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The choice of management of popliteal artery aneurysms

Wybór postępowania w tętniakach tętnic podkolanowych

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Summary

Popliteal artery aneurysms always constitute a diagnostic and a therapeutic problem. The authors have analysed the literature published since 2000 and 24 cases of popliteal artery aneurysms treated at the Department of Vascular Surgery and Angiology of the Medical Centre for Postgraduate Education. Diagnosis is based on medical history, physical examination and ultrasound evaluation. Ultrasound evaluation is also useful to qualify the patients for emergency surgery and for monitoring in order to observe a growing aneurysm. Computed tomography arteriography and magnetic resonance imaging are used for selection of an optimal method of an elective surgery. Treatment of aneurysms (depending on their size and symptoms) is based on a classic surgery or intravascular treatment. The decision of the type of treatment should definitely include the surgeon's experience. A similar diagnostic and therapeutic procedure was used at the Department of Vascular Surgery and Angiology of the Medical Centre for Postgraduate Education. Treatment outcome in popliteal artery aneurysms is quite good. Prognosis in treatment of complicated popliteal artery aneurysms is uncertain.

Key words: popliteal artery, aneurysm, diagnostics and treatment

Streszczenie

Tętniaki tętnic podkolanowych cały czas stanowią problem diagnostyczny i terapeutyczny. Autorzy przeanalizowali piśmiennictwo od 2000 roku oraz 24 przypadki leczonych w Klinice Chirurgii Naczyniowej i Angiologii CMKP, tętniaków tętnic podkolanowych. Rozpoznanie opiera się na wywiadzie, badaniu przedmiotowym i badaniu ultrasonograficznym. Badanie USG jest także przydatne w kwalifikacji do pilnej operacji i monitorowaniu powiększania się tętniaka. Badania arteriografii tomografii komputerowej i rezonansu magnetycznego stosowane są do wyboru optymalnego zabiegu planowego. Leczenie tętniaków (w zależności od rozmiarów i objawów) opiera się na klasycznej operacji lub leczeniu wewnątrznaczyniowym. Decyzja o rodzaju zabiegu powinna uwzględnić doświadczenie chirurga.

Podobne postępowanie diagnostyczno-terapeutyczne było stosowane w Klinice Chirurgii Naczyniowej i Angiologii CMKP. Wyniki leczenia tętniaków tętnicy podkolanowej są dość dobre. Rokowanie w leczeniu powikłanych tętniaków.

Słowa kluczowe: tętnica podkolanowa, tętniak, diagnostyka i leczenie

INTRODUCTION

Popliteal artery aneurysms constitute the largest group of aneurysms in vessels of the lower limbs. Dilatation of the artery by 50% comparing to a diameter of the artery above and below the dilatation is defined as aneurysms and due to possible occurrence of severe complications, it should not be underestimated (1, 2). In differential diagnosis, a popliteal cyst (Baker's cyst) and dilatation of the venous system within the peroneal vein should be mainly considered (3, 4).

Popliteal artery aneurysms may occur unilaterally and bilaterally and they may coexist with other aneurysms, e.g. aortic aneurysms, iliac aneurysms and femoral aneurysms (5). Sometimes, there are multiple aneurysms, which are the form of so-called elastopa-

thy – dilations and expansions in many locations in the arteries. A cause of aneurysm formation has not been fully explained.

AIM OF THE STUDY

Based on review of literature and own experience, the authors established a few goals regarding diagnosis and treatment of popliteal artery aneurysms:

1. Establishing suitability of the diagnostic methods in diagnosing and detecting popliteal artery aneurysms,
2. Selection of a surgical method: classical or endovascular,
3. Evaluation of outcome in the respective treatment methods.

MATERIAL, METHODS AND RESULT OF A STUDY

The articles published in Polish and foreign medical journals since 2000, dedicated to symptoms, diagnostics, diagnosis and treatment of popliteal artery aneurysms were analysed. The authors of this article also analysed 24 cases of popliteal artery aneurysms in 18 patients treated at the Department of Vascular Surgery and Angiology of the Medical Centre for Postgraduate Education. In 6 patients, popliteal artery aneurysms occurred bilaterally (33.3%).

SYMPTOMS

Popliteal artery aneurysms may be asymptomatic, they may be detected by accident and they may manifest various symptoms ("symptomatic" aneurysms) (6).

The most common symptom of a chronic popliteal artery aneurysm established by the patient included growing tumour in the popliteal fossa, sometimes this tumour was pulsating in nature and accompanied by discomfort within the area of this limb. The second most common symptom in course of a popliteal artery aneurysm is intermittent claudication of varied intensity. Relatively common symptoms include peripheral oedema of the limb, digital cyanosis ("blue digit syndrome"), paresthesia and other disturbances of skin sensation, and a deep vein thrombosis of the shank. Persistent and intensive pain in the knee region occurs rarely. Severe and sudden pain may occur in case of the aneurysm rupture, which occurs rarely (a few percent) (7).

Ischemia of distal parts of the foot, digits, which may lead to necrosis, may be caused by embolization of a popliteal artery aneurysm (8). Symptoms of an acute ischemia of the lower limb (shank) result from thrombosis in the aneurysm, and they may characterise with quite peracute course (9).

Majority of the patients in the group treated at the Clinic revealed a pulsating tumour in the popliteal fossa (83.3%), exacerbation of intermittent claudication symptoms (66.7%), symptoms of an acute ischemia of the limb (33.3%) and a blue digit syndrome (27.8%).

DIAGNOSTICS

Asymptomatic popliteal artery aneurysms are the most frequently established by accident, mainly during ultrasound screening evaluations or during evaluations of other structures of the knee. Also during an interview and a physical examination it is possible to obtain information suggesting possible presence of popliteal artery aneurysms. The interview provides us with data regarding occurrence of aforementioned symptoms. Many times during examination, the protrusion in the popliteal fossa is established, sometimes with noticeable pulsation in this area. In palpation, a pulsating, and practically painless tumour is established. It is also possible to evaluate progress of the potential ischemia of the limb, condition of the venous system, oedema and

cyanosis of the digits (10). It encourages performing additional examinations, mainly ultrasound evaluation. In case of asymptomatic and symptomatic popliteal artery aneurysm, the ultrasound evaluation with colour imaging is the basic and generally available method of evaluation. Ultrasound evaluation is a quite precise method, especially if performed by an experienced physician, who knows the vascular pathology well. It is possible to evaluate size, shape and wall of the aneurysm, and to evaluate thickness and appearance of the thrombus inside of the aneurysm sac, blood flow in the aneurysm, as well as in the arteries above and below the aneurysm, and the ones branching off the aneurysm sac, and to evaluate lesions in the venous system (pressure on the veins caused by the aneurysm, and thrombotic lesions in the veins).

Newer and more precise studies to evaluate aneurysms include a computed tomography and a magnetic resonance with possible angiogram (CTA). These evaluations are helpful in planning surgical tactics, especially in case of endovascular treatment (11,12). However, these evaluations are less available and significantly more expensive than ultrasound evaluations.

Classical arteriography and subtraction arteriography are currently reserved to be performed during surgical procedure (13, 14).

In analyzed group of patients, who were hospitalized at Department of Vascular Surgery and Angiology, ultrasound evaluation was performed in all of them. Based on ultrasound evaluation, 12 aneurysms in 10 patients were qualified for treatment. These patients were at risk of loss of the limb due to thrombosis of the aneurysm and acute ischemia of the limb or exacerbation and critical ischemia of the limb. In other patients (12 aneurysms in 8 persons), an additional CTA evaluation was performed. These patients did not require an immediate treatment.

TREATMENT

Therapeutic management in popliteal artery aneurysms depends on symptoms, which may occur within a course of a disease (15). If acute complications occur, such as acute ischemia of the lower limb, it is necessary to start treatment immediately (16). **Acute ischemia in popliteal artery aneurysms is caused by thrombosis of the aneurysm or embolism of the shank arteries and rarely by its rupture** (17, 18). It creates a risk of necrosis and loss of the limb.

In case of a thrombosis and an acute ischemia, if the patient is stable in terms of circulation and respiration, the treatment may start from an attempt to restore patency of the artery with thrombolytic treatment (19, 20). Such medicines as streptokinase, urokinase, tissue plasminogen activator or recombinant plasminogen activator administered intravenously by an infusion pump may be used generally or – which is recommended – locally, using an intra-arterial route through a special catheters. In case of intra-arterial local treatment, it is

required to be able to place such catheter and it should be possible to monitor progress of therapy (ultrasound evaluation, control arteriograms). Such therapy should be conducted in specialist vascular centre. In such case, small doses of thrombolytic drug are administered (mainly recombinant plasminogen activator), which allow avoiding or reducing the number of possible complications of thrombolysis, especially bleeding. Restoring patency of the vessels with thrombolytic treatment may instantly protect the limb against amputation and by restoring microcirculation – improve prognosis after unavoidable surgical treatment. In case of no beneficial effect of the therapy, it is necessary to perform surgical treatment.

Thrombolytic treatment may also be used in embolized popliteal artery aneurysm and in the blue digit syndrome in patients, whose limb is not at direct risk of necrosis.

If we diagnose the aneurysm rupture, it is necessary to perform an emergency surgical treatment (18, 21, 22). In such cases, the classical surgery is performed, which includes ligation of the aneurysm and bypass graft or implantation of the graft into the aneurysm sac. Own vein of the patient, the most frequently the saphenous vein, or the vascular prosthesis made of artificial material are used as grafts (23). Recently, the articles have been published, which were dedicated to endovascular treatment of ruptured popliteal artery aneurysms, but the outcomes are not fully satisfying.

Surgical treatment

If the patient does not require an emergency surgery due to complicated aneurysm, tactics of therapeutic management may be considered and an optimum method of surgical treatment may be selected. Evaluation has to include size of an aneurysm and progression of the aneurysm grow, as well as atherosclerotic lesions accompanying the aneurysm, establishing which arteries are branching off within a changed wall of the aneurysm and what possible consequences may occur as a result of their “elimination” (24-27). The structures surrounding the aneurysm, especially including a venous and a muscular system, should also be evaluated. Mechanics of the knee joint is also important (12, 28, 29). After analysis of aforementioned factors, the patient is qualified for suitable surgical method of treatment. Selecting a type of classical surgery mainly depends on the operator’s experience (fig. 1). Advantage of a bypass graft surgery includes easier surgical approach, but bypass graft lengthens blood flow route and causes possibility of more frequent exposure to injuries and bending of the implant (the implant is placed under the skin at medial side of the knee). It is also necessary to ligate the aneurysm, i.e. to close its inflow and outflow, but the aneurysm stays in place. Advantage of implant placement into the aneurysm sac includes reconstruction of a “physiological” blood flow route and possibility of implantation of patent bypasses going from the aneurysm to the graft. The aneurysm

is almost totally removed, as well as the thrombus inside. This type of surgery is burdened with higher number of complications, and surgical approach is difficult (30-35).



Fig. 1. Popliteal artery aneurysm.

Classical surgical treatment of popliteal artery aneurysms includes a radical treatment method, which permanently eliminates an aneurysm from circulation.

In a period of dynamically developing techniques of endovascular treatment of peripheral artery diseases, they also became used in treatment of popliteal artery aneurysms. **Used methods include stenting or implanting covered stents intended for popliteal artery aneurysms (36-44). These methods are significantly less invasive than a classical surgery, but they are not free from disadvantages.** Stents may migrate, undergo destruction and break as well as occlude. These complications are frequently connected with physiological mechanics of the knee joint, and its mobility. Besides, the aneurysm practically stays unchanged, and only physiological blood flow through the aneurysm is reconstructed. Endovascular imaging of lesions allows evaluating the vascular wall; it is difficult to establish whether the areas above and below the lesion are involved in the disease. An advantage of endovascular procedures is possibility to repair other lesions in the lower limb arteries during the same procedure, e.g. atherosclerotic stenoses of the arteries of the shank. Studies on the new stents, their flexibility, and durability provide hope that treatment of complications following endovascular surgeries performed in popliteal artery aneurysms will occur less and less frequently.

In the group of patients treated at the Department of Vascular Surgery and Angiology, 12 patients were admitted within the emergency duty due to symptoms of an acute ischemia at the lower limb. After performing ultrasound evaluation, 6 patients underwent emergency surgery. 4 patients were treated with femoropopliteal bypass graft and with the aneurysm ligation, and 2 other patients – with femoropopliteal bypass graft of “end-to-end” type to the aneurysm sac with removal of the thrombus and reduction of the aneurysm wall. Peripheral arteries were controlled in all patients, and embolic material or thrombus was removed

in 5 of them. In all cases, the lower limb was saved in emergency procedure. In case of remaining 6 patients, thrombolytic treatment was initiated at the beginning of therapy. Two patients received streptokinase in intravenous infusions through the infusion pump, and the remaining 4 – were treated with placement of the intra-arterial catheter and local administration of recombinant plasminogen activator. In all cases, the clinical improvement was achieved, but in 1 patient, repeated acute ischemia of the limb occurred after streptokinase administration and it was caused by embolism with the thrombus coming from the aneurysm, so an emergency surgery was performed in order to place a bypass graft. As a result of postoperative complications, necrosis of the limb developed and later, it was necessary to perform amputation of the limb at the level of the thigh.

Out of remaining 12 cases of popliteal artery aneurysms (5 – in patients with former emergency surgery of the aneurysm in the other lower limb and 1- with bilateral popliteal artery aneurysm previously untreated) – 7 underwent a classical surgery (5 bypass grafts and 2 – grafts implanted into the aneurysm sac), and 5 – underwent endovascular procedures. All procedures resulted in good immediate outcome and patients were discharged from the hospital. Covered stents were implanted in 3 cases of the patients undergoing endovascular procedures, and in 2 cases, stents without prosthesis were implanted. These patients underwent observation lasting from 2 up to 12 months and no alarming symptoms were established in these cases, and stent locations and blood flows were normal.

DISCUSSION

The first mentions about pulsating tumour in the popliteal fossa may be found in studies performed in 200 B.C. by Antyllus, one of remarkable antique surgeons, (45, 46). He described relationship between injury in the popliteal region and development of a popliteal artery aneurysm; and he also described a method of removal and ligation of the aneurysm. In 1657, French, Jean Viger, described ligation of an aneurysm without its removal. In the forties of 18th century, a French military surgeon, Pierre Keisleyre, described surgeries in 4 patients with a popliteal artery aneurysm. Similar surgeries were performed by excellent surgeons, Pierre-Joseph Desault and John Hunter (proximal ligation of an aneurysm), which took place in the eighties of 18th century. The beginning of the 20th century provided the first obliterations of popliteal artery aneurysms (Matas – 1903) and venous transplant following an aneurysm removal – 1906, Jose Goyanes. Since 1969, when WS. Edwards described a procedure technique for the removal of a popliteal artery aneurysm and venous bypass graft, modern era of surgical treatment of these aneurysm has begun (45, 47). In the eighties of 20th century, a role of thrombolysis in the thrombus of a popliteal artery aneurysm and acute ischemia of the lower limb was described (1084- H. Berkowitz and W. Schwartz) (45). The nineties included development of an endo-

vascular treatment method and insertion of stents and stent-grafts within the course of treatment of popliteal artery aneurysms (1994 – ML. Marin et al.) (46).

Popliteal artery aneurysms are the most common aneurysms of the peripheral arteries. They constitute 70-80% of all peripheral aneurysms, but they constitute only 0.1 to 2.8% of all aneurysms. The aneurysm is diagnosed if its diameter exceeds a diameter of a given vessel by 50%. The popliteal artery is measuring 5-9 mm in diameter on average, but it is assumed that the aneurysm is diagnosed if a diameter is at least 1.5 cm. Depending on authors, so-called “small” popliteal artery aneurysm is measuring up to 2-2.5 cm in diameter. Symptoms and complications are significantly less common in case of aneurysms of smaller size than they are in case of aneurysms with larger diameters (48-50).

Popliteal artery aneurysms are significantly more common in males; various studies revealed that their incidence in males is 20 and 40 fold higher comparing to females. These aneurysms are the most frequently diagnosed in 55-80 years of age. They frequently accompany an aortic aneurysm (a few – more than ten) (51), and if a primary popliteal artery aneurysm is diagnosed, approximately half of the patients suffer from an aortic aneurysm as well. Bilateral popliteal artery aneurysms occur in 30-70% of the patients (depending on the study).

In analyzed group of 18 persons, bilateral popliteal artery aneurysms occurred in 6 patients (33.3%), an abdominal aortic aneurysm coexisted in 8 patients (44.45%) and all of these patients were males above 60 years of age (63-88 years of age).

Factors leading to development of popliteal artery aneurysms are not fully known. An attention is paid to coexistence with a peripheral atherosclerosis (in up to 50% of cases) (52, 53) and corresponding increased peripheral resistance leading to increased pressure in the popliteal artery, turbulent blood flow and the vascular wall destruction, mainly in structure of proteins, and influence of local proteolytic enzymes. A substantial role is played by mechanical micro injuries related to repetitive flexion function and mobility of the knee joint (29). Genetic background for aneurysm formation has not been proven so far. In the past, popliteal artery aneurysms were caused by infections, mainly mycotic infection and syphilis (18, 27) as well as massive injuries of the knee joint area.

Importance of the problem of popliteal artery aneurysms is determined by the fact that complications would be extremely dangerous and they frequently relate to risk of the lower limb loss. It is influenced by various factors, including anatomical ones (54-59). The popliteal artery is a single artery, which constitutes a direct extension of the femoral artery; its collateral circulation is very limited and its location determines constant exposure to pressure, stretching, and micro-injuries by surrounding structures. Closing the lumen of the vessel causes fast-progressing and severe lesions in distal part of the lower limb, including necrosis.

The main evaluation in diagnostics of popliteal artery aneurysms is ultrasound with Doppler and colour imaging (Colour Duplex-Doppler). It is easily available and cheap method. It is a base for diagnosis, monitoring and evaluation of a course of the aneurysm development; it is also very useful as a method for qualifying patients for emergency surgery in complicated popliteal artery aneurysms and imminent necrosis of the limb. Subtraction arteriography is mainly useful during endovascular procedures. Computed tomography angiography and magnetic resonance angiography are practically reserved for planning postponed or elective surgery of popliteal artery aneurysms.

Treatment of asymptomatic popliteal artery aneurysm includes surgery. Aneurysms measuring over 2.5 cm in diameter and aneurysms, which are symptomatic, are qualified for a surgical procedure. Smaller asymptomatic aneurysms should be observed and monitored using ultrasound evaluation performed every few months (50, 60, 61). Indications for surgical treatment also include progression in the aneurysm growth, which exceeds 0.7 cm in diameter annually.

In surgical treatment, not only classical surgical procedures, but also intravascular procedures are used (62-65). Classical surgical treatment is based on "exclusion" of the aneurysm and bypass graft or implantation of the graft into the aneurysm sac (the best is the patient's own vein, or alternatively, an implant made of artificial material). It is a radical method (66-69). Intravascular procedures include stent or stent-graft implantation into the popliteal artery, but the aneurysm sac together with its content remains in place (36-38, 71). Immediate outcomes are comparable. Long-term outcomes of both surgical treatment methods suggest performing classical surgery. Dynamically developing technology of stent and stent-graft production and improving techniques of endovascular procedures provide hope that endovascular treatment will soon become as effective as the classical method, or probably become the basic surgical technique in treatment of popliteal artery aneurysms.

In some cases, there are attempts to combine both surgical techniques or to place implants made of biological materials (allografts) (72, 73).

In some cases of popliteal artery aneurysms, thrombolytic treatment is used. It is administered in such complications as thrombosis in the aneurysm and in the peripheral arteries, and accompanying venous thrombosis and the blue digit syndrome.

All aforementioned treatment methods were used at the Department of Vascular Surgery and Angiology in versions adopted to specific clinical cases and coexisting symptoms. Efficacy comparable to efficacy described in literature was achieved.

The authors again emphasize complexity of pathology, diagnosis and treatment of popliteal artery aneurysms and suggest not underestimating this problem.

CONCLUSIONS

1. Ultrasound evaluation with colour imaging, performed by an experienced physician, is a good diagnostic method to diagnose popliteal artery aneurysms and to qualify them for surgical treatment.
2. CTA and MRA are very useful in establishing indications for endovascular and surgical treatment in anatomically complex cases of popliteal artery aneurysms.
3. In treatment of popliteal artery aneurysms, not only classical surgery, but also endovascular methods are used, and both methods have advantages and disadvantages.
4. Complicated aneurysms with risk of loss of the lower limb and with complications caused by endovascular treatment should be treated with classical surgical methods.
5. Within the period of development in manufacturing techniques and modernization of stents and stent-grafts, endovascular treatment may achieve superiority over a classical surgical method.
6. Outcomes of classical surgery in popliteal artery aneurysms are good, and outcomes of endovascular treatment are promising, but due to relatively short observation period and not too large groups treated with this method, it is difficult to evaluate long-term outcome.

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received/otrzymano: 14.05.2012

accepted/zaakceptowano: 11.06.2012

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