THE OPTIMIZATION OF SURGICAL MANAGEMENT OF ABDOMINAL AORTIC ANEURYSMS COMBINED WITH CORONARY HEART DISEASE

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The aim of the investigation was to develop an optimal approach enabling to improve the results of surgical management of abdominal aortic aneurysms combined with coronary heart disease.

Materials and Methods. We analyzed prospectively and retrospectively the results of surgical management of 203 patients operated for abdominal aortic aneurysm, including 173 male and 30 female patients. Mean age was 65.20±9.26 years. 133 patients (65.7%) were found to have coronary heart disease (CHD). Noncomplicated aneurysms were revealed in 121 patients (59.6%), among them 71 (58.7%) had CHD, 82 (40.4%) patients had complicated aneurysms including 62 (75.6%) with CHD.

The surgical treatment modality was determined due to clinical progression of the disease and diagnostic findings. We used a single-stage coronary and abdominal aortic pathology correction, and two-stage correction with primary coronary correction and isolated correction of abdominal aortic pathology.

Results. 30 of 203 patients had lethal outcomes, among them there were 24 cases with complicated aneurysm, 6 — with noncomplicated aneurysm. In 24 cases (77.4%) the death was caused by acute cardiovascular insufficiency due to massive blood loss in 15 (48.4%) patients and myocardial infarction — in 9 (29%). In 4 patients the death was caused by acute renal failure, in one — gastrointestinal bleeding, and in one — multi-organ failure. Among dead patients there were 28 (90.3%) with CHD, all of them having complicated aneurysms.

Conclusion. The leading cause of fatal cases in operations for abdominal aortic aneurysms is acute cardiovascular insufficiency due to major bleeding, as well as fatal coronary event. The use of a staged surgical approach enables to improve the results of surgical management of patients with abdominal aortic aneurysm combined with CHD.

Key words: abdominal aortic aneurysm; coronary heart disease.

Abdominal aortic aneurysm (AAA) incidence is rather high. According to 30-year observation data of A.A. Vishnevsky Central Military Clinical Hospital (Moscow, Russia), it averages 4.6%, and has the tendency for increasing [1]. The disease is rather dangerous in terms of prognosis, since the rupture risk in the first year is from 40 to 60% depending on an aneurysm size. Clinical presentations of AAA rupture are multiform, and in 17.7% of cases proceed under a mask of other diseases preventing from early and correct diagnosis [2]. The mortality among nonoperated patients with AAA rupture is 100%, while in operated patients it varies from 40 to 90% depending on management [3–8].

Coronary heart disease (CHD) is one of the risk factors in surgical AAA management [9], and occurs in 50–90% of patients [10–16], its incidence increasing with age [17].

In conservative treatment of AAA combined with CHD 65% of patients die in the first year, among them the percentage of patients dying of myocardial infarction is 12%, and of aneurysm rupture — 53% [11]. The lethal outcomes after reconstructive operations on abdominal aorta in over 50% of cases are caused by cardiovascular complications, and primarily myocardial infarction [18]. Case fatality after AAA resection in patients without CHD is 4%, with CHD — 14.1%, with acute myocardial infarction in past history — 27.4%, and patients with CHD complicated by heart failure — 37.5% [19]. Surgical intervention in complicated AAA is related to high risk of massive blood loss worsening the treatment results [4, 8].

The analysis of surgical management of patients with AAA in combination with CHD shows topical diagnosis, the choice of treatment modality and the surgical correction method to

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pose a problem. The lack of the uniform AAA classification [9, 18, 20, 21], the variety of AAA clinical progression forms including those combined with CHD prevent from standardization of diagnostic and treatment process.

The aim of the investigation was to develop an optimal approach enabling to improve the results of surgical management of abdominal aortic aneurysms combined with coronary heart disease.

Materials and Methods. We analyzed prospectively and retrospectively the results of surgical management of 203 patients operated for abdominal aortic aneurysm from January 1995 to December 2011. The survey included 173 male (85.2%) and 30 female (14.8%) patients. Mean age was 65.2±9.3 years.

All the patients besides physical examination underwent electrocardiography (ECG), echocardiography (EchoCG), duplex scanning of abdominal aorta and low limb arteries, multispiral computed and/or magnetic resonance tomography with angiography, aortoarteriography and selective coronary angiography (SCA).

AAA types were determined according to the classification used in Russia [9, 18, 21]. This classification has many items and is highly-structured that significantly complicates the unification and statement of management decisions. We modified the classification scheme to optimize the choice of treatment modality.

We distinguished noncomplicated and complicated AAA according to clinical progression. A complicated course was subdivided into imminent rupture and manifestating rupture.

Painful forms, as well as large and giant aneurysms, dissections were referred to imminent ruptures. Such patients are to be examined and treated promptly, but not to the detriment of diagnosis correctness and accuracy.

The patients with ruptures compose an urgent group, and the majority of them are examined and operated immediately.

Asymptomatic and painless course of small- and medium-sized aneurysms was referred to noncomplicated forms since the examination and management of such patients are the same.

All patients were divided into 2 groups: group 1 consisted of 121 patients (59.6%) with noncomplicated aneurysms including those with associated CHD — 71 patients (58.7%), group 2 included 82 patients (40.4%) with complicated AAA. In this group CHD was revealed in 62 patients (75.6%).

Total number of CHD patients was 133 (65.7%), among them stable functional class (FC) II angina according to NYHA was found in 28 patients (21.1%), FC III — in 30 (22.6%), FC IV — in 1 (0.8%). 34 patients had had myocardial infarction (25.6%). IIA stage chronic circulatory failure (CCF) (in accordance with Strazhesko–Vasilenko–Langa classification) was revealed in 15 patients (11.3%), IIB stage — in 7 patients (5.3%) (Table 1).

Selective coronary angiography was performed if indicated [22]. When analyzing the data necessary for making decision on the management, we distinguished trunk involvements (stenoses of over 50% of the left coronary arterial trunk, as well as stenoses of over 75% of the orifices of the anterior interventricular and cirthe frequency of AAA and CHD combination is over 65.7% that is consistent with the data reported in literature. In patients

Table 1

Characteristic of patients with noncomplicated and complicated abdominal aortic aneurysms, absolute number/%

Parameters	Group 1 — noncomplicated AAA (n=121)	Group 2 — complicated AAA (n=82)	Total (n=203)
Male patients	96/79.3	77/93.9	173/85.2
Mean age (M±m), years	63.8±5.3	66.1±5.4	64.3±5.3
Aneurysm dimensions according to ultrasound (M±m), mm:			
cross dimension	72.25±22.98	72.25±22.98	81.9±32.6
longitudinal dimension	100.15±33.14	100.15±33.14	110.1±43.4
SCA:	43/60.6	14/21.5	57/42.9
Trunk involvement	5/11.6	3/21.4	8/14.0
Non-trunk involvement	24/55.8	9/64.3	33/57.9
Hemodynamically non-significant involvement	14/32.6	2/14.3	16/28.1
Associated CHD:	71/58.7	62/75.6	133/100
Myocardial infarction in past history	16/22.5	18/29	34/25.6
FC II angina	14/19.7	14/22.6	28/21.1
FC III angina	13/18.3	17/27.4	30/22.6
FC IV angina	—	1/1.6	1/0.8
IIA stage CCF	8/11.3	7/11.3	15/11.3
IIB stage CCF	2/2.8	5/8.1	7/5.3

Table 2

Surgical management (staged surgery) in accordance with the course of the disease and the nature of coronary bed involvement

Nature of the involvement	Noncomplicated AAA	Complicated AAA	
		Разрыв	Угроза разрыва
Trunk involvement	Two-stage planned operation	One-stage Two-stage urgent	Two-stage elayed
Non-trunk involvement	Two-stage planned Isolated	Isolated	Two-stage elayed Isolated

with complicated AAA an associated CHD occurred statistically significantly more frequently (p=0.021) and was more severe. Their longitudinal (p=0.003) as well as cross (p<0.001) dimensions were statistically significantly larger than the similar parameters in noncomplicated AAA. We confirmed the conclusions made by the authors [9, 18, 21] that risk complication is directly proportional to AAA dimensions: the size of aneurysmal sac of over 8 cm in diameter is a good reason to consider it as a rupture risk factor.

SCA was performed much more rarely in patients with complicated aortic aneurysm (group 2) than in noncomplicated course (group 1) (21.5% versus 60.6%; p<0.001), since group 2 patients were mainly examined and managed in district hospitals and inpatient departments, which have no SCA available. Group 2 patients were found to have a larger proportion of involvements requiring surgical correction (87.5 versus 67.4%; p=0.003) that indicated the more severe course of CHD.

Since 2005 in order to reduce cardiac complications in patients with the combination of AAA and CHD we have used a staged surgical management, which depends on the course of the disease and the nature of coronary bed involvement (Table 2).

We have used the following types of approaches: a one-stage correction (a combined or hybrid operation), a two-stage correction with prior surgical treatment of coronary arteries and an isolated correction of abdominal aortic pathology.

In two-stage correction due to the characteristics of aortic aneurysm and the nature of coronary bed involvement we used: a two-stage urgent operation — an interval between the stages being no more than 1–3 days, when it is possible to perform coronary stenting in patients with stabilized aortic aneurysm rupture; a two-stage operation — with an interval between the stages up to 2 weeks in case of aneurysm rupture risk, without discharge from the hospital; a two-stage planned operation — with patient's discharge from the hospital and the second stage performed 1–3 months later due to the peculiarities of coronary bed condition and an aneurysm size.

In complicated AAA and the presence of trunk involvement of coronary bed we used a one-stage or two-stage urgent correction, and in aneurysm rupture risk and trunk involvement of coronary bed – a two-stage delayed correction, in noncomplicated aneurysms combined with trunk involvement — a two-stage planned correction.

In non-trunk involvements of coronary bed and aneurysm rupture we used isolated correction of aortic pathology; in case of imminent aneurysm rupture the correction staging was considered individually. In aneurysms with high probability of rupture we performed an isolated correction, and in low probability of rupture we gave preference to a two-stage delayed correction.

In noncomplicated aortic aneurysms with non-trunk involvement requiring correction we used a two-stage planned operation, and if there were no contradictions for operation on coronary arteries, an isolated aortic aneurysm resection was performed. Table 3 represents the structure of performed operations on coronary arteries in various management approaches. 2 patients underwent a one-stage correction of coronary bed and abdominal aortic pathology. A two-stage operation with primary correction of coronary arteries was made in 39 patients (19.2%): as the first stage, coronary bypass surgery was performed in 6 patients, and coronary stenting — in 33 patients.

An isolated correction of abdominal aortic pathology without an operation on coronary arteries was performed in 162 patients (79.8%).

To our opinion, if the correction of coronary disorders is required, a two-stage operation is the most optimal. One-stage (combined) operations are considered to be rather serious for a patient and require high professionalism and detailed coordination of all the participants of the procedure. An obvious advantage is a complete control over the blood loss. However, the organization level of emergency care for patients with combined cardiovascular pathology in most regions of Russia prevents from using a one-stage repair as the main modality in the treatment of patients with complicated AAA and severe coronary involvement. The application of hybrid techniques seems to be promising in such patients.

Table 3

Structure of coronary surgeries in various management approaches

Correction type	Coronary artery bypass grafting	Stenting	Total
One-stage	1	1	2
Two-stage, urgent	—	5	5
Two-stage, delayed	1	2	3
Two-stage, planned	5	26	31
Isolated	—	—	—
Total	7	34	41

Table 4

The blood loss volume and the part of its replacement before and after the introduction of autoerythrocyte reinfusion

Parameters	Before 2005	After 2005
Blood loss, ml	1127.9±954.5	1169.0±630.9
Transfused donor blood, ml	591.0±485.7	777.3±472.5
Reinfusion, ml	—	340.0±181.1
Blood loss replacement, %	52.4	95.6
including patients with blood replaced Using Cell Saver, %	0	30.4

Table 5

The number of lethal outcomes before and after the introduction of a staged surgical approach, absolute number/%

AAA type	Before introduction (n=90)	After introduction (n=113)	Total (n=203)	p
Noncomplicated	4/9.5 (n=42)	2/2.5 (n=79)	6/5.0 (n=121)	0.002
Complicated	15/31.3 (n=48)	9/26.5 (n=34)	24/29.3 (n=82)	NS*
Total	19 (20.0)	11 (9.7)	30 (15.3)	0.041

Note: *NS — statistically unreliable

Blood loss during AAA surgery varied from 200 to 5000 ml (averaged 1083.0±803.6 ml). In noncomplicated aneurysms it averaged 926.7±550.6 ml, and in complications was statistically significantly higher — 1962.0±1429.3 ml (p=0.05). 62 patients (66.7%) required blood replacement. On the average 676.7±485.5 ml of donor packed red blood cells were transfused to every patient.

Intraoperative blood loss is a risk factor for both general and cardiac complications [4, 8, 18, 21]. According to some authors, blood loss is to be replaced in the ratio 1:1, and the most optimal method is autoinfusion [21]. We have used autoerythrocyte reinfusion since 2005 in operations for AAA using Cell Saver Medtronic Autolong (Medtronic, USA), if donor specific transfusion has been needed. In addition, great attention we pay to the volume of blood replaced (Table 4).

Autoerythrocyte reinfusion was used in 36 patients, among them 5 patients underwent an emergency operation for complicated aneurysm, and 31 — a planned surgery for noncomplicated aneurysm. Almost complete blood loss replacement was achieved by autoerythrocyte reinfusion, while conventional reinfusion replaced 30.4% of blood volume.

30 of 203 patients (15.3%) had lethal outcomes, among them 24 patients had complicated aneurysm (mortality 29.3%), and 6 — noncomplicated aneurysms (Table 5). In 24 patients (77.4%) the death was caused by acute cardiovascular insufficiency due to massive blood loss in 15 cases (48.4%) and in 9 cases (29%) — due to myocardial infarction. 4 patients died of acute renal failure, one patients — of gastrointestinal hemorrhage, and one — multiorgan failure. 28 of 31 dead patients (90.3%) had CHD — all the patients had complicated aortic aneurysms; CHD was found statistically significantly more rarely among those who survived — in 78 of 172 (64.5%) (p=0.006).

The use of a staged surgical approach enabled to reduce significantly hospital mortality. It should be noted that mortality decreased mainly due to the patients with noncomplicated aortic aneurysms.

Conclusion. Associated chronic heart disease in 65.7% of patients with abdominal aortic aneurysm modifies clinical progression of the disease determining more rigorous management approach to the choice of surgical technique and its schedule.

The leading cause of fatal cases in operations is acute cardiovascular insufficiency due to major bleeding, as well as fatal coronary event.

The risk factors of failures in AAA operational intervention are the following: complicated aneurysm, associated CHD, large-sized aneurysms (over 8 cm).

The use of a staged surgical approach enables to improve the results of surgical management of patients with abdominal aortic aneurysm combined with CHD due to the reduced number of fatal coronary events.

The use of autoerythrocyte reinfusion enables to replace blood loss more physiologically and completely, and reduce hospital mortality.

References

1. Veretenin V.A. *Puti uluchsheniya rezul'tatov lecheniya bol'nykh s anevrizmami bryushnoy aorty.* Dis. … dokt. med. nauk [The ways to improve the treatment results of patients with abdominal aortic aneurysms. Dissertation for the degree of Doctor of medical science]. Moscow; 2008.

2. Sotnikov P.G. *Puti uluchsheniya rezul'tatov khirurgicheskogo lecheniya razryvov anevrizm bryushnoy aorty.* Dis. … kand. med. nauk [The ways to improve the surgical management results of ruptured abdominal aortic aneurysm. Dissertation for the degree of Candidate of medical science]. Moscow; 2003.

3. Belov Yu.V., Sultanyan T.P., Stepanenko A.B., Gens A.P., Seleznev M.N. *Odnomomentnaya revaskulyarizatsiya miokarda s protezirovaniem bryushnogo otdela aorty i pochechnoy arterii* [Single-stage myocardial revascularization with replacement of abdominal aorta and renal artery]. *Angiol Sosud Hir — Angiology and Vascular Surgery* 1997; 4: 123–130.

4. Shcherbyuk A.A. *Khirurgicheskoe lechenie bol'nykh s razryvom anevrizm bryushnoy aorty.* Dis. … kand. med. nauk [Surgical management of patients with ruptured abdominal aortic aneurysm. Dissertation for the degree of Candidate of medical science]. Moscow; 2003.

5. Armour R.H. Survivors of ruptured abdominal aortic aneurysm: the iceberg's tip. *Br Med J* 1977; 2: 1055–1057.

6. Collin J., Walton J., Araugo L., Lindsell D. Oxford screening programme for abdominal aortic aneurysms in men aged 65 to 74 years. *Lancet* 1988; 12(4): 429–437.

7. Harris P.L. Recognizing abdominal aortic aneurysms with serial ultrasound examinations. *Gefasschirurgie* 1996; 11: 16–20.

8. Morishita Y., Arikawa K., Yamashita M., Shimokawa S., Ohzono H., Saigenji H., Taira A. Ruptured abdominal aortic aneurysm: factors influencing operative mortality. *Jpn J Surg* 1986; 16: 272–276.

9. Spiridonov A.A., Arakelyan V.S., Tutov E.G., Sukhareva T.V. *Khirurgicheskoe lechenie anevrizm bryushnoy aorty* [Surgical management of abdominal aortic aneurysms]. Moscow: NTsSSKh im. A.N. Bakuleva RAMN; 2005; 294 p.

10. Ambat'ello S.G. *Diagnostika i lechenie bol'nykh mul'tifokal'nym aterosklerozom.* Dis. … dokt. med. nauk [Diagnostics and treatment of patients with multifocal atherosclerosis. Dissertation for the degree of Doctor of medical science]. Moscow; 2002.

11. Belov Yu.V., Stepanenko A.B., Gens A.P. Khirurgicheskoe lechenie bol'nykh anevrizmoy aorty v sochetanii s ishemicheskoy bolezn'yu serdtsa [Surgical management of patients with aortic aneurysms combined with coronary heart disease]. *Khirurgiya. Zhurnal im. N.I. Pirogova — Surgery. Journal named after N.I. Pirogov* 2004; 9: 4.

12. Kazanchyan P.O., Popov V.A., Sotnikov P.G., Kozorin M.G., Kazakov A.Yu. Khirurgicheskaya taktika u bol'nykh s anevrizmoy bryushnoy aorty i ishemicheskoy bolezn'yu serdtsa [Surgical approach in patients with abdominal aortic aneurysm and coronary heart disease]. *Grudnaya i serdechno-sosudistaya khirurgiya — Thoracic and Cardiovascular Surgery* 2008; 2: 30–35.

13. Pokrovskiy A.B., Dan V.N., Zlatovchen A.M., Il'in S.A. Vliyanie kardial'nogo statusa i arterial'noy gipertenzii na rezul'taty khirurgicheskogo lecheniya bol'nykh s anevrizmami bryushnoy aorty starshe 70 let [The effect of cardial status and arterial hypertension on the surgical management results of patients over 70 with abdominal aortic aneurysms]. *Angiol Sosud Hir — Angiology and Vascular Surgery* 2003; 9(1): 71–76.

14. Robert C. King, Patrick E. Parrino, Janet L. Hurst, Kimberly S. Shockey, Curtis G. Tribble, Irving L. Kron. Simultaneous coronary artery bypass grafting and abdominal aneurysm repair decreases stay and costs. *Ann Thorac Surg* 1998; 66: 1273–1276.

15. William Brown O., Larry H. Hollier, Peter C. Pairolero, Francis J. Kazmier, Robert A. McCready. Abdominal aortic aneurysm and coronary artery disease: a reassessment. *Arch Surg* 1981; 116(11): 1484–1488.

16. Chemurziev G.M. *Neposredstvennye i otdalennye rezul'taty odnomomentnykh i etapnykh operatsiy u bol'nykh s anevrizmami bryushnoy aorty s sochetannym porazheniem sonnykh i koronarnykh arteriy.* Dis. … kand. med. nauk [Immediate and long-term results of single-stage and staged operations in patients with abdominal aortic aneurysms with combined involvements of carotid and coronary arteries. Dissertation for the degree of Candidate of medical science]. Moscow; 2009.

17. Aygunov Sh.S. *Rezul'taty khirurgicheskogo lecheniya anevrizmy bryushnoy aorty u bol'nykh 70 let i starshe.* Dis. … kand. med. nauk [The results of surgical management of abdominal aortic aneurysm in patients over 70 years and older. Dissertation for the degree of Candidate of medical science]. Moscow; 2005.

18. Kazanchyan P.O., Popov V.A. *Oslozhneniya v khirurgii anevrizm bryushnoy aorty* [Complications in abdominal aortic aneurysm surgery]. Moscow: Izd-vo MEI; 2002; 304 p.

19. Belov Yu.V., Goryunov V.S., Martynov A.A. Khirurgicheskoe lechenie bol'nykh s ateroskleroticheskim porazheniem sosudov serdtsa, golovnogo mozga i nizhnikh konechnostey [Surgical management of patients with arterial sclerotic disease of cardiac, cerebral and low limb vessels]. *Kardiologia — Cardiology* 1992; 32(11): 103–104.

20. Savello V.E., Andreychuk K.A., Basek I.V., Andreychuk N.N. *Anevrizma bryushnoy aorty. Luchevaya diagnostika, khirurgicheskoe lechenie, posleoperatsionnyy luchevoy monitoring, organizatsionnye aspekty* [Abdominal aortic aneurysm. Radiodiagnosis, surgical management, postoperative radiation monitoring, organizational aspects]. Tver: OOO "Izdatel'stvo "Triada"; 2012; 256 p.

21. Khubulava G.G., Sazonov A.B. *Khirurgicheskoe lechenie anevrizm infrarenal'nogo otdela aorty* [Surgical management of infrarenal aortic aneurysms]. Saint Petersburg; 2009; 144 p.

22. Savchenko A.P., Cherkavskaya O.V., Rudenko B.A., Bolotov P.A. *Interventsionnaya kardiologiya. Koronarnaya angiografiya i stentirovanie* [Interventional cardiology. Coronary angiography and stenting]. Moscow: GEOTAR-Media, 2010; 448 p.