Open repair of ruptured abdominal aortic aneurysm in the endovascular era

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Abstract:

Published literature is supporting endovascular repair (EVAR) of ruptured abdominal aortic aneurysm (RAAA) and in the recent years, papers about open repair (OR) of RAAA are scares. Does OR of RAAA has its' own place in endovascular era.

Substantial rate of RAAA are not anatomically suitable which confirms necessity to conquer techniques of open repair, even nowadays. Fast diagnosis and bleeding control followed by rational tactics and reconstruction strategies to perform safe procedure in optimal time are very important. Postoperative care and medical management of hemodynamic condition of the patient with thorough assessment of coagulation and timely diagnosis of any complication are important for improved survival. This paper presents some of the detailed technical tricks used in high volume RAAA center that has treated over 1500 patients during last 25 years.

Providing both options, would allow careful selection and probably optimal results. Lack of experience in elective procedures is devastating experience of new generation of vascular surgeons and therefore education of young vascular residents and surgeons in open aortic surgery is of an utmost importance.

INTRODUCTION

Published literature is supporting endovascular repair (EVAR) of ruptured abdominal aortic aneurysm (RAAA) and in the recent years, papers about open repair (OR) of RAAA are scarce. In the following text some literature data and our institutional protocol based on more than 1500 patients with RAAA operated by OR since 1992 will be presented. (Figure 1)

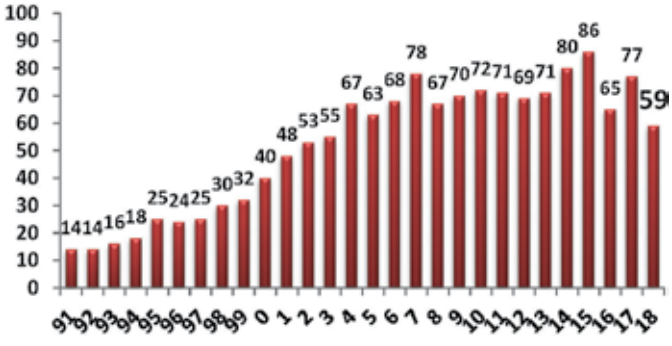

Figure 1. A repair of RAAA 1992-2018 at the Clinic for Vascular and Endovascular Surgery, Clinical Center of Serbia.

INDICATIONS FOR OPEN REPAIR OF RUPTURED AAA

As in elective cases EVAR has the same and very important advantages regarding treatment of ruptured AAA (REVAR): avoiding laparotomy, aortic cross clamping and general anesthesia, together with significantly lower blood loss[1]. However, multicenter randomized controlled trials showed relatively unexpected results[2-6]. The first of them is AJAX trial that has been performed in 10 hospitals in the Netherlands[2]. Out of total number of 520 RAAA 116 were randomized. According to this study, majority of severe complications were more frequent in open surgical group, but not significantly. Then, prolonged postoperative mechanical ventilation, perioperative blood loss and consumption of blood products have been significantly higher in open surgical group. However, there was no difference regarding the length of ICU and total hospital stay while mean time of OR was shorter than mean time of EVAR. Finally this trial did not show a significant difference regarding 30 day mortality between EVAR and OR of RAAA (21% in the EVAR and 25% in the OR group)[2]. An IMPROVE trial has randomized 613 (316 for EVAR and 297 for OR) RAAA from 30 centers[3-5]. That trial, did not also show significant difference regarding 30-day mortality (35% for EVAR and 37% for OR group), duration of procedure (The median length of the EVAR was 180 minutes, while 199 minutes for OR) and 30 day cost, between endovascular and open groups. At the same time in cases under local anesthesia EVAR has been associated with a lower mortality than those under general anesthesia. (Mortality in local anesthesia group was 13%, while 34% was in general anesthesia group)[3]. ECAR trial that has been performed in 14 hospitals in France between 2008 and 2013, randomized 107 out of 524 patients with RAAA[6]. In this study 30 day mortality after open and endovascular repair of RAAA was also equal (18% in the EVAR group versus 24% in the OR group)[6]. In AJAX and ECAR trials less than 25% of all patients with identified RAAA, were randomized[3,4]. According to IM-

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PROVE, trial 30-day mortality after REVAR at relatively hemodynamic stabile patients with good aortic anatomy was 25%. Still, this group represents only 60% of patients with RAAA[3]. Namely, patients who were not suitable for EVAR and those with severe hemodynamic instability have not been included. Consequently these trials are not representing real life conditions and it is difficult to follow them in clinical routine practice, even though randomized controlled trials are the best option to compare different methods and procedures in the era of evidence based medicine[7].

In the real life, more than 80% of hemodynamically unstable patients with RAAA, if not treated immediately upon admission, will die within two hours[6]. Prerequisites for EVAR are multidetector computed tomography (MDCT) examination, available endovascular team, stent grafts and material. In some countries and/or hospitals it is difficult or impossible to provide these conditions within two hours upon admission, and yet, without it EVAR is not possible while natural outcome of RAAA is fast. REVAR is associated with relatively significant incidence of abdominal compartment syndrome, which is followed by a mortality rate of 60%[9]. REVAR is also associated with high cumulative risk of secondary interventions during the follow up period[10]. There is no significant difference regarding long term survival and quality of life between open and endovascular repair of RAAA[11, 12]. All being said, OR of RAAA is still very important. But, can we improve early surviving? Yes actually, we can. In the past 26 years, we managed to decrease the 30-day mortality since more than 50% between 1991 and 2001, to 28% in the last two years [13-15].

TECHNICAL CONSIDERATIONS

During OR of RAAA we use modified Crawford`s strategy that includes fast diagnosis, permissive hypotension, non-selective supraceliac aortic cross clamping, cell saving and auto transfusion, as well as fast and simple aortic replacement[15].

Diagnosis

In unstable patients with abdominal or low back pain who have pulsatile abdominal tumor and profound shock, we perform emergency surgery after ultrasonography confirmation of RAAA. MDCT is performed prior to emergency surgery only to patients with suspected RAAA or extensive suprarenal and thoracoabdominal anerurysm or in hemodinamicaly stable patients especially when diagnostic dilemmas are present or endovascular solution is option due to comorbid conditions. Thanks to previous strategy we significantly reduced the mean time from arrival to emergency room to entering an operating suite, from more than two hours during the first time of our investigation, to just 43 minutes in the past 3 years[13-15]. Unfortunately we are not able to influence time since symptoms or first medical examination. In our country no helicopter transportation is routinely used for these patients. Our hospital is 24/7/365 aortic emergency referral center and all doctors in the country are informed which is saving time due to avoiding repetitive call to different hospitals. It is of interest to note that durndown rate in our experience is very low, less than 5%, and it is only considered in patients with malignant extensive diseases or old age with poor pre-rupture condition. Hemodinamic status is not reason for turndown in our clinical practice[15,16]. (Figure 2)

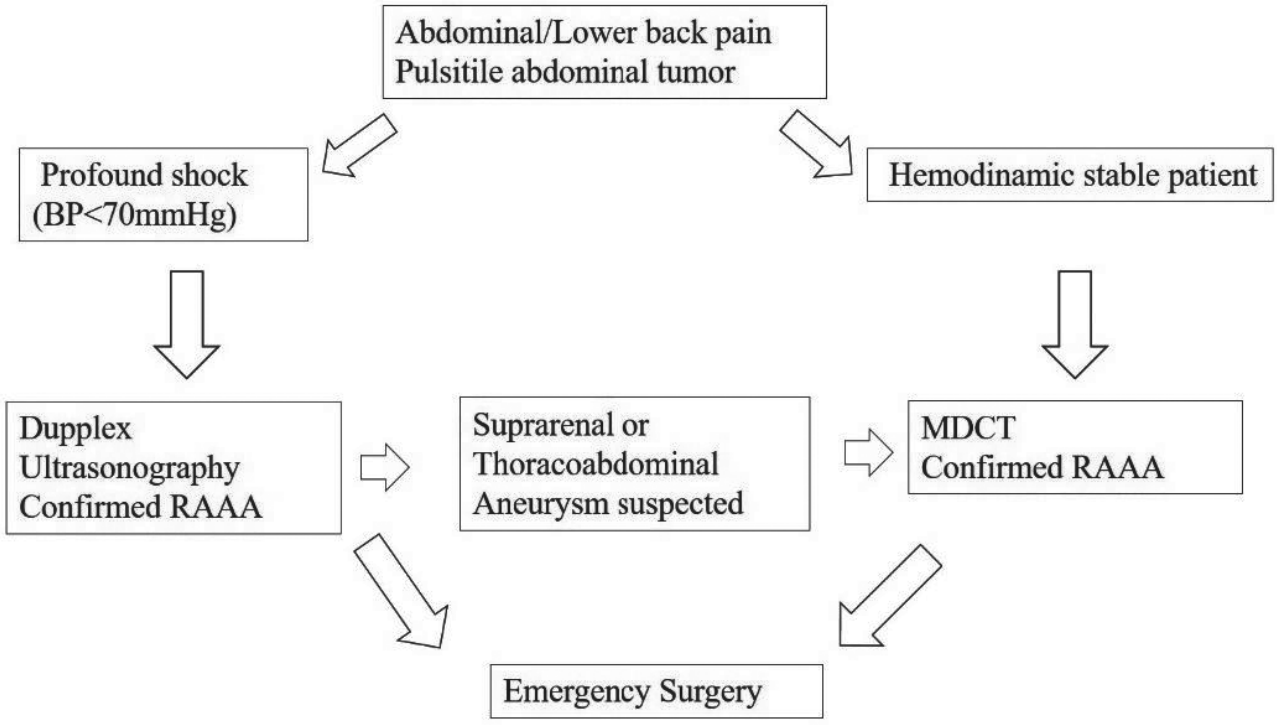

Figure 2. Diagnostic algorithm used in our settings prior to open repair of ruptured abdominal aortic aneurysms.

Permissive Hypotension

One of the biggest mistakes in the initial RAAA treatment, both during transport and upon admission, is an aggressive restitution of circulatory volume. It increases arterial pressure that, in addition, annuls the initial retroperitoneum tamponed and leads to new bleeding with conversion of retroperitoneal rupture into intraperitoneal one. Crawford was the first to insist on "permissive hypotension"[16]. Volume should be compensated to a level required to maintain consciousness and to prevent ST depression[17].

Approach

A trans-peritoneal approach through a long midline incision is the mostly used during OR of RAAA. This approach is more comfortable for anesthetists, especially if patients are hemodynamically unstable, or even if they require reanimation[17-20]. This approach enables easier exploration of the abdominal cavity, as well as dissection of the iliac and femoral arteries, especially on the right side. The patient is positioned supine on the operating table. The operative field is prepped and draped from the nipples to the knees before introduction of general anesthesia with consequent relaxation (that can reduce intrabdominal pressure due to relaxation of muscles and promote further bleeding). Immediately after intubation follows a midline incision, made from xyphoid (it can be excised if necessary) to the pubis[20,21]. In patients with RAAA and extensive proximal pathology towards suprarenal or even thoracoabdominal individual strategy is made based on patient condition, MDCT findings and surgeons' and his team experience.

Bleeding Control

We perform OR of RAAA routinely under supraceliac aortic cross clamping. That is a fast, efficient and safe proximal bleeding control, which, in addition, enables to prevent iatrogenic injuries in the presence of huge retroperitoneal hematoma. An experienced vascular surgeon needs less than 10 minutes - from the initiation of laparotomy to supraceliac aortic cross clamping[13-15]. This procedure begins with resection of the left triangular ligament and retracting the left lobe of the liver to the right. Then, the gastro hepatic omentum is opened to allow entry into the laser sac. The nasogastric tube is used to identify the esophagus and proximal part of the stomach, which are retracted to the left. The final step, before aortic cross clamping, is splitting or resecting of the crura of the diaphragm[18-21]. One should be advised that, during this procedure, the first assistant retracts esophagus and stomach downward to the left. Excessive retraction during supra celiac aortic cross clamping might cause spleen injury. In most cases, spleen repair is unsuccessful and requires early re-intervention, due to prolonged hemorrhage. Because of that, we always perform splenectomy in such cases.

The removing and relocation of the proximal clamp from initial supraceliac to infrarenal position, is not recommendable, however in cases of convenient anatomy this can be done in selected cases. Namely infrarenal aortic cross clamping requires additional dissection through retroperitoneal hematoma that increases risk of iatrogenic injury of duodenum, aorta, inferior vena cava, etc. In our last article we have found that supraceliac aortic cross clamping longer than 35 minutes increased an early mortality[13-15]. In cases of prolonged supraceliac or suprarenal aortic cross clamping, we recommend renal protection using cold renoplegic solution (500 ml NaCl, 5000 IU Heparin, 125mg Urbazon, 30 ml 20% Manitol). Initially, 250ml of this solution is administered into each kidney, with the procedure being repeated if the kidney circulation is not established after 30 minutes.

In the presence of large retroperitoneal hematoma the dissection of iliac arteries should be also avoided to prevent iatrogenic injuries of the ureters and iliac veins[13-15]. Instead that the distal bleeding control can be performed, by placement of balloon occlusive catheters into both iliac arteries after opening of the aneurysm sac. (Figure 3)

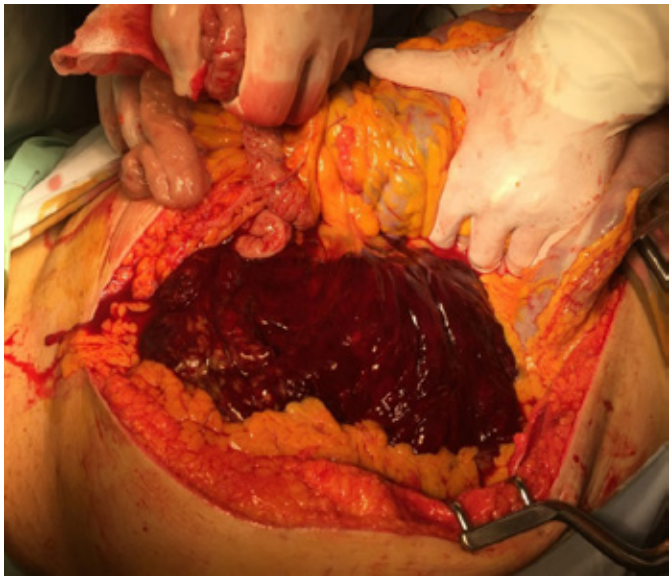

Figure 3. A huge retroperitoneal hematoma caused by AAA rupture which makes it difficult or even impossible the dissection of the infra- and juxta-renal aorta as well as iliac arteries.

The Opening of the Aneurysm Sac

After proximal and distal clamping an omentum and transverse colon are retracted cephalad, while the small bowel is packed in the right hemi-abdomen. If more working space is necessary, the small bowel can be temporary eviscerated out of the abdominal cavity. In this case adequate protection with either warm moist towels or sterile plastic bags is necessary[13,14]. The aneurysm sack is opened longitudinally. The course of that incision is important. Namely in cases of ruptured AAA where anatomical landmarks are not perfectly clear, it is important to open the aneurysm to the left (side of the patient) to avoid injury to the duodenum. The opening of the aneurysm sac is followed by removal of the thrombus and by suture of patent's inferior mesenteric (IMA) and lumbar arteries[18-21]. The usage of self-retaining retractor placed in the aneurysm sac allows ligature of lumbar arteries, as well as suture of both proximal and distal anastomosis.

Inferior mesenteric artery

According to our experience during OR of RAAA, IMA should be ligated. That ligature has to be done at IMA origin from the aneurysm sac to preserve left colic artery [18,19] (Figure 4).

Figure 4. The ligature of the inferior mesenteric artery at origin from the aneurysm sac to preserve left colic artery.

Aortic Repair

Vascular reconstruction during OR of RAAA should be performed in the simplest method possible. The usage of bifurcated graft can increase mortality[2-4], but that was not confirmed by our last study[13-15]. Anyway it is important to keep at least one of the hypogastric arteries patent to prevent colonic ischemia.

At patients with cardiac diseases, de-clamping may lead to myocardial infarction or cardiac insufficiency. Bearing this in mind, it is apparent that cooperation with anesthetist is extremely important. Namely, prior to decamping, the volume should be substituted optimally to avoid hypotension and to prevent hypo-perfusion of brain and kidneys[18-21].

An evacuation of retroperitoneal hematoma

A development of ACS should be avoided by careful manual evacuation of retroperitoneal hematoma. That is followed by separate drainage of an abdominal cavity and retroperitoneal space.

Cell Saving and Auto-transfusion

The intraoperative cell saving and auto-transfusion are obligatory during OR of RAAA. According to our and some other studies the intraoperative cell saving with auto-transfusion reduces significantly the 30-day mortality after OR of RAAA[22-24].

Postoperative complications

Postoperative complications after repair of ruptured abdominal aortic aneurysm might not fit in few paragraphs. These complications are mostly the cause of mortality in these patients since intraoperative death incidence is low[15]. One of the most severe complications is abdominal compartment syndrome and colon ischemia. In our algorithm intraabdominal pressure is followed routinely after RAAA repair while colonoscopy is performed in patients suspected for colon ischemia. In case of obvious signs of acute abdomen exploratory laparotomy is preferred. Routine colonoscopy might be option for timely diagnosis however these patients should be followed thoroughly since colon ischemia might occur any time in the early postoperative time[25].

CONCLUSIONS

Besides well-known advantages associated with endovascular repair, multicenter randomized controlled trials did not find significant difference regarding 30-day mortality between open and endovascular repair of ruptured abdominal aortic aneurysm. Endovascular repair offers improved survival when it is anatomically feasible and when haemodinamic condition of the patient allows. Providing both options, in high volume center, would allow careful selection and probably optimal results. Lack of experience in elective procedures is devastating experience of new generation and therefore education of young vascular residents and surgeons in open aortic surgery is of an utmost importance.

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