Postępy Nauk Medycznych, t. XXV, nr 8, 2012

*Bartosz Pacewski, Włodzimierz Hendiger, Walerian Staszkiewicz, Grzegorz Madycki

Iliac artery aneurysms – underestimated problem of vascular surgery

Tętniaki tętnic biodrowych – niedoceniany problem angiochirurgii

Department of Vascular Surgery and Angiology of the Madical Centre for Postgraduate Education,
The Jerzy Popiełuszko Memorial Bielański Hospital
Head of Department: prof. Walerian Staszkiewicz, MD, PhD

S u m m a r y

Iliac artery aneurysms (IAA) are underestimated problem of vascular surgery. Their atypical medical manifestations cause that iliac aneurysms are dicovered accidentaly or in late stage of disease. High mortality due to rupture demand to consider about this problem. This reviev shows informations of pathophysiology of iliac aneurysms, theirs anatomical classification and treatment strategy. This reviev also shows basic knowledge of anatomy of iliac vessels. There is a few data about this vascular patologhy. Iliac artery aneurysms are described in connection with treatment of abdominal aorta aneurysm (AAA). There is a lack of standards of practise supported by numerous studies.This review also shows results of treatment in patients with iliac artery aneurysms. They show much better results of endovascular treatment compared to classic surgical treatment in short follow-up period.

Key words: iliac artery aneurysm, standards of practice, pathophysiology of aneurysm, treatment of aneurysm

S t r e s z c z e n i e

Tętniaki tętnic biodrowych (TTB) stanowią niedoceniany problem w angiochirugii. Ich nietypowy obraz kliniczny powoduje że są one wykrywane przypadkowo lub późnym stadium choroby, kiedy osiągną duże rozmiary.Wysoka śmiertelność z powodu pęknięcia nakazuje zastanowić się nad ich problemem. Praca ta przedstawia informacje na temat patofizjologii tętniaków tętnic biodrowych. Pokazuje podział tętniaków pod względem anatomicznym oraz sposoby ich leczenia. Praca przedstawia również podstawową wiedzę z zakresu anatomi naczyń biodrowych. Jest niewiele prac dotyczących tej patologii naczyniowej. Przede wszystkim tętniaki tętnic biodrowych są opisywane w związku z leczeniem tętniaka aorty brzusznej (TAB). Brak jest wypracowanych standardów postępowania z tętniakami popartych licznymi badaniami naukowymi. Praca przestawia również wyniki leczenia pacjentów z tętniakami tętnic biodrowych. Wykazują one znacznie lepsze rezultaty leczenia endowaskularnego w porównaniu z klasycznym leczeniem chirurgicznym w krótkim okresie obserwacji.

Słowa kluczowe: tętniak tętnic biodrowych, standardy postępowania, patofizjologia tętniaka, leczenie tętniaka

INTRODUCTION

Within the last decade, publications regarding diseases of the circulatory system devotes much attention to problems related to aneurysms of the aorta, the popliteal arteries and the visceral arteries. Iliac artery aneurysms in isolated form and accompanying the aortic aneurysms are more and more frequently diagnosed. However, literature and studies regarding these problems are rather not extensive comparing to previously listed problems. It is still underestimated problem of modern angiology and vascular surgery.

CLASSIFICATION AND EPIDEMIOLOGY

The iliac artery aneurysm (IAA) may be classified in 2 groups:

1. Aneurysms related to AAA (occurring in 10-20% of cases).
2. Isolated iliac artery aneurysms. The most frequent location is the common iliac artery, then the internal iliac artery and the most rare, the external iliac artery. In case of the abdominal aneurysms, they constitute (0.9-2%). Internal iliac artery aneurysms constitute (0.03-0.4%).

IAA may occur in form of fusiform aneurysm as well as saccular aneurysm. The aneurysm is defined as widening of the artery lumen by more than 50%. Practical diameter for the iliac artery aneurysm is 18 mm (in case of normal diameter of 8-14 mm). Although some sources provide diameter of the common iliac artery aneurysm exceeding 1.5 cm (1.7 cm in males) and over 0.8 cm for the internal iliac artery aneurysm. (Subcommittee on Reporting Standards for Arterial Aneurysm of The Society for Vascular Surgery).

IAA more frequently occur in male patients (7:1) in 7th and 8th decade of life. 30% of IAA occur bilaterally (2, 8, 10).

ETIOLOGY AND PATHOPHYSIOLOGY

Due to low number of publications about problems of the iliac artery aneurysms, there is no studies about their etiology.

Due to etiology, aneurysms may be classified as:

1. degenerative – related to the process of the vessel wall damage. This process is related to the vessel atherosclerosis,
2. inflammatory – with significantly thickened wall combined with the process of retroperitoneal fibrosis and significant perivascular inflammatory reaction,
3. dissection,
4. post-traumatic (also iatrogenic),
5. post-infective,
6. congenital.

The base for development of the aneurysm is functional and structural loss of elastin in the arterial wall. Elastin, which is the main structural protein of the arterial wall besides collagen, ensures normal extensibility (elasticity) of the vessel. Elastin is not the protein synthesized by an adult human. Its half-life is about 70 years, which correlates with number of aneurysms in elderly persons.

Enzymes of the group of matrix metalloproteinases (MMPs) are responsible for elastin disintegration. They are produced by the cells of the smooth muscles, endothelium, fibroblasts as well as lymphocytes and macrophages infiltrating the aneurysm wall. The most important is MMP-9, which is released from macrophages nearby the nutrient vessels of the adventitia.

Tissue inhibitor of metalloproteinases (TIMPs) is the inhibitor of metalloproteinase. Fall in the level of its activity may intensify elastolysis. Doxycycline is a nonspecific inhibitor of metalloproteinases.

Drugs of NSAID group indirectly acts on MMPs. Indomethacin, by inhibiting release of cytokines (IL-1, IL-6), reduces release of MMPs. On the other hand, maximum doses of the statins inhibit synthesis of MMP-9 in the aneurysms.

Deficiency of alpha 1-antiprotease is also a reason for increasing elastolysis in the vessels of the arteries.

Presence of the paramural clot is a separate problem in development of the aneurysms. This heterogeneous structure creates the barrier in transport of oxygen and nutritional elements to the aneurysm wall, which leads to hypoxia and its further damage. Oxidation disturbances in the clot activate metalloproteinases, which weaken the aneurysm wall.

Chronic injury of the arterial wall related to the wave of the arterial pressure is very important factor in development of the aneurysms. Combination of factors including high pressure, rigidity of the wall related to loss of the elastic fibers and increase in the peripheral resistance is the next reason for development of the aneurysm (2-4).

In order to illustrate the problem of the aneurysm development, we may use the figure 1 on page.

Risk factors for the aneurysms and factors reducing the risk are presented in the table 1.

Table 1. Risk factors in the aneurysm development.

Risk factors for aneurysms	
Increased risk	**Decreased risk**
Smoking	Diagnostics of the abdominal cavity within 5 years
Family history	Deep vein thrombosis
Age over 70 years	Diabetes mellitus
Coronary heart disease	Black race
Lipid disturbances	Female gender
COPD	

THE MOST CERTAIN RISK FACTORS FOR THE ANEURYSMS INCLUDE SMOKING AND FAMILY HISTORY

Course of the disease and symptoms

Natural course of the disease in patient with the iliac artery aneurysm is its growth. Due to small number of cases, there are no detailed studies regarding size and growth rate of IAA. Growth of IAA depends on the diameter of the aneurysm. The aneurysm measuring below 3 cm in diameter grows by 1.1 mm per year, and the aneurysm measuring 3-5 cm in diameter grows up to 2.6 mm per year.

Such significant increase in growth rate of the diameter is associated with weakening of the wall of the aneurysm. Growth of diameter of IAA seems to be the main factor determining its rupture. Average size of ruptured IAA is 6-6.8 cm in diameter.

Majority of IAA is asymptomatic (65-70%). Symptoms of IAA include peripheral embolism (blue toe syndrome) and rupture. Additional symptoms include complaints related to effect of the mass, which is created by IAA in the pelvis minor. They include the following: the ureter involved in the disease, impaired urine outflow, ureter dilation above the lesion and development of hydronephrosis, the rectum compression and permanent rectal tenesmus, pain radiating to the hip joint, paresthesiae associated with the pelvic nerves compression, deep vein thrombosis, bleeding into the alimentary tract.

Asymptomatic course or no typical symptoms lead to late diagnosis of this vascular pathology. Average size of IAA at the moment of diagnosis is usually 5-6 cm.

DIAGNOSTICS

The most important evaluation in diagnostics of IAA is ultrasound. It allows diagnosing pathology and performing control check-ups in patients before and after surgical treatment. Majority of ultrasound diagnoses of IAA is accidental, it usually takes place during examination evaluating diseases of the urinary system, especially evaluation of the urinary bladder and

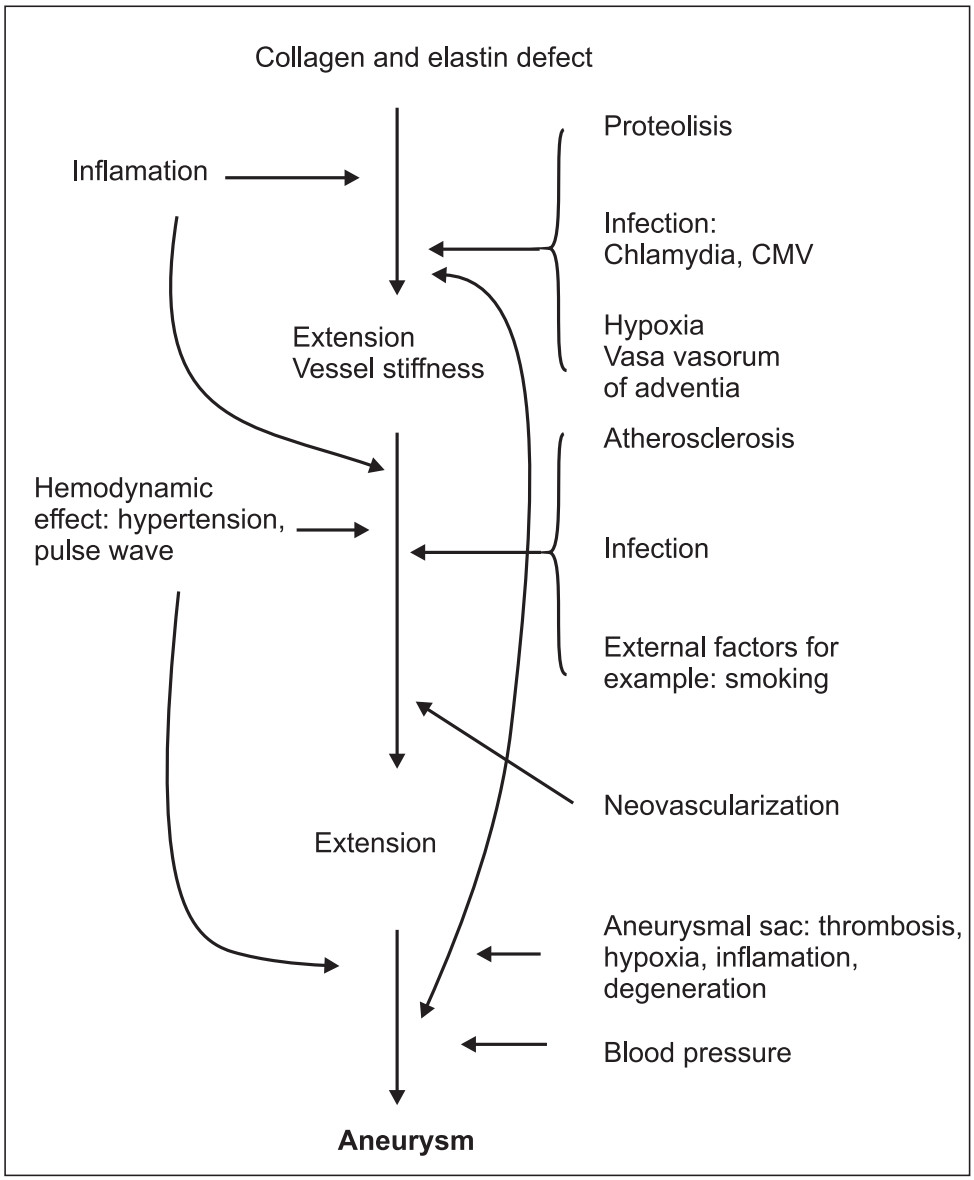

Fig. 1. The diagram of the aneurysm development (according to 5).

the prostate. CT-scan is evaluation, which is necessary for planning a surgical treatment. It is used for precise measurement of IAA in order to select suitable intravascular instruments. Aneurysms measuring 3-3.5 cm should be evaluated every 6 months (2, 8, 12)

ANATOMY

The common iliac arteries originate from the aorta creating the subaortic angle, which ranges from 75 degrees in females to 65 degrees in males. This angle is located at the level of the fifth lumbar vertebra. The aortic bifurcation is located at the lower third and a part of the fourth lumbar vertebra. The artery is measuring 11 mm (8-14 mm) in diameter. The right iliac artery may be larger. Its average length is 5 cm. The artery divides into two branches at the level of the inferior edge of the fifth lumbar vertebra.

The external iliac artery constitute the anterolateral branch of the bifurcation. The length is 10-12cm and the diameter is 1 cm. The length is difficult to be measured in elderly people due to its tortuosity. Below the inguinal groove, the external iliac artery transforms into the common femoral artery. The internal iliac artery is the main arterial branch supplying organs of the small pelvis. Only the median sacral artery is an exception, as the final branch of the aorta.

The internal iliac artery is measuring 8-9 mm in diameter and 4-5 cm in length. It divides into 2 trunks.

The following branches originate from the anterior trunk: the obturator artery, the inferior gluteal artery, the umbilical artery, the inferior vesical artery, the artery of the vas deferens (the uterine artery), the middle hemorrhoidal artery, and the internal pudendal artery.

The following branches originate from the posterior trunk: the iliolumbar arteries, the lateral sacral arteries, and the superior gluteal arteries.

Due to numerous branches, the internal iliac artery creates the arterial network. It has great clinical signifi-

cance due to development of the collateral circulation. There are connections with the vessels of the contralateral side and with branches of the same side.

Connections with neighboring arteries are the most important.

1. Connection with the aorta through the artery of the vas deferens and the testicular artery, the uterine artery and the ovarian artery, the iliolumbar artery and the inferior lumbar arteries as well as the middle and the superior hemorrhoidal arteries.
2. Connection with the external iliac artery through the obturator artery and the inferior epigastric artery as well as the iliolumbar artery and the deep circumflex iliac artery.
3. Connection with the femoral artery through the inferior gluteal artery and the superior perforating artery (from the profunda femoris artery), the inferior gluteal artery and the medial circumflex femoral artery as well as the internal pudendal artery and the external pudendal artery.

Such extensive network of connections provides us with opportunity of unilateral banding of the internal iliac artery without affecting blood supply to the organs.

The external iliac artery, before transforming into the common femoral artery, provides two branches: the deep circumflex iliac artery and the inferior epigastric artery. They create connections with the internal iliac artery, the subclavian artery and the abdominal aorta (1).

ANATOMICAL CLASSIFICATION OF IAA

Type A – the proximal neck at the common iliac artery is shorter than 1.5 cm and it ends at the internal iliac artery (fig. 2).

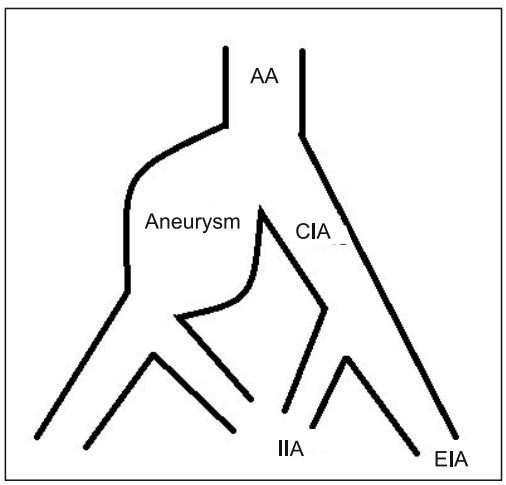

Fig. 2. Type A. AA – the abdominal aorta, CIA – the common iliac artery, IIA – the internal iliac artery, EIA – the external iliac artery.

Type B – the proximal neck at the common iliac artery is longer than 1.5 cm, but the distal neck is shorter than 1.5 cm (from the internal iliac artery) (fig. 3).

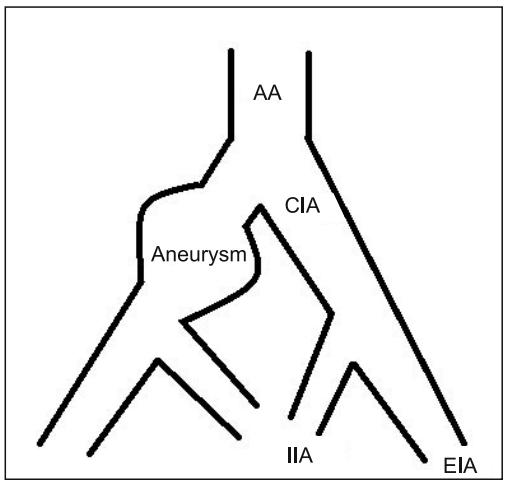

Fig. 3. Type B. AA – the abdominal aorta, CIA – the common iliac artery, IIA – the internal iliac artery, EIA – the external iliac artery.

Type C – the proximal and the distal neck exceeds 1.5 cm in length (fig. 4).

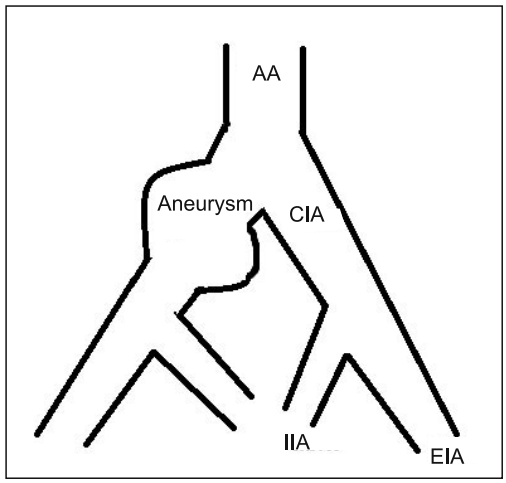

Fig. 4. Type C. AA – the abdominal aorta, CIA – the common iliac artery, IIA – the internal iliac artery, EIA – the external iliac artery.

Type D – isolated aneurysm of the internal iliac artery, which does not reach the common iliac artery (proximal segment of the internal iliac artery of at least 1 cm) (fig. 5)

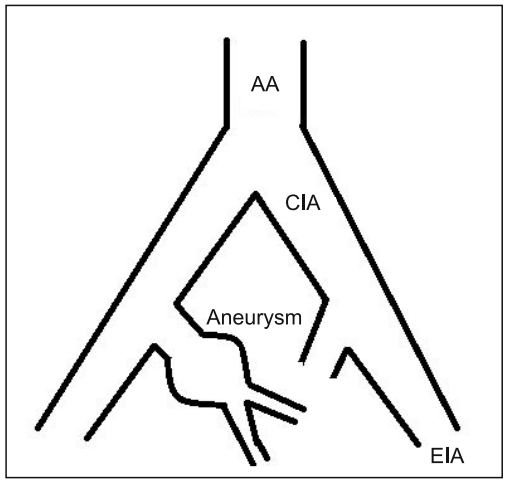

Fig. 5. Type D. AA – the abdominal aorta, CIA – the common iliac artery, IIA – the internal iliac artery, EIA – the external iliac artery.

Type E – aneurysm of the common iliac artery reaching the internal iliac artery (fig. 6).

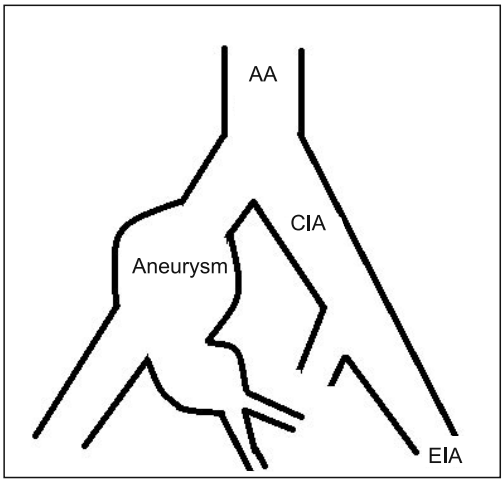

Fig. 6. Type E. AA – the abdominal aorta, CIA – the common iliac artery, IIA – the internal iliac artery, EIA – the external iliac artery.

TREATMENT (6, 7, 9)

Conservative treatment

Pharmacological treatment mainly relates to the inflammatory aneurysms. Similarly to the inflammatory aneurysms of the aorta, steroids, antibiotics and anti-inflammatory drugs are used.

Statins, non-steroidal anti-inflammatory drugs, doxycycline, beta-blockers are the drugs, which inhibit growth of the aneurysms. Beta-blockers are recommended in patients with the thoracic aortic aneurysm and in aneurysms related to Marfan syndrome. These drugs may lead to slowing down the progress of the lesions, but they cannot inhibit the growth. During treatment, it is recommended to monitor effects of the therapy by repeated ultrasound examinations, and biochemical evaluation of the blood: ESR, leukocytosis, and CRP. There are no uniform recommendations related to recommended drugs and treatment duration. There are also no publications regarding long-term treatment effects. Available publications do not include any randomized studies. Reports from the single centers usually refer to small number of patients.

Studies published in 2010 demonstrated accelerated growth of the aneurysms after using ACE inhibitors.

This variety of many pharmacological options obviously confirms comprehensive and unclear pathophysiology of the aneurysm wall (5, 6, 8).

Surgical treatment may be divided into two groups:

1. Classical surgical procedures – used less and less often due to higher risk of complications. It is reserved for cases with complications and for large aneurysms. Cases of IAA with complications include cases associated with massive atherosclerosis of the iliac arteries, which makes intravascular treatment impossible, and ruptured aneurysms in patients with shock.

2. Intravascular procedures

Indications for surgical treatment include IAA measuring over 3.5 cm in diameter and so-called symptomatic aneurysms. Absolute contraindications to surgical treatment of the aneurysm include: no consent of the patient, hemorrhagic diathesis and massive inflammatory condition in the groins.

Relative contraindications include: allergy to contrast medium, massive atherosclerotic lesions in the iliac and femoral vessels.

Purpose of the surgical treatment is to eliminate the aneurysm from circulation. Therapeutic options depend on the aneurysm anatomy. There are the following factors determining the method of the aneurysm treatment:

- length of the proximal and distal part of the aneurysm (landing zones) – minimum length is 1.5 cm
- simultaneous involvement of the internal iliac artery
- bilateral presence of aneurysms
- presence of the abdominal aortic aneurysm.

For intravascular procedures we use self-expanding and balloon-expandable iliac stent grafts. Stent grafts intended for AAA treatment or for extending branches of stent grafts in AAA treatment may also be used.

Some of IAA may be treated with embolization. Various types of coils may be used for this purpose, as well as Amplatzer system, and thrombin solution (2, 6-9, 11).

Techniques of IAA treatment depend on its anatomic type.

Type A (fig. 7).

In order to prevent leakage from the internal iliac artery, embolization of this artery should be performed first, and then bifurcated stent graft for the aortic aneurysm with extension of the branch to the external iliac

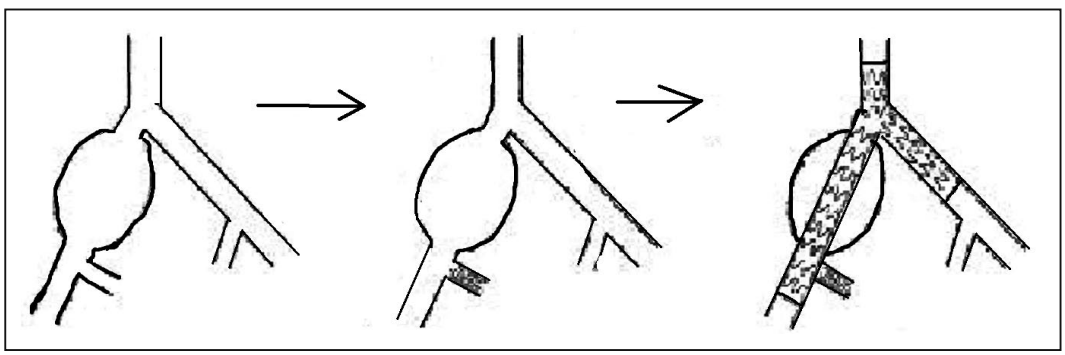

Fig. 7. Treatment of type A.

artery should be implanted. Also bilateral aneurysms of the common iliac arteries may be treated with this method.

Type B (fig. 8).

The initial segment of the internal iliac artery should be closed, and then the covered stent should be inserted into the aneurysm, and it should end in the external iliac artery.

Type C (fig. 9).

In this type of aneurysm, there are segments of healthy artery above and below the aneurysm, which are measuring over 1.5 cm in length, so in order to eliminate the aneurysm, the stent graft is sufficient. Other possible option of treatment includes the aneurysm embolization and performing femoro-femoral suprapubic crossover bypass.

Type D (fig. 10).

Embolization of the distal branches of the aneurysm should be performed, and then the originating site of the internal iliac artery should be closed.

Type E (fig. 11).

Embolization of the distal branches should be performed the same way as in type D. Then, the common iliac artery aneurysm should be eliminated with the stent graft. If the aneurysm reaches the aortic bifurcation, the bifurcated graft should be implanted (7-9).

Results of IAA treatment are good, mortality rates range from (0 to 5.5%) and mainly depend on the patient's general condition and coexisting diseases.

The most frequent complications include: leakages, bending or closure of the graft, buttock claudication, local complications in the groin (access-site), and peripheral embolism.

Ischemia in the last segment of the large intestine is an important complication. According to literature, it occurs in 0.5-2% of cases. Risk of occurrence of this complication is higher if bilateral implantation of the branches of the stent graft in the external iliac arteries is necessary. The most often, this is transient complication.

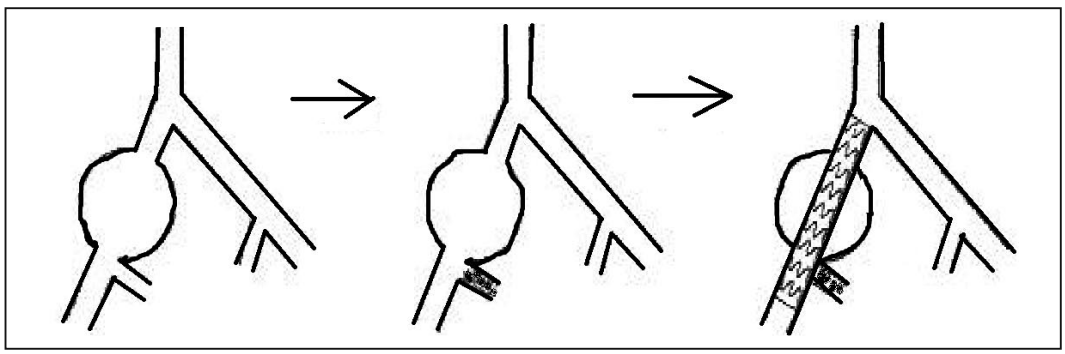

Fig. 8. Treatment of type B.

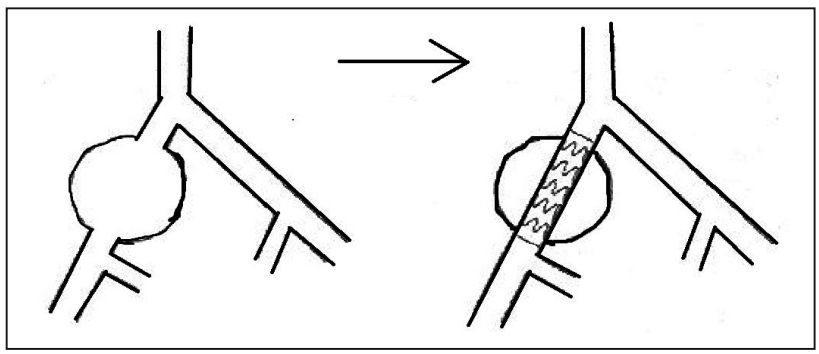

Fig. 9. Treatment of type C.

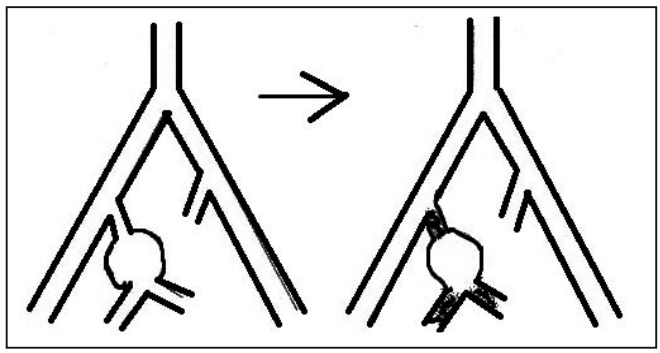

Fig. 10. Treatment of type D.

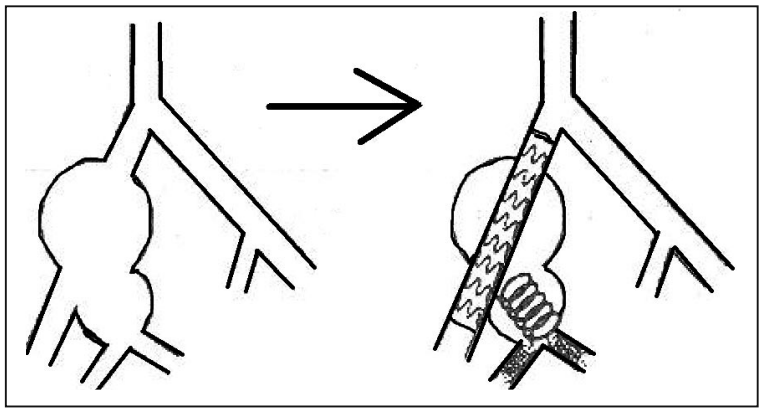

Fig. 11. Treatment of type E.

Control check-ups depend on the centers performing these procedures. In general, it is recommended to perform ultrasound evaluation every 3-6 months and the abdominal CT-scan once a year. If alarming symptoms begin to occur in patient or the aneurysm is growing larger, the CT-scan should be performed earlier. The aneurysm grown over 5 mm is significant and it requires future intervention.

Other method of the patient observation includes only ultrasound evaluation and after finding pathology within the aneurysm, performing CT-scan is indicated. It is a method recommended in patients with renal failure (7-9, 11).

PURPOSE OF THE PAPER

Purpose of the paper is to present current knowledge about aneurysms and results in treatment of the iliac artery aneurysms in patients treated in the Clinic of Vascular Surgery of Medical Centre for Postgraduate Education in 2002-2011.

MATERIAL AND METHODS

Two group of patients with the iliac artery aneurysms treated at the Clinic in 2002-2006 and in 2007-2011 were compared. The following (variable) factors were taken into consideration: type of procedure, period of hospitalization, "large" and "small" complications. The results were statistically compared.

RESULTS

The patients were divided into two groups. The first group included patients treated at the clinic in 2002--2006, and the second group included patients treated in 2007-2011. Evaluation considered the following variables: period of hospitalization, "large" complications (death, myocardial infarction, cerebral stroke, amputation) and "small" complications (wound suppuration, ischemia in the limb, lymphorrhage, edema of the limb, hematoma).

The first group included 22 patients, and the second group included 25 patients. All patients in the first group were surgically treated with classical methods, and in the second group, 3 patients were surgically treated with classical methods, and remaining ones were treated with endovascular method.

Group 1 (n-22) (tab. 2).

Table 2. Group 1 – patients treated in 2002-2006.

Hospitalization period	"Large" complications	"Small" complications
12 days (10-37)	amputation 1	wound suppuration 3
	stroke 1	ischemia of the limb 1
	death 1	lymphorrhage 1
	myocardial infarction 1	edema 1
Total	4	6

Group 2 (n-25) (tab. 3).

Table 3. Group 2 – patients treated in 2007-2011.

Classic procedures n-3			Endovascular procedures n-22		
Hospitalization period 14 days (5-29)	"Large" complications	"Small" complications	Hospitalization period 5 days (4-9)	"Large" complications	"Small" complications
	amputation 1	wound suppuration 1		stroke 1	ischemia 1
					hematoma 2
Total	1	1		1	3

Comparison of the patients treated with classical and endovascular methods (tab. 4).

Table 4. The patients treated with classical and endovascular methods.

	Group 1	Group 2
Hospitalization period	12	5
"Large" complications	4	1
"Small" complications	6	3
Mortality	1	0

Results explicitly indicate obvious benefits resulted from use of the endovascular techniques in surgical treatment of the iliac artery aneurysms. Decrease in mortality rate was established (chi-square test, $p < 0.01$). There were four-fold decrease of "large" complications (chi-square test, $p < 0.01$) and two-fold decrease of "small" complications (chi-square test, $p < 0.01$). In addition, radical shortening of average period of hospitalization, from 12 days to 5 days, was established, $p < 0.01$.

CONCLUSIONS

The iliac artery aneurysms occur as often as the aortic aneurysms and they are underestimated problem even among vascular surgeons. There is no explicit studies related to pathophysiology and development of the disease. The most frequent complications include compressions and involvement of surrounding organs, especially the ureters, in the disease process, as well as ruptures, which are life-threatening. The most often, the diagnosis is accidental during ultrasound evaluation of the abdominal cavity and the urinary system or other diseases of the vascular system. Modern treatment methods, not only classic, but also endovascular, are effective and they allow avoiding dangerous complications.

Endovascular procedures significantly improve early treatment results of the iliac artery aneurysms. They relate to lower mortality rates and lower risk of "large" complications. They significantly shorten period of hospitalization of the patients. In our Clinic, further studies are conducted related to the iliac artery aneurysms. They are focused on evaluation of long-term effects of treatment and on the aneurysm condition following endovascular treatment.

BIBLIOGRAPHY

1. Bochenek, Reicher: Anatomia Człowieka. Tom III. 1993; p. 294-318.
2. Noszczyk W: Chirurgia tętnic i żył obwodowych. Wyd. II, Wydawnictwo Lekarskie PZWL 2007.
3. Gredmark-Russ S: Active cytomegalovirus infection in aortic smooth muscle cells from patients with abdominal aortic aneurysm. J Mol Med 2009; 87: 347-356.
4. Tromp G: Elevated Expresion of Matrix Metalloproteinase +13 in Abdominal Aortic Aneurysm. Ann Vasc Surg 2004;18: 414-420.
5. Bergqvist D: Pharmacological Interventions to Attenuate the Expansion of Abdominal Aortic Aneurysm (AAA) – systemic review. Eur J Vasc Endovasc Surg 2011; 41, 663-667.
6. Hirsch A, Haskal Z, Hertzer N et al.: ACC/AHA Guidelines for Manegment of PAD. JACC 2006; 20, 10.
7. Uberoi R: Standard of Practise for Interventional Managment of Isolated Iliac Artery Aneurysms. Cardiovasc. Intervent Radiol 2011; 34: 3-13.
8. Dix FP, Al-Khaffaf MTH: The Isolated Internal Iliac Artery Aneurysm – a review. Eur J Vasc Endovasc Surg 2005; 30, 119-129.
9. Sakamoto I, Sueyoshi E, Hazama S et al.: Endovascular Treatment of Iliac Artery Aneurysms. RadioGraphics 2005; 25: S213-S227.
10. Eugster T, Bolli M, Pfeiffer T et al.: The incidence of iliac aneurysms in patients with abdominal aortic aneurysms: comparison of four centers in Europe and the USA. VASA 2004; 33, 2: 68-71.
11. Fahrni M, Lachat MM, Wildermuth S, Pfammatter T: Endovascular therapeutic options for isolated iliac aneurysms with a working classification. Cardiovasc Intervent Radiol 2003; 26(5): 443-7.
12. Päivänsalo MJ, Merikanto J, Jerkkola T: Effect of hypertension and risk factors on diameters of abdominal aorta and common iliac and femoral arteries in middle-aged hypertensive and control subjects: a cross-sectional systematic study with duplex ultrasound. Atherosclerosis 2000; 153(1): 99-106.

received/otrzymano: 14.05.2012
accepted/zaakceptowano: 11.06.2012

Address/adres:
*Bartosz Pacewski
Department of Vascular Surgery and Angiology
Medical Centre for Postgraduate Education
The Jerzy Popiełuszko Memorial Bielański Hospital
ul. Cegłowska 80, 01-809 Warszawa
tel.: +48 (22) 569-02-85
e-mail: barpac@gazeta.pl