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# Limb salvage procedure in occlusion of the infrapopliteal arteries

## *Limb salvage* procedura kod okluzije arterija infrapoplitealnog segmenta

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**Abstract**

**Background/Aim.** Limb salvage is a procedure for treatment of the causes of ischemia in the peripheral arteries of the lower limbs. This procedure consists of percutaneous transluminal angioplasty (PTA) of arteries of the infrapopliteal segment in the lower limbs, endovascular stents implantation and selective intraarterial thrombolytic therapy. The main PTA principle is balloon dilatation of a blood vessel and increasing blood flow in this zone. The aim of this study was to show the validity and benefits of applying this procedure in pathologically corrupted arteries of the infrapopliteal segment. **Methods.** A prospective study included 30 patients: 15 with PTA dilatations, 13 with stents implantations and five with thrombolytic therapy. The follow-up pertiod was: immediately after the procedure, a month later, and six months later. **Results.** Of the 15 patiens with balloon dilatation, three still suffered from artery stenosis, and they additionally underwent stents implantation. These three patients were in the group of 13 patients who had underwent stent implantation.. The last group consisted of five patients with thrombolytic therapy (urokinase, streptokinase, rt-PA – recombinant tissue plasminogen activator). Restenosis appeared only in the three patients from the first group (PTA) immediately after the intervention. A month later, there was no restenosis or ischemia of the limbs. After six months, restenosis appeared in three patients from the first group (PTA), in one patient from the second group (stent), and in two patients from the third group (thrombolytic therapy). The best results were shown by the stent implantation method (successful in 92.3% of the cases), PTA (75%), and thrombolytic therapy (60%). **Conclusion.** On the basis of the obtained results it can be concluded that the limb salvage method in case of occluded arteries of infrapopliteal segment is fully justified, especially the stent implantation method being successful in 92.3% of the patients within a six month-period of time, which is a relevant proof of its efficiency.

**Key words:**
**leg; arterial occlusive diseases; constriction, pathologic; angioplasty, baloon; stents; fibrinolytic agents.**

**Apstrakt**

**Uvod/Cilj.** *Limb salvage* (spasavanje ekstremiteta) predstavlja proceduru kojom se vrši otklanjanje uzroka ishemije u perifernim arterijama donjih ekstremiteta. Ova metoda podrazumeva perkutanu translumensku angioplastiku (PTA) arterija infrapoplitealnog segmenta ekstremiteta, postavljanje endovaskularnih proteza – stentova i selektivnu intraarterijsku trombolitičku terapiju. Osnovni princip PTA jeste da se balonom na mestu stenoze načini dilatacija, proširi lumen krvnog suda i poveća količina krvi koja protiče kroz ovu zonu. Cilj ove studije bio je da se pokaže opravdanost i rezultati primene ovih procedura kod patološki izmenjenih arterija infrapoplitealnog segmenta. **Metode.** Urađena je prospektivna studija kod 30 bolesnika: 15 dilatacija, 13 stentova i pet tretmana trombolitičkom terapijom. Vreme praćenja rezultata bilo je neposredno nakon intervencije, mesec dana i šest meseci nakon intervencije. **Rezultati.** Od 15 bolesnika sa urađenom balon dilatacijom, kod tri je ostalo suženje arterije i kod njih je naknadno postavljen stent. U grupi od 13 bolesnika sa ugrađenim stentom bila su i tri bolesnika kod kojih je pokušana dilatacija. Poslednju grupu činilo je pet bolesnika koji su bili podvrgnuti trombolitičkoj terapiji (urokinaza, streptokinaza, rt-PA-rekombinantni tkivni aktivator plazminogena). Neposredno nakon intervencije, samo je u prvoj grupi (PTA) kod tri bolesnika došlo do restenoze. Mesec dana posle intervencije kod bolesnika nije bilo restenoza, niti ishemije ekstremiteta. Nakon šest meseci u prvoj (PTA) grupi je kod tri bolesnika došlo do restenoze, u drugoj (stent) grupi kod jednog bolesnika i u trećoj (trombolitička terapija) kod dva bolesnika. Najbolji rezultat pokazala je stent metoda (92,3% uspešnosti), zatim PTA (75%), i trombolitička terapija (60%). **Zaključak.** Na osnovu postignutih rezultata, može se zaključiti da *limb salvage* metoda kod okluzije arterija infrapoplitealnog segmenta ima svoju punu opravdanost, i to naročito stent metoda koja je u intervalu posle šest meseci pokazala uspeh od 92,3%, što dokazuje veliku efikasnost ove metode.

**Ključne reči:**
**potkolenica; arterije, okluzione bolesti; stenoza; angioplastika, balonska; stentovi; fibrinolitici.**

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**Introduction**

Limb salvage is a procedure for treatment of the causes of ischemia in the lower limbs peripheral arteries. This procedure consists of percutaneous transluminal angioplasty (PTA) of the infrapopliteal segment arteries of the lower limbs, endovascular stents implantation and selective intra-arterial thrombolytic therapy [1–3].

The main principle of PTA is balloon dilatation of a occluded blood vessel, increasing its lumen and thus blood flow in this zone (Fig. 1 and 2) [4]. This method is widely used today for removal of the causes of ischemia in the peripheral, visceral and coronary arteries. The method is equally efficient as surgical vascular reconstructions, and, yet simpler, safer and cheaper. The clearly specified indications should, of course, be respected [5]

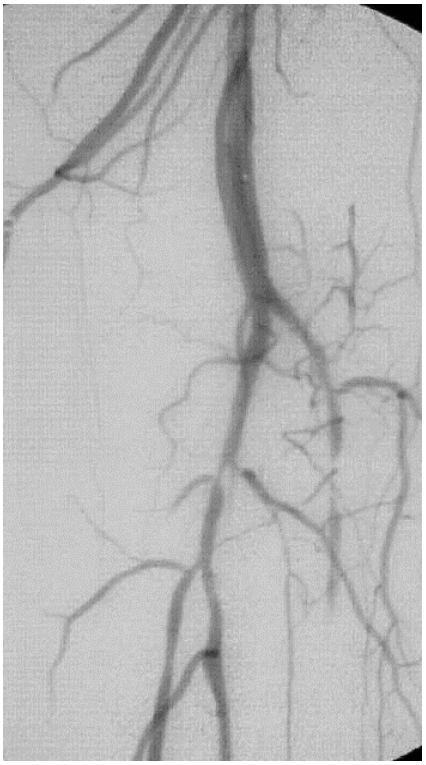

**Fig. 1 – Stenosis of *a.tibialis* enterior and *truncus tibiofibularis***

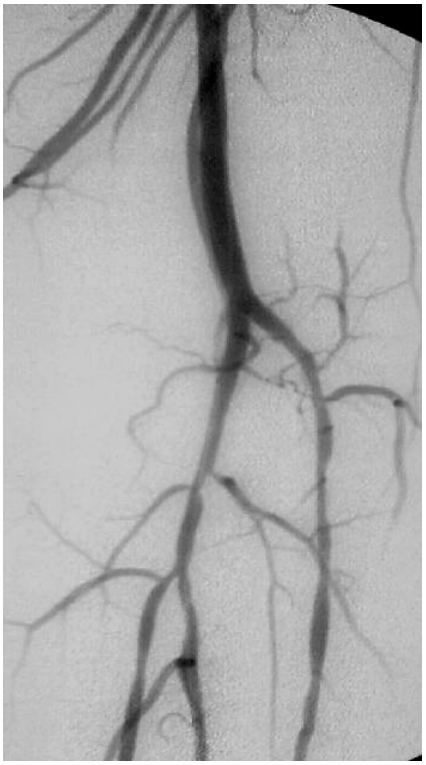

**Fig. 2 – The condition after baloon dilatation**

The placement of stents is a method for various endovascular stents implantation in cases of vascular stenosis. An insufficient PTA with residual stenosis, is the indication for applying this method. Stents are made of different, biologically inert metals (stainless steel, tantalium) which, once implanted, are covered by the vascular intima and incorporated into its wall, supporting it and preventing the appearance of restenosis. The application of stents has improved the results of PTA so far [3].

A selective intraarterial thrombolytic therapy consists of a selective application of thrombolytic agents (urokinase, streptokinase, rt-PA – recombinant tissue plasminogen activator) to the place of stenosis occurrence. The therapy is performed by using a continuous infusion following a selective catheterization, wherein it is essential to come to the thromb as close as possible. An alternative to the local thrombolytic therapy is systemic intravenous infusion of thrombolytic enzymes, wherein selective catheterization becomes redundant [6–8].

All the three above mentioned methods are included into the limb salvage procedure in order to save the extremities and lives of a large number of people, to reduce the treatment expenses and to help the patients recover quickly and go on living normally [1].

A sudden stoppage of circulation in the infrapopliteal region leads to ischemia of extremities causing release of toxic products due to anaerobic metabolism, which endangers not only the extremities, but also the entire organism unless an appropriate treatment is conducted on time [1, 2].

A critical location in this region is the branching of *a.poplitea* into its final branches. Acute arterial occlusions appear as a consequence of embolism, thrombosis and trauma. The most common causes of chronic occlusive lesions are: distrophic arterial processes, non-specific arteritis and specific arteritis [2].

The causes of embolism in this region are heart diseases in 90% of the of patients. Most commonly, these are mitral stenoses, myocardial infarctions with thrombosis of the wall, and subacute endocarditis. The sources of embolies outside the heart can be thrombs in arterial aneurysms and atheromatous ulcerations [1, 2].

Acute thrombosis is a partial or a complete occlusion of the arterial lumen by a coagulum. In the pathogenesis of acute thrombosis in peripheral arteries, arteriosclerosis is the most significant factor, and it is the branchs of the large

blood vessels (*a.iliacae, a.femoris*) that are most often affected, being the possible sources of intravascular embolus migrating, which can, carried by bloodstream, also reaches the tibial arteries and causes acute occlusion [8].

A fat embolism and air embolism very rarely cause an acute occlusion of the infrapopliteal segment.

The aim of this study was to demonstrate the justification of the application of the limb salvage procedure in pathologically modified arteries of the infrapopliteal segment, as well as to prove the efficiency of its individual methods in the period immediately after the intervention, as well as a month and six months after the intervention.

**Methods**

A prospective study included 30 patients with sclerotic or occlusive changes in the arteries of the infrapopliteal segment.

All the patients were previously diagnosed using ultrasonography and digital subtraction angiography. The option of "roadmapping" was also used in order to make more precise and accurate diagnostics and angioplasty. In accordance with the obtained results and indications, the patients underwent different methods of limb salvage procedure: the first group consisted of 15 patients who underwent balloon dilatation (PTA); the second group consisted of 13 patients who had stent implentation; the third group consisted of 5 patients who had underwent thrombolytic therapy.

The patients were divided into three groups according to the clinical picture : Fontaine's stages – atypical complaints - stage I, claudication - stage II, rest pain - stage III and gangrenous lesions - stage IV, and the angiographic results: the location of a change, the number of affected arteries, and the length of the lesion – shorter or longer than 1 cm.

All the patients were followed-up during the three different periods: immediately after the intervention, a month, and six months after the intervention.

The efficiency of the procedure was assessed as follows: the angiography immediately preceeding and following the intervention, a month, and six months later, and the clinical status after a six-months period.

The technique of balloon dilatation (PTA) and stents implantation included a few basic steps: anterograde punction of the femoral artery; diagnostic angiography of the region as a preliminary roadmapping; placing a catheter guide through the lesion; placing the appropriate balloon catheter or stent in the lesion; local application of appropriate drugs; dilatation and postprocedural angiography.

The entire procedure required a great deal of attentiveness, concentration, fine technique and a coordinated team working in the angio-division. From the very beginning, i.e. the punction, all the possible complications should be considered and prevented by all the available means.

The complications could be divided into: local, at the site of the punction; local, at the site of the dilatation; remote and systemic.

**Results**

In our group of patients, the male sex was represented by 87% or 26 patients, and the female sex with 13% or 6 patients. The youngest patient was 38-, and the oldest 75-year old. The average age was 56.5 years. Of the 30 patients, 25 (83%) were smokers, and 5 (17%) non-smokers. Within 19 patients, or 63%, the risk factor for diabetes mellitus was present. Seventeen patients, or 57%, suffered from hypertension. An increased level of cholesterol was present in 20 patients, or 67% of the cases.

The clinical picture – Fontaine's stages showed the following distribution: the largest number of patients were presented for examination with claudication that occured at a distance shorter than 100 m – 15 patients (50%), rest pain – 10 patients (33.3%), and gangrenous changes – 5 patients (16.6%).

The research results were observed according to the groups in three different periods of time (Tables 1 and 2). Immediately after the intervention in the first group of thepatients (PTA group) restenosis occurred in the three patients. These three patients then underwent stents implantation (the second – stent group).

In the second and third groups, there were no cases of restenosis.

A month after the intervention none of the patients had restenosis.

**Table 1**

**The number of patients who experienced restenosis**

| Method | Immediately after the intervention | A month after the intervention | Six months after the intervention |
|---|---|---|---|
| Balloon dilatation | 3 | 0 | 3 |
| Stent | 0 | 0 | 1 |
| Thrombolytic therapy | 0 | 0 | 2 |

**Table 2**

**The success rate of limb salvage procedures**

| Method | Immediately after the intervention | A month after the intervention | Six months after the intervention |
|---|---|---|---|
| Balloon dilatation | 80 % | 100 % | 75.0 % |
| Stent | 100 % | 100 % | 92.3 % |
| Thrombolytic therapy | 100 % | 100 % | 60.0 % |

Six months after the intervention three, one and two patients experienced restenosis in the first, the second and the third group, respectively.

## Discussion

On the basis of the obtained results we can conclude that in the period immediately after the intervention the stent implantation method and thrombolytic therapy proved to be the most efficient (100%), while the PTA was successfully applied in 80% of the patients. A month after the intervention the success rate of all the three methods was 100%. Six months after the intervention, the stent implantation method showed to be the most efficient (92.3%), followed by the PTA (75%), and thrombolytic therapy (60%).

The patients were referred to examination mostly often because of claudication (stage II) and ischemic rest pain (stage III). A few patients had gangrenous changes in the lower extremities (stage IV). The stenoses longer than 1 cm followed by ischemic leg pain were indication for stent implantation, whereas the shorter ones with claudication were indication for PTA. Where neither procedure was applicable (in the cases of significantly longer stenoses and gangrenous changes in legs), selective intraarterial thrombolytic urokinase therapy was applied. After six months, the patients with successfully stents implantation at stage III transferred into stage II (92.3 %), while the PTA proved to be slightly less efficient, with 75% patients at stage II transferring into stage I.

Considering the results in our patients, depending on their symptoms before the intervention, we came to the conclusion that the patients with a less serious clinical and a significantly better angiographic picture had a better prognosis. The conclusion that the lesions longer than 4–5 cm should not be rechanneled (because these are real occlusions that cannot be considered independent lesions), was also made [3].

Apart from the limb salvage method there is also the surgical one, entailing the implantation of by-passes made of different materials (venous grafts, artificial grafts, composite grafts). All surgical procedures carry certain risks for a patient, starting from application of anaesthesia, invasive operative procedures, need for transfusion, potential infections, a long postoperative recovery period and a relatively limited working capacity. All this makes the whole procedure more complex and expensive and makes hospitalization necessary [6, 7]. As we do not have institutions dealing exclusively with reconstructive vascular surgery of this distal segment (it is limited to sporadic practices of individual surgeons), the limb salvage procedure represents the best choice with anatomically suitable patients.

## Conclusion

On the basis of the obtained results it can be concluded that the limb salvage method for the arteries occlusions in the infrapopliteal segment is fully justified as a non-surgical treatment, and especially stent implantation which have shown the success rate of 92.3% after six months. This was a proof of the high efficiency of this method. Exact criteria for application of the PTA and stent implantation were established, and those were the patients in Fontaine's stages II or III, i.e. the patients with claudication or ischemic rest pain. Despite the high efficiency of this method, stents (which are very expensive) are used in our country only in cases of lesions refractory to dilatation, unexpected side-effects of angioplasty (dissection) or persisting relapse of stenosis.

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