspect ratio (neck/ width and dome/width), surface irregularity, daughter sacs etc (5). Once the aneurysm has ruptured, one third die and two thirds survive, with 50% of survivors leading independent lives (6). Warning symptoms that herald the onset of a major subarachnoid hemorrhage (SAH) occurs in 25-50% of all patients. History of sudden severe headaches (thunderclap headache), loss of consciousness, neck pain, nausea or vomiting, photophobia, neurological deficits are important hallmarks of severe SAH (7). In the weeks prior to classical presentation of SAH, 25% of patients reports "sentinel headaches" which may represent minor leaks or acute aneurysm expansion. The sensitivity/specificity of SAH detection on computed tomography (CT) scan is greater than 98% in the first 2 days (8). Devised Fisher tomographic classification of aSAH based on the amount and distribution of intradural blood because of its flaws was revised and redesigned into Fisher – HR classification. It is useful to predict the likelihood of developing cerebral vasospasm and brain infarction, risk and seriousness of intracranial rebleeding in terms of finally neurological status of the patients (9) (Table 1,2).

Table 1,2. Effect of blood after aSAH on risk of delayed vasospasm and cerebral ischemia (10)

Fisher and Modified Fisher Grading Scale

Grade	Fisher Scale	% with Symptomatic Vasospasm	Modified Fisher Scale	% with Symptomatic Vasospasm
1	Focal thin	21%	Focal or diffuse thin SAH, no IVH	24%
2	Diffuse thin SAH	25%	Focal or diffuse thin SAH, with IVH	33%
3	Thick SAH present	37%	Thick SAH present, no IVH	33%
4	Focal or diffuse thin SAH with significant ICH or IVH	31%	Thick SAH present, with IVH	40%

If the clinical history suggestively refers to SAH, performed CT angiogram (CTA) in 99% reveals aneurysms larger than 2mm (11). If the CTA scan is negative but suspicion remains high, digital subtraction angiography (DSA) may be performed. Magnetic resonance imaging (MRI) reveals subarachnoid blood even after several days with 94% 100% sensitivity, but is unfortunately less available in many emergency departments (12). When spontaneous aSAH is confirmed blood pressure, heart rate, oxymetry, electrolyte status and electrocardiogram (ECG) are components of most emergency care in admission protocols of intensive care unit (ICU). Severity of aSAH has been categoriseed by variety of grading scales recommended by the authors to provide information about patient's status during and after their hospital stay. The most commonly used grading scales for aSAH are the World Federation of

Neurosurgical Societies (WFNS) and Hunt-Hess grading scales (Table 3,4) (13).

Table 3,4. WFNS and Hunt and Hess grading scores which describes the clinical presentation after aSAH

WFNS Score Clinical score – correlates with outcome	A five-point ordinal scale based on a combination of Glasgow Coma Scale and presence of a neurological deficit	
Grade	Glasgow Coma Scale	Motor deficit
I	15	–
II	14–13	–
III	14–13	+
IV	12–7	+/–
V	6–3	+/–

Hunt and Hess Score Clinical score – correlates with outcome	Five-point ordinal scale describing the clinical state of a patient considering consciousness and neurological deficit
Score	Motor deficit
1	Asymptomatic, mild headache, slight nuchal rigidity
2	Moderate to severe headache, nuchal rigidity, no neurological deficit other than cranial nerve palsy
3	Drowsiness/confusion, mild focal neurological deficit
4	Stupor, moderate-severe hemiparesis
5	Coma, decerebrate posturing

The main treatment options for aneurysm occlusion after aSAH remain surgical clipping and endovascular coiling. Surgical treatment is favoured in young patients (< 40 years), surgically accessible aneurysms of the middle cerebral artery (14), in cases of presence of significant intraparenchymal haemorrhage (e.g., >50 cm3) or space-occupying acute subdural haematoma or brain herniation (15). Endovascular techniques are believed to be preferable than surgery in eldery patients (> 70 years) with severe comorbidities and poor clinical grade at admission, posterior circulation aneurysms (16), or delayed aneurysms during vasospasm period. Patients with aSAH develop complications that are important causes of morbidity and mortality. aSAH is associated with cerebral and extracerebral complications or by the time divided on acute (0-3 day), subacute (3-30 day) and chronic (after one month) (17). Among cerebral complications rebleeding is the most serious which occurs in the first three days after the initial bleeding (18), vasospasm as the most common complication with highest risk between 4- 15 day (19), acute ischaemic lesion linked with diffuse cortical ischemia leading to death within hours after the SAH (20) and acute hydrocephalus seen in up to 20% of patientsn (21). Underlying mechanism of extracerebral complications due to aSAH includes massive sympathetic nervous activation, inflammatory responses and metabolic derangements which correlate with the severity of brain injury (22). Neurocardiogenic injury, neurogenic pulmonary edema and pneumonia, renal dysfunction (0.8% -7%), stress hyperglycemia (70-90%) and electrolyte disturbances are the most frequent extracerebral cause of morbidity and mortality after aSAH (23). The prolonged mechanical ventilation of neurosurgical patients in the ICU is one of the most common indications for performing tracheotomy. Tracheooesophageal fistula (TOF) is a rare (<1% of tracheotomised patients) but serious late complication that occures after more than 7 days of tracheotomy. Perforation or erosion of the back tracheal wall is caused by excessive cuff pressure or pressure of the endotracheal cannula (24). Symptoms and signs of TOF include increased secretion, dyspnoea, signs and symptoms of aspiration, "cuff leak", gastric drift (25). After one month aSAH patients may present disturbances in verbal and nonverbal memory, psychomotor speed, disturbances of mood, executive function, visual-spatial function and other cognitive domains (26). The impact on quality of life and psychosocial performance are commonly reached by using tests: The modified Rankin scale, Glasgow outcome scale and Mini mental state (27) (Table 5).

Table 5. Modified Rankin grading scale for outcome assessment (13)

Modified Rankin scale Grading scale for outcome assessment	A seven-point ordinal scale describing different states of disability from dead to free of symptoms
Grade	Symptoms
0	No symptoms
1	No significant disability. Able to carry out all usual activities despite some symptoms
2	Slight disability without assistance in everyday living, but unable to carry out all previous activities
3	Moderate disability requiring some help. Able to walk without assistance
4	Moderate severe disability without ability to attend own bodily needs
5	Severe disability requiring constant care
6	Dead

Patient and study design

A 41-year-old female was admitted to the Emergency Room of Cantonal Hospital Zenica, Bosnia and Herzegovina due to sudden impaired state of consciousness up to coma (GCS 6: V1, E1, M4). At the time of admission the patient was comatose, hemodynamically stable, afebrile, right pupil slightly narrower and sluggish reactive (Hunt Hess V). Laboratory findings have shown referente values besides slightly hypocalyaemia (3.0 mmol/L). During diagnostic evaluation native computed tomography (CT) showed signs of voluminous subarachnoidal hemorrhage into basal cisterns filled with hemorrhagic content (Fisher III) (Figure 1.)

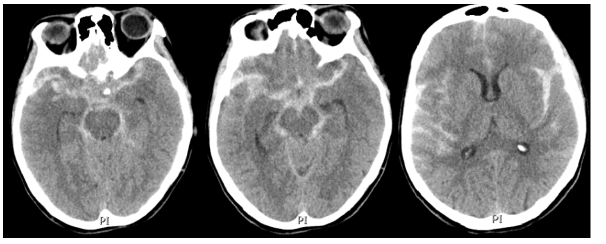

Figure 1. a,b,c Axial noncontrast-enhanced computed tomography (CT) indicates a suspicious right MCA aneurysmatic rupture (Department of Radiology, Cantonal Hospital Zenica, 2016)

The patient was intubated, sedated, relaxed, and sent to referral neurovascular centre Sarajevo with expertise in treatment of aSAH. Two hours later the control brain CT showed additional bleeding in the basal cisterns with the development of brain edema (Fisher IV) (Fig 2. a,b) and CT angiography showed ruptured aneurysma of right middle cerebral artery (MCA) with aspect ratio neck/ width and dome/width 4,5mm : 10mm (Fig 2.c).

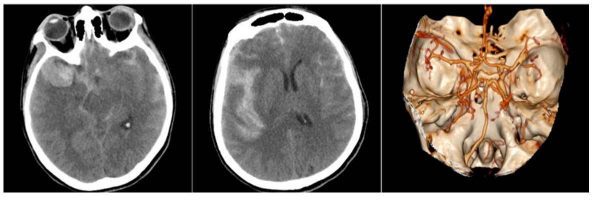

Figure 2. a,b - Axial noncontrast-enhanced computed tomography (CT) shows shows localized right intracerebral temporopolar hematoma aneurysmal origin with significant brain edema, c. - CT angiography shows ruptured aneurysma of right middle cerebral artery (MCA) (Department of Radiology, Clinical Center University of Sarajevo, 2016)

The patient was cleared for emergency surgery. Due to edema, extended pterional approach with a large decompressive craniectomy was performed in order to get significant brain release. After aneurysmal clipping, which was performed within 6 hours of symptoms onset, dural closure was enabled only with artificial dural patch (Fig. 3 a,b).

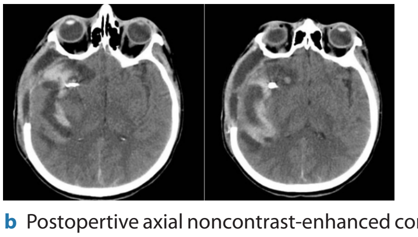

Figure 3. a, b Postopertive axial noncontrast-enhanced computed tomography (CT) shows status after clip occlusion of MCA aneurism linked with enormous brain edema, (Department of Radiology, Clinical Center University of Sarajevo 2016)

In the further course the patient was intubated, sedated and connected to the mehanical ventilation (MV). On several occasions sedation was excluded but due to inadequate respiratory status the patient was tracheotomized two weeks later and turned back to the mechanical ventilation. Prevention of secondary brain damage was accompanied following the protocol throughout hospitalization. After control brain CT showed signs of brain edema resolution (Fig. 3), a new operation was made to restore the bone flap.

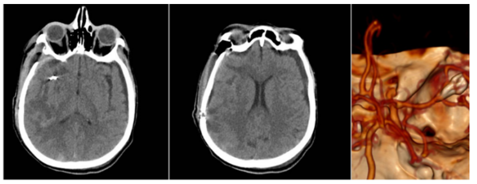

Figure 4. a,b Axial noncontrast-enhanced computed tomography (CT) after bone flap reimplantation; c. – Control CT angiography showed satisfactory clip position complete occlusion of aneurysm (Department of Radiology, Clinical Center University of Sarajevo 2016)

Through a further intrahospital period the patient gradually wakes up, accomplish required commands and establish verbal contact. Since the clinical status, the control brain CT and angio CT were satisfactory, the patient was transfered to the parent institution for continuing hospital treatment. During per oral nutrition, the leakage of liquid content from the tracheostomy area was recorded. The esophagoscopy and CT of the neck confirmed the presence of communication between the digestive and the respiratory tract, causing the patient to undergo surgical plasticizing of 5cm long tracheoesophageal fistula. After healing the fistula the patient was involved in swallowing act exercising supported by speech therapist.

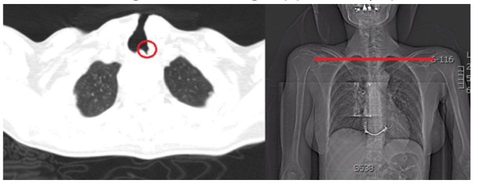

Figure 2. Axial noncontrast-enhanced computed tomography (CT) shows at the upper edge of the tracheostomy an diverticular extension corresponding to the tracheooesophageal fistula (TOF) (Department of Radiology, Cantonal Hospital Zenica, 2016)

One year later, the patient completely returned to normal life activities without any significant sings of disability (Modified Rankin scale grade I). Objective psychological instruments (Minnesota Multiphasic Personality Inventory (MMPI), Wechsler-Bellevue Adult Intelligence Scale and subtests, Testing visual memory (TVP), Rorschach test) have not revealed organic type of cognitive decline.

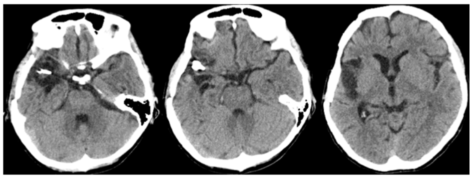

Figure 3. Axial noncontrast-enhanced computed tomography (CT) shows satisfactory finding one year later (Department of Neurosurgery, Cantonal Hospital Zenica, 2017)

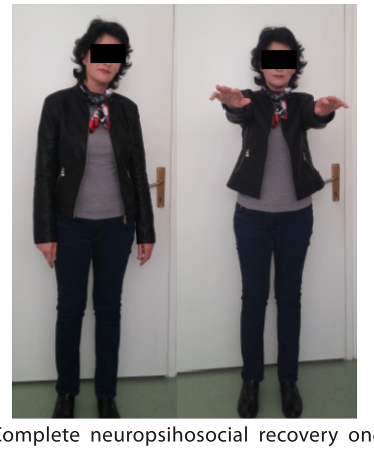

Figure 4. Complete neuropsihosocial recovery one year later (Department of Neurosurgery, Cantonal Hospital Zenica, 2017)

DISCUSSION

Aneurysmal subarachnoid haemorrhage (aSAH) as 5 % of all cerebrovascular events occurs as a result of rupture of an intracranial aneurysm mostly in younger population. Considerable variation in the annual incidence of aSAH exists in different regions of the world. A World Health Organization study found a 10-fold variation in the age-adjusted annual incidence in countries in Europe and Asia, from 2.0 cases per 100 000 population in China to 22.5 cases per 100 000 in Finland (28). Nearly 30,000 individuals in the United States are affected by aneurysmal SAH each year (29). It remains a worldwide leading cause of death and neurological disability with mortality rate approaching 50% and less than 60% of aSAH survivors return to functional independence (30). Well-established risk factors for mortality included poor clinical grade at presentation, older age, aneurysm rebleeding, large aneurysm size, and cerebral infarction from vasospasm (31). Although well-timed treatment of ruptured aneurysms and aggressive postoperative management has improved the overall outcome in patients, SAH continues to be responsible for enormous financial damage in developing and developed countries. Germany alone, close to half a billion Euro spent every year on the treatment of aSAH (32). The clinical suspicion of aSAH is one of the most distinctive in medicine and is based on a history of complaint on "the worst headache of my life" which is described by 80% of patients associated with additional signs including nausea and/or vomiting, stiff neck, photophobia, brief loss of consciousness, or focal neurological deficits (including cranial nerve palsies) (33). About one in five patients with aSAH recall atypical severe headache in the days before the bleed, which is termed sentinel headache and should raise the clinical suspicion for aSAH (34). Noncontrast head CT remains the cornerstone of diagnosis of aSAH sensitivity of CT in the first 3 days after aSAH remains very high (close to 100%), after which it decreases moderately during the next few days (35). Cerebral angiography (CTA) is still widely used in the investigation of aSAH and a 64-slice scanner is an accurate tool for detecting and characterizing aneurysms in acute aSAH (36). In our case, CTA was performed three hours after the initial onset of symptoms and it confirmed the presence of ruptured aneurysm at the MCA bifurcation with aspect ratio neck/ width and dome/width 4,5mm : 10mm. DSA with 3-dimensional rotational angiography is indicated for detection of aneurysm in patients with aSAH (except when the aneurysm was previously diagnosed by a noninvasive angiogram) and for planning treatment (to determine whether an aneurysm is amenable to coiling or to expedite microsurgery) (37). Surgical clipping or endovascular coiling of the ruptured aneurysm as two main treatment options should be performed as early as feasible in the majority of patients to reduce acute complications after aSAH. Algorithms that determine the proper patient population and aneurysmal characteristics for each treatment are continually undergoing refinement. Middle cerebral artery (MCA) aneurysms can be difficult to treat with coil embolization, and in this location, surgical treatment has tended to yield more favorable results (38). According to Rinne Jaakko, et al. if the intraparenchymal hematoma after aSAH evacuates within 3.5 hours it has shown improvement in outcome in favor of microsurgery form of treatment (39). Another study from Clemens et al. showed that early hemicraniectomy (within 48 hours) is associated with a better long-term outcome. This is useful intervention to relieve intracranial hypertension in patients with high-grade aSAH (40). These facts corresponds to our case where early hemicraniectomy was made which, in addition to basic treatment, resulted in better long-term recovery.

Due to need for prolonged mechanical ventilation of neurosurgical patients in the ICU after aSAH nonneurologic medical complications, such as tracheooesophageal fistula, could occure. Study from Paraschiv, M. confirmes tracheoesophageal fistula as rare (0,3-3%), late complication of prolonged tracheal intubation but also that tracheostomy does not seem to decrease the risk of developing postintubation tracheoesophageal fistula. The aim of TOF surgical treatment is the dissolution of the fistula, esophageal suture with or without segmental tracheal resection. Optimal time for surgery is established when the patient no longer requires mechanical ventilation and his biological status is improved (41).

As aSAH most commonly affects people of working age even slight neurological disturbances can seriously impact their ability to return to their previous occupation. Adequate outcome measures such as Glasgow outcome or Modified Rankin scales enable an adequate grading of the recovery stage (42). One year after successfully accomplished microsurgical treatment our patient, elementary school teacher by vocation, has returned to normal life activities without any significant sings of disability (Modified Rankin scale grade I).

After discharging patients follow-up is evaluated clinically as well as radiologically. A clinical examination should be planned in order to identify any recurrence of neurological symptoms (headaches or weakness) and radiological follow-up ensures that no recurrence or denovo aneurysm occurs (43) at suggested empirical intervals for imaging of 6 months, 1, 2 and 5 years (44).

CONCLUSION

Aneurysmal subarachnoid haemorrhage (aSAH) is a devastating condition that we should to think about in patients presenting with sudden impaired state of consciousness up to coma like it was in our case. Computed tomography (CT) and CT angiography (CTA) present a gold standard and should be routinely performed in order to exlude or confirm the presence of ruptured intracranial aneurysm. Prompt surgical decompression and occlusion of ruptured aneurysm is an absolute surgical indication.

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