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Original research article – *Special issue: Cardiovascular Surgery*

Incidence of small abdominal aortic aneurysms rupture, impact of comorbidities and our experience with rupture risk prediction based on wall stress assessment

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ARTICLE INFO

Article history:
Received 19 January 2015
Accepted 16 February 2015
Available online 12 March 2015

Keywords:
Abdominal aortic aneurysm
Rupture
Small AAA
Prediction
Wall stress assessment

ABSTRACT

Aim: Abdominal aortic aneurysm rupture (AAA) threatens a patient's life, requiring an urgent open repair or endovascular surgery. If an asymptomatic AAA is found before a rupture the next steps are directed by its diameter – if it is less than 55 mm the patient is dispensarized, and if it is more a repair is indicated. According to literary sources 10–24% of ruptured AAA are less than 55 mm in diameter, thus a significant portion of dispensarized patients are threatened by a rupture. The objective of our study was to determine a portion of small ruptured AAA repaired in our center in the last four years and try to identify potential risk factor. The secondary goal was to show our experience with a modern method of rupture prediction, using CT scans to compute the wall stress of AAA and thus predict its rupture risk.

Methods: A retrospective study of documentation of patients with ruptured AAA in last four years. CT findings were used to measure maximal diameter of ruptured AAA and portion of small AAA was determined. Some other important information from patient's medical history were also compared in both groups and statistically evaluated.

Results: 41 patients underwent an open repair of ruptured AAA. Out of this number 7 ruptured AAA were small, which is equivalent to 17.1%.

Conclusion: This finding shows us the shortages of the present indication criteria based on an AAA diameter. In accordance to these criteria patients with small AAA are dispensarized and thus a significant part of them are in risk of rupture.

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http://dx.doi.org/10.1016/j.crvasa.2015.02.005

Introduction

Ruptured abdominal aortic aneurysm is one of the most challenging urgent situations in vascular surgery, directly threatening a patient's life, and even after a successful operative intervention, it still carries a high mortality and high perioperative morbidity rate [1]. Since the AAA is often asymptomatic and does not cause the patient any subjective problems, in a lot of cases the rupture is unfortunately the first sign of AAA and needs urgent action (Fig. 1). It is a controversial question whether to repair (either by an open repair or endovascular repair) an unruptured AAA in case of a patient with AAA diagnosed as an accidental discovery during a different diagnostic procedure. According to current guidelines [2] the threshold for elective repair of an asymptomatic AAA is its maximal diameter bigger than 5.5 cm (measured in CT findings). Regardless of the guidelines, there is a large number of research showing that a considerable portion of ruptured AAA (10–24%) [3–5] is less than 5.5 cm in diameter (small ruptured AAA). This means that even dispensarized patients with a small AAA are in danger of a life-threatening rupture, even though they do not meet the criteria for AAA repair (Fig. 2). On the contrary, there are some studies showing that a significant part of AAA with diameter far bigger than 5.5 cm (large AAA) never rupture [6] and the AAA was found during the autopsy of the patient's death from another cause [7]. The aim of this paper is the retrospective study of patients with ruptured AAA, who underwent an urgent repair in our center between the years 2009 and 2012. The main goal was to determine the percentage of patients with ruptured small AAA (with a diameter less than 5.5 cm or borderline – thus which would be indicated for dispensarization) and compare mortality of patients with a small and large ruptured AAA. We also try to identify potential risk factor for AAA rupture. Our second goal was to share our experience with mathematical modeling of AAA wall stress using CT findings and finite element analysis and thus predict a rupture risk of our subject's small AAA. Since several studies suggest this method to be superior to maximal diameter criterion [8,9] therefore there is a good chance that in the future such methods will be used to help physicians to find patients with small AAA with a high risk of rupture. And on the contrary the same could prevent putting borderline patients with severe comorbidities at risk of open or endovascular repair, if the rupture risk would be assessed lower than the risk of repair.

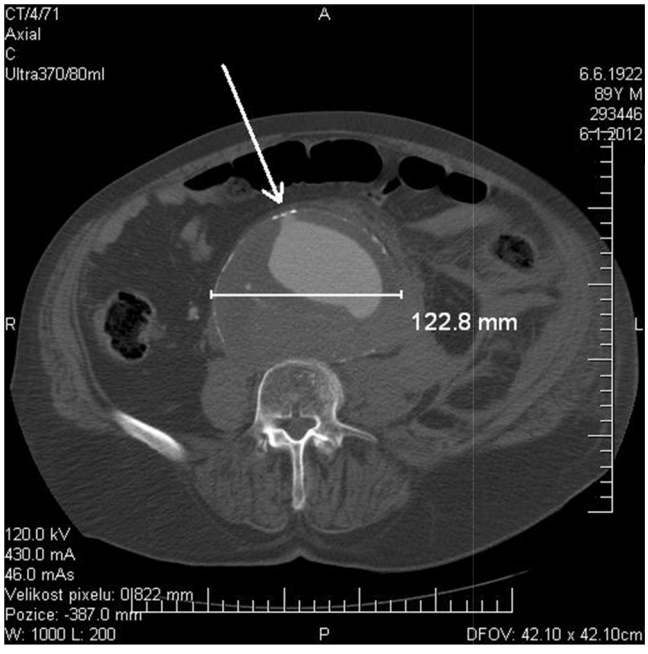

Fig. 1 – Rupture of large AAA. Ruptured AAA with diameter bigger than threshold for elective repair. Maximal diameter is 122.8 mm. The rupture is marked with an arrow.

Materials and methods

This paper is based on the retrospective study arising from a documentation of the patients of our center, intensive care unit and extended care unit of our hospital. There were 49 patients (male $n = 40$, female $n = 9$) undergoing urgent repair of ruptured AAA in the years 2009–2012. Eight patients did not have the necessary CT angiographic findings of ruptured AAA (the reason was either that the CT was performed in another center and the findings are not available, or that the rupture was confirmed by another way and the state was so urgent that it did not allow us to perform CT), thus these patients were excluded from the study. Complete data including all CT findings were available in 41 cases (male $n = 32$, female $n = 9$). All patients with ruptured AAA were treated by an urgent open resection of ruptured AAA. The CT angiographic findings of all patients were evaluated using TomoCon 3.0 Viewer (TatraMed, Bratislava, SK) and the maximal diameter of all ruptured AAAs was measured. We also evaluated the documentation of all of the patients for information of their survival during hospitalization in our hospital or extended care department until the time of the patient's discharge or death. After-discharge mortality of our patients was not traced because we assumed that after discharging the patient in stable condition, the risk of death was the same as the risk of death of any other cause [10]. The Fisher's exact test was used to statistically evaluate the outcome. In addition we compared data from patients medical history including information about hypertension, COPD, diabetes mellitus, hyperlipidemia, ischemic heart and lower limb disease. Then those data were statistically tested (using non-parametric Mann–Whitney test) to reveal if there is a relation between any of these conditions and diameter of ruptured AAA. Finally, the portion of females, patients with hypertension, ischemic heart disease or diabetes mellitus in our group is significantly different from groups of patient with non-ruptured AAA (reference groups taken from studies [11,12]). For this a one sample portion test was used.

Results

From the set of 41 patients there were 7 with small AAA at the time of rupture (male $n = 6$, female $n = 1$), expressed as a percentage of all of the patients with ruptured AAA this means 17.1%, and this outcome is corresponding to available literary sources. From all of the patients with ruptured AAA there were 8