

SZUCIAK, Anna, TALAREK, Konrad, SZEWCZYK, Julia, ŚWITA, Michał, SKIERKOWSKI, Bartosz, DRELICHOWSKA, Alicja, CISZEWSKI, Przemysław, AZIERSKI, Michał and PIKOR, Damian. Effectiveness of lower limb arterial angioplasty. *Quality in Sport*. 2024;36:56801. eISSN 2450-3118.

<https://doi.org/10.12775/QS.2024.36.56801>

<https://apcz.umk.pl/QS/article/view/56801>

The journal has been 20 points in the Ministry of Higher Education and Science of Poland parametric evaluation. Annex to the announcement of the Minister of Higher Education and Science of 05.01.2024. No. 32553.

Has a Journal's Unique Identifier: 201398. Scientific disciplines assigned: Economics and finance (Field of social sciences); Management and Quality Sciences (Field of social sciences).

Punkty Ministerialne z 2019 - aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 r. Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398.

Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych).

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The authors declare that there is no conflict of interests regarding the publication of this paper.

Received: 08.12.2024. Revised: 19.12.2024. Accepted: 19.12.2024. Published: 20.12.2024.

## **Effectiveness of lower limb arterial angioplasty**

### **Anna Szuciak**

Medical University of Lublin,

Aleje Raławickie 1, 20-059 Lublin, Poland

medann990@gmail.com

<https://orcid.org/0009-0002-0754-6682>

### **Konrad Talarek**

Medical University of Lublin,

Aleje Raławickie 1, 20-059 Lublin, Poland

konradtalarek18@gmail.com

<https://orcid.org/0009-0008-6501-168X>

### **Julia Szewczyk**

Medical University of Lublin,

Aleje Raławickie 1, 20-059 Lublin, Poland

julia.szewczyk028@gmail.com

<https://orcid.org/0009-0008-5108-3172>

**Michał Świta**

Medical University of Lublin,  
Aleje Raławickie 1, 20-059 Lublin, Poland  
michal.swita10@gmail.com  
<https://orcid.org/0009-0007-8426-9224>

**Bartosz Skierkowski**

Medical University of Lublin,  
Aleje Raławickie 1, 20-059 Lublin, Poland  
skierabartek@gmail.com  
<https://orcid.org/0009-0001-1353-4736>

**Alicja Drelichowska**

Medical University of Silesia in Katowice, Poland  
ul. Medyków 18, 40-752 Katowice  
drelichowskaalicja@gmail.com  
<https://orcid.org/0009-0000-6901-9269>

**Przemysław Ciszewski**

Medical University of Silesia in Katowice, Poland  
ul. Medyków 18, 40-752 Katowice  
pciszewski2001@gmail.com  
<https://orcid.org/0009-0004-6579-3256>

**Michał Azierski**

Medical University of Silesia in Katowice, Poland  
ul. Medyków 18, 40-752 Katowice  
michal.azierski@gmail.com  
<https://orcid.org/0009-0009-7247-2086>

**Damian Pikor**

Poznan University of Medical Sciences, Poland  
ul. Przybyszewskiego 49, 61-701 Poznan  
damianpikormed@gmail.com

## **Abstract**

**Introduction:** Over 200 million individuals worldwide suffer with peripheral artery disease (PAD). The disease makes it difficult to function properly by limiting walking and physical activity, which also translates into a reduced quality of life.

**Purpose of the Study:** The purpose of this review is to evaluate the effectiveness of lower limb angioplasty as a treatment to restore arterial patency, improve the patient's quality of life and reduce complications.

**Methodology:** A comprehensive search of databases was conducted from 2016, using PubMed, Scopus and Google Scholar, using keywords such as "angioplasty", "peripheral artery disease", "revascularization", "endovascular intervention", "atherosclerosis, "quality of life".

**Results:** Angioplasty and bypass surgery showed comparable amputation-free survival at two years, though bypass surgery improved overall survival by approximately seven months. Bypass surgery had significantly higher rates of infection compared to angioplasty, leading to increased hospital stays and associated costs. Socioeconomic status significantly influenced outcomes, with lower status relating to higher amputation rates. No significant superiority was observed between bypass surgery and angioplasty in many studies, though treatment choice should be guided by patient condition.

**Conclusions:** Angioplasty is a safe and effective way to treat PAD can help alleviate the growing global burden of the disease and reduce bed occupancy and improve productivity.

**Keywords:** angioplasty, peripheral artery disease, revascularization, endovascular intervention, atherosclerosis, quality of life.

## **Introduction**

Peripheral artery disease (PAD) is the term for occlusive disease of the arteries of the lower extremities that arises from atherosclerosis [1]. It specifically refers to atherosclerotic lesions occurring from the aortoiliac segments to the arteries of the foot. PAD contributes to difficulty walking and reduces physical activity. It can manifest as intermittent claudication (IC) or abnormal exercise-induced leg pain. Its complications include acute limb ischemia (ALI), critical limb ischemia (CLI), and lower limb amputation. ALI manifests as pain, pallor, paresthesias, and paralysis, while CLI is characterized by chronic ischemic rest pain, gangrene, and non-healing ulcers [2,3]. There is evidence to suggest that PAD is a strong predictor of the occurrence of myocardial infarction or stroke [2]. The global prevalence of PAD is more than 200 million people. Between 2000 and 2010, the prevalence increased by 23.5%. An important risk factor is age. Between 12% and 20% of Americans aged 60 and older suffer from PAD, and as many as 50% of Americans aged 85 and older [1]. In a 2004 prospective German epidemiological study (n=6880, mean age: 72.5 years), PAD was detected in 19.8% of male patients and 16.8% of female patients. In addition, PAD sufferers were characterized by comorbidity (diabetes, dyslipidemias, hypertension, other symptoms of atherosclerotic disease) [4]. PAD represents a significant medical and economic burden worldwide. Its treatment uses a multidirectional approach. These can be divided into: lifestyle modifications, medical management (including pharmacotherapy), surgical treatment, and endovascular therapy (angioplasty). Despite the clinical relevance of PAD and the seriousness of its complications, relatively few studies have evaluated the efficacy of the treatment used. [4,5]. Lifestyle modification and the use of medical management are the first component of treatment, but in more severe cases that limit the patient's lifestyle, surgical treatment and endovascular interventions are the essence. According to the American Heart Association, endovascular interventions are superior to surgical treatment because they are much less invasive and have been recognized as the optimal treatment for patients with intermittent claudication [6]. This review aims to assess the effectiveness of lower extremity arterial angioplasty in improving circulation, patients' quality of life and, reducing complications.

## **Background and causes of lower extremity arterial disease**

The main cause of PAD development is atherosclerotic obstruction. Rarer causes may include vasculitis or popliteal entrapment [7]. Atherosclerotic plaque deposition in the peripheral arteries is the substrate of PAD. Atherosclerosis disrupts blood flow in the peripheral arteries, leading to impaired nutritional circulatory function, severe skeletal muscle damage and mitochondrial dysfunction in skeletal muscle. In addition to the presence of atherosclerotic plaques, oxidative stress and sometimes a high degree of inflammation were present in patients with PAD. Muscle biopsy from PAD patients showed high apoptosis of muscle cells and reduced amounts of type I fibers. In turn, mitochondrial dysfunction contributed to an increase in reactive oxygen species and vascular endothelial dysfunction [8].

Risk factors for PAD include typical cardiovascular risk factors (diabetes, smoking, hypertension, dyslipidemias). Smoking and diabetes were particularly strong in the pathogenesis of PAD, each doubling the risk of PAD. Physical inactivity may also contribute to peripheral artery disease. Elevated inflammatory markers (reactive protein C, interleukin 6) were also detected in patients with the most severe disease [2]. Age over 65 and the black race also increase the risk of PAD. Overlapping risk factors significantly increase the chances of peripheral artery disease [1].

### **Lower limb angioplasty procedure**

Balloon angioplasty is otherwise known as percutaneous transluminal angioplasty (PTA). The procedure consists of inserting a catheter with a balloon at the end into the lumen of the artery. When the balloon is at the site of the narrowed vessel, it is filled with a saline solution of NaCl with a contrast medium. This causes the artery to dilate, as a result of deliberate disruption of the vessel's inner and middle membranes. To achieve a satisfactory result of the procedure, the balloon must be inflated several times [9]. Many methods are available for endovascular treatment. These include balloon angioplasty (drug-coated or uncoated balloon), bare-metal stents, drug-eluting stents, covered stents and atherectomy. Regardless of the method used, the goal of treatment is to restore blood flow in the narrowed or blocked arteries to alleviate symptoms such as motion sickness and reduce the risk of more advanced lower extremity disease, including critical ischemia [10].

### **Advantages and disadvantages of lower limb angioplasty**

Every medical procedure has certain advantages as well as limitations. Especially when the procedure is new, meticulously evaluate the results. It compares advantages and disadvantages. It analyzes whether the procedure can be improved so that it has the best possible outcomes. Most often, new methods are quite expensive. Mainly because of new tools and equipment and

also the training of medical staff [11]. Minimally invasive procedures allow patients to recover faster, reduce pain, and shorten hospital stays [12]. It should be noted that the longer the hospital stay, the higher the cost of treatment. A significant advantage of endovascular procedures is the short hospital stay after the procedures and faster recovery time [13, 14]. Which is also combined with lower costs for the patient's overall treatment including post-operative treatment and follow-up visits. Even despite the slightly increased rate of restenosis after angioplasty, repeat revascularization still does not outweigh the cost of the overall treatment after surgical bypass (BYP). The average total cost of admission was \$27,849 for BYP and \$8758 for PTA. For PTA, the average bed stay was 3.77, whereas for BYP, it was 10.25. The cost of postoperative care is much higher for BYP due to postoperative complications and follow-up visits. However, there are also limitations to PTA. During the procedure, the patient is burdened by the administration of iodine contrast so patients with allergies or kidney failure are not qualified for this type of procedure. Often after a failed PTA, patients are more likely to choose BYP. Vascular disease more amenable to surgical intervention leads operators to choose bypass in cases of PAD [13]. Flow-limiting dissections and severely calcified lesions frequently undermine the technical success of PTA [15]. Karpińska et al. conducted a study evaluating the functional performance and quality of life after revascularization of patients with PAD including angioplasty. Demonstrated increase in somatic, psychological, social and environmental quality of life at 3 months after revascularization [16]. Patients in whom the procedure was unsuccessful, despite hemodynamic failure, patients reported improved symptoms after the procedure [16,17].

### **Effectiveness of angioplasty in the treatment of PAD**

The percentage of lower limb amputations is a crucial metric to evaluate when analyzing the efficacy of PAD treatment. This is an important factor especially by the fact that it affects the later quality of life of patients. Lower limb ischemia is a significant risk factor for amputation. Treatments that restore blood flow in the obstructed artery increase the chance of saving the limb. A study conducted by Hughes (2022) showed reduced effectiveness of treatments to restore patency of lower extremity arteries depending on the patient's socioeconomic situation. The lower the patient's socioeconomic status, the higher the rate of lower limb amputations. Findings of study suggest impact of patient condition on treatment outcomes. The type of revascularization procedure was not as important as the patient's condition [18]. Kronlage et al. in their study conducted on 425 patients undergoing angioplasty, showed overall survival and amputation-free survival rates >95% after 24 months [19].

Compared to bypass surgery, balloon angioplasty has the advantages of a shorter hospital stay and fewer short-term post interventional problems. Additionally, it has been demonstrated to have comparable overall and amputation-free survival at two years to open surgery. On long-term follow-up, amputation-free survival stayed the same, although bypass surgery with autologous venous conduit was associated with a seven-month increase in overall survival [20]. In Ngu et al.'s study, compared to PTA, the BYP group experienced a significantly higher rate of periprocedural complications for infection {n = 9 (10%) vs. n = 1 (1%), P = 0.001}. Such results may involve a longer stay in the hospital and the implementation of antibiotic therapy, which entails higher costs [13]. Percutaneous transluminal angioplasty with or without stenting (PTA/S) proponents assert that collaterals are preserved after the procedure and that unsuccessful angioplasty poses no threats to subsequent surgery. Recent evidence, on the other hand, not only contradicted this, but also showed increased rates of restenosis [14]. The risk of subsequent vascular restenosis is significant for all interventional treatments used to treat PAD in the lower limbs. Antiproliferative drug-eluting stents have begun to be used to reduce this risk. Of specific use was paclitaxel, which prevents hyperplasia of the neointimal artery membrane. The results of using Drug-eluting balloon (DEB) were promising. They did not cause stent thrombosis and provided adequate blood flow. However, DEBs are more expensive and may cause elastic recoil and long-term unfavorable vascular remodeling [20]. However, in many studies, including Scatena et al., in their study, they observed no significant superiority of a given procedure comparing bypass surgery and endovascular treatment [13, 21, 22].

The choice of the type of revascularization procedure may depend on the patient's risk, severity of the limb and anatomical complexity. Endovascular treatment is the preferred method for patients with less complex anatomy, intermediate severity limb threat, or high patient risk [21]. Endovascular procedures like PTA are ideal for patients with a variety of conditions that are contraindications to general anesthesia, as such a procedure can be performed under local anesthesia. This advantage increases the chances of overall survival and survival without lower limb amputation in these patients [13]. Adjusting the type of treatment to the patient, punctal balloon angioplasty may be particularly applicable in heavily calcified endovascular lesions of the lower extremities as a form of atraumatic vasodilation. Especially for cases with a high risk of dissection [19].

Surgical management is indicated when people develop CLI or debilitating IC that is refractory to nonoperative management [20]. Conservative treatment alone has no lasting effect. The best

results are observed with revascularization surgery and a healthy lifestyle including physical activity and no smoking [16, 23].

### **Conclusions**

Currently, the lower extremity angioplasty method uses a variety of options. The development of the technology of many studies allows to improve the given procedure. But there are also clinical cases in which bypass surgery will be a better option for the patient. Therefore, it is important to tailor the method to the individual patient's needs. Combining surgical treatment with physical activity and healthy habits allows for better treatment results. Angioplasty, thanks to its promising outcomes, is a safe and effective way to treat PAD can help alleviate the growing global burden of the disease and reduce bed occupancy and improve productivity.

### **Disclosures**

#### **Author's contribution:**

Conceptualization: Anna Szuciak, Konrad Talarek; methodology: Bartosz Skierkowski; software: Michał Świta; check: Alicja Derlichowska, Michał Azierski; formal analysis: Przemek Ciszewski, Michał Azierski; investigation: Konrad Talarek; resources: Alicja Derlichowska, Damian Pikor; data curation: Bartosz Skierkowski; writing-rough preparation: Piotr Ciszewski; writing-review and editing: Julia Szewczyk, Michał Świta, Damian Pikor; visualization: Julia Szewczyk; supervision: Anna Szuciak; project administration: Anna Szuciak, Konrad Talarek

All authors have read and agreed with the published version of the manuscript.

Funding statement: The study did not receive special funding.

Institutional review board statement: Not applicable.

Informed consent statement: Not applicable.

Data availability statement: Not applicable.

Conflict of interest: The authors declare no conflict of interest.

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