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Femorodistal bypasses using venous "cuffs"

Femorodistalni *bypass* korišćenjem venske „manžetne"

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Abstract

Background/Aim. Although distal venous patch and cuff techniques are recommended to improve the patency of bypass in the lower extremities, the advantage of these techniques remains unproven. Autovenous bypass graft remains the method of choice, but when there is no possibility of using the great saphenous vein, the venous cuff method may have an advantage. The aim of this study was to evaluate the results of femorodistal bypass procedures with a venous cuff in critical lower extremity ischemia. **Methods.** The study described the results of femorodistal bypass procedures after a follow-up period of 6 to 24 months. We followed 28 patients with distal composite anastomosis of femorodistal arterial reconstruction. Indications for surgical treatment were set on the basis of the clinical exam and morphological criteria based on multidetector computed tomographic angiography. Three types of distal graft-arterial anastomoses were applied: Miller's cuff, Taylor's patch, and St. Mary's vein boot anastomosis. **Results.** After 6 months of surgery, all bypasses were passable; after one year, 2 (7%) patients had graft occlusion and above-knee amputation, and 8 (28%) patients died; after 24 months, 18 (64%) patients had primary bypass patency. **Conclusion.** Femorodistal bypass procedures using a synthetic graft and venous cuff have good long-term results. The optimal anastomosis type is St. Mary's boot. A longer follow-up period and comparison with the autovenous bypass are necessary for a more detailed assessment of the final conclusion.

Key words:
computed tomography angiography; graft occlusion, vascular; ischemia; leg; multidetector computed tomography; vascular surgical procedures.

Apstrakt

Uvod/Cilj. Iako se distalni venski *patch* („zakrpa") i *cuff* („manžetna") tehnike preporučuju za poboljšanje prolaznosti *bypass*-a na donjim ekstremitetima, prednost tih tehnika ostaje nedokazana. Autovenski *bypass* graft ostaje metoda izbora, ali kada ne postoji mogućnost korišćenja velike potkožne vene, metode venske „manžetne" mogu imati prednost. Cilj rada bio je da se procene rezultati femorodistalnih *bypass* procedura primenom venske „manžetne" kod bolesnika sa kritičnom ishemijom donjih ekstremiteta. **Metode.** Prikazani su rezultati femorodistalnih *bypass* procedura nakon perioda praćenja od 6 do 24 meseca. Praćeno je ukupno 28 bolesnika sa distalnom kompozitnom anastomozom femorodistalne arterijske rekonstrukcije. Indikacije za hirurško lečenje postavljene su na osnovu kliničke slike i morfoloških kriterijuma, na osnovu nalaza multidetektorske kompjuterizovane tomografske angiografije. Primenjena su tri tipa distalnih graft-arterijskih anastomoza: *Miller's cuff*, *Taylor's patch* i *St. Mary's vein boot* anastomoza. **Rezultati.** Nakon 6 meseci, svi bolesnici imali su prolazan *bypass*; nakon godinu dana, 2 (7%) bolesnika imalo je okluziju grafta i natkolenu amputaciju, a njih 8 (28%) imalo je smrtni ishod; nakon 24 meseca, 18 (64%) bolesnika imalo je primarnu prolaznost *bypass*-a. **Zaključak.** Femorodistalne *bypass* procedure korišćenjem sintetičkog grafta i venske „manžetne", imaju dobre dugoročne rezultate. Optimalna anastomoza je ona po tipu *St. Mary's boot*. Duži period praćenja i poređenje sa autovenskim *bypass*-om su neophodni za konačni zaključak.

Ključne reči:
angiografija, tomografska, kompjuterizovana; vaskularni graft, okluzija; ishemija; noga; tomografija, kompjuterizovana, multidetektorska; hirurgija, vaskularna, procedure.

Introduction

Femoropopliteal bypass procedures above or below the knee on the popliteal artery or the tibioperoneal trunk (femorodistal bypass) are frequently necessary as "limb salvage" therapy. Those patients have critical limb ischemia because of an extensive occlusive arterial disease. Below-knee bypass becomes very often dysfunctional in the early postoperative

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period because of technical reasons such as the choice of the artery, difficulties in creating anastomosis, and the choice of conduit. The most often used conduits for femorodistal reconstruction are autogenous vein, synthetic, or composite vein-synthetic grafts. The synthetic graft used for distal bypass revascularization in the early postoperative period becomes dysfunctional due to thrombosis [1–4]. In the second half of the 20th century, new techniques were described in below-knee femoropopliteal bypass surgery: Miller's cuff (1984), Taylor's patch (1992), and St. Mary's boot vein cuff (1997) [5–7]. Not long ago, the boat-form vein cuff technique appeared; it is easy to create and enables surgeons to adjust the anastomotic size and angle [8]. Vein cuff decreases intimal hyperplasia on end-to-side prosthetic-graft anastomosis [9]. Autovenous graft has better patency than polytetrafluoroethylene (PTFE) graft and a low degree of ischemic complication [10]. Distal vein cuff on composite femoropopliteal bypass leads to better long-term outcomes [11]. The saphenous graft should be a method of choice in femoropopliteal bypass surgery if the great saphenous vein (GSV) is available [12]. However, it may not be accessible in some cases, such as: if formerly used in the previous reconstruction or for coronary bypass; if the diameter of the GSV was small; previous thrombosis of the vein; previous stripping of the GSV. Therefore, the small saphenous vein, the superficial femoral vein, the basilic and cephalic vein, the part of the superficial femoral artery after endarterectomy, and the radial artery can be used for conduit. The interposition of vein tissue between the PTFE graft and artery reduces turbulence and also affects the thrombogenicity-vein patch, which is a border between highly resistant arterial outflow and a little bit extended PTFE graft [13, 14]. The aim of this study was to evaluate the results of femorodistal bypass grafting and vein cuff for critical lower extremity ischemia.

Methods

This study presents early surgical morbidity and mortality results, patency, limb salvage, and survivals for femorodistal procedures performed from 2012 through 2014 at the Clinic for Vascular and Endovascular Surgery of the Military Medical Academy, Belgrade, Serbia. General characteristics of patients, demographic factors, and comorbidity are shown in Table 1.

Indications for surgical treatment were clinical and morphological features based on multidetector computed tomographic angiography (MDCTA) finding (Figure 1).

For all patients who had indications for below knee bypass treatment with composite distal anastomosis, popliteal bypass above the knee was created with composite anastomosis if the diameter of the popliteal artery was less than 4 mm.

Miller's cuff technique (Figure 2) uses a small part of the vein of 4–6 cm, with longitudinal incision and after excision of the valves. This vein patch was running suture to the edge of the arteriotomy (incision). The cuff was formed in that manner. PTFE graft was then running sutured to the edge of vein cuff [6]. The deficiency of this technique is the

Table 1

General characteristics and comorbidities of patients with femoropopliteal reconstruction

Parameter	Miller's cuff	Taylor's patch	St. Mary's vein boot	Synthetic femoropopliteal graft	Total
Man	5	3	18	31	57
Woman	/	/	2	16	18
Diabetes mellitus	1	/	9	19	29
Smoking	4	2	15	38	58
Arterial hypertension	5	3	19	42	67

All values are expressed as numbers (of patients).

Fig. 1 – Multidetector computed tomographic angiography finding in a patient with an indication for femoropopliteal below-knee bypass.

large anastomotic reservoir, turbulence blood flow, and "move" anastomosis.

Taylor's patch technique (Figure 3) uses a part of the vein of 2–3 cm with longitudinal incision and after excision of the valve. The arteriotomy incision is also at a length of 2–3 cm. The part of the vein was sutured to the distal half of the arteriotomy incision. PTFE graft was directly sutured to the proximal half of the arteriotomy incision and the distal half of the PTFE graft to the edges of the vein cuff [15].

Tyrrel and Wolf [7] improved their own technique – St. Mary's vein boot (Figure 4). The suture technique is similar to Miller's cuff technique, except the edges of the vein cuff were sutured to the proximal part of the arteriotomy incision, and, in that way, the anastomotic toe was formed. These authors forced this technique because, according to them, the previous techniques had deficiencies such as turbulence in blood flow, the low position of the anastomotic reservoir, and inadequate angle between graft and artery.

Surgical procedures were performed by 3 surgeons from the clinic, but in a standardized way so that there was no difference in surgical technique. The technique consisted of proximal latero-terminal (L-T) arterial graft anastomosis and distal composite anastomosis as previously described with previous popliteal artery endarterectomy.

For the bypass patency, we used ultrasound duplex sonography, and all of the patients were monitored clinically for possible complications: graft thrombosis, infection, and amputation. Besides, general complications were followed: myocardial infarction, stroke, pulmonary embolism, and death.

Results

In the period between 2012 to 2014, 75 patients were operated on due to femoropopliteal occlusive disease: 47 (63%) patients were treated with above-knee femoropopliteal synthetic graft bypass without vein cuff anastomosis, and 28 (37%) patients with vein cuff femorodistal reconstruction.

Out of the 28 followed patients with vein cuff distal anastomosis, 26 (93%) were male, and 2 (7%) were female. Femoropopliteal bypass above the knee was made on 10 (36%) patients, and femoropopliteal below the knee (or on tibioperoneal trunk) bypass was made on 18 (64%) patients. The indications for reconstructions were rest pain in 23 (82%) patients and tissue defect in 5 (18%) patients. We used PTFE graft on 10 (36%) patients, and on 18 (64%) patients, reconstruction was made with Dacron graft. Taylor's patch was done on 3 (11%) patients, 5 (18%) had Miller's cuff, and the remaining 20 (71%) patients had St. Mary's boot reconstruction. Except for vascular reconstruction, no additional procedures, such as stenting or toe amputation, were necessary for our study.

The period for evaluating primary patency was 6–24 months. The control examinations were 1, 3, 6, 12, and 24 months after surgical treatment. Through this period, we followed 28 patients. Eight (28%) of them had some general complications: 4 (14%) had a myocardial infarction, 3 (11%) had a stroke, and 1 (3%) had a pulmonary embolism 6 months after bypass surgery. Twenty (72%) patients had a real follow-up.

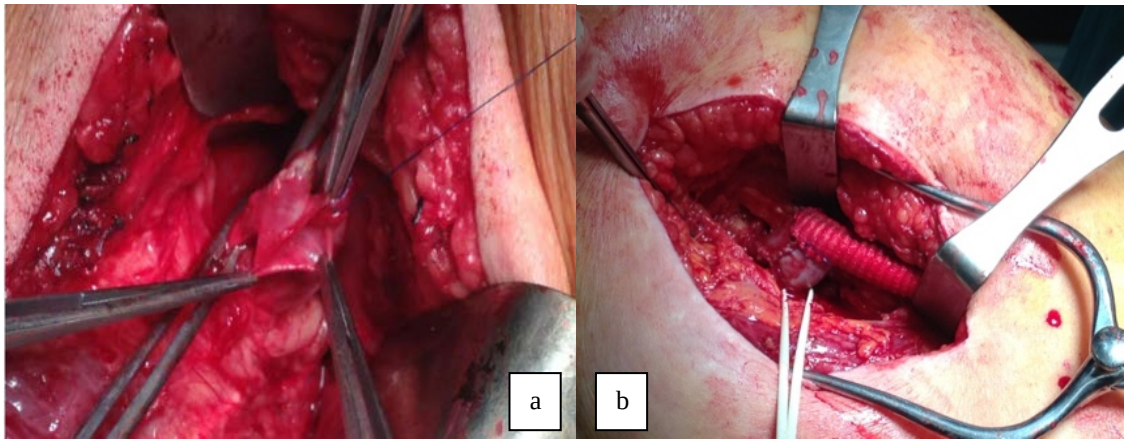

Fig 2. − Miller's-cuff technique: a) creation of anastomosis; b) anastomosis is completed.

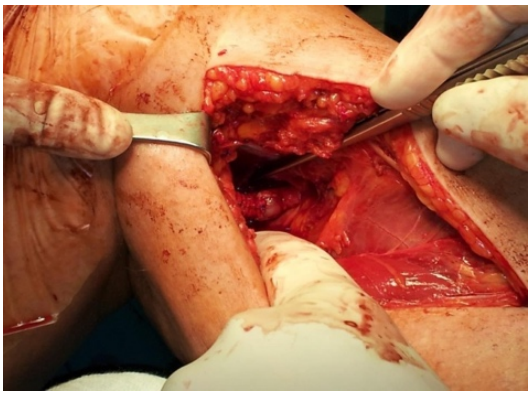

Fig. 3 − Taylor's patch technique: anastomosis is completed.

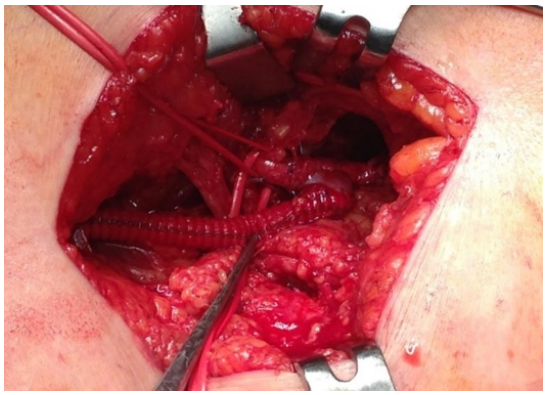

Fig. 4. − St. Marry's vein boot technique: anastomosis is completed.

After 6 months of follow-up, 20 (72%) patients had primary patency.

After one year of follow-up, 2 (7%) patients had an occlusion of bypass, and 18 (64%) had primary patency. One (20%) of the 5 patients with Miller's cuff and 1 (33%) of the 3 patients with Taylor's cuff had graft thrombosis, and amputation above the knee was indicated. Two (7%) more of the 28 followed up patients had amputation surgery.

After 24 months of follow-up, none of the new patients had occlusion of femorodistal bypass, and 18 (64%) had primary patency. During the follow-up period of 2 years, we did not observe infection as a complication.

Discussion

According to the literature, the historical aspect of this method began in 1979 when Siegman [5] proposed a new technique – vein cuff. The aim of this technique is to lengthen the patency of distal bypass. Miller et al. [6] proposed a new variant of vein cuff to facilitate the anastomosis of a prosthetic graft to a small artery. Taylor et al. [15] reported results of vein cuff patency after one, three, and five years of evaluations. Tyrell and Wolf [7] reported results of distal bypass reconstruction with PTFE graft and Taylor's patch (74%) vs. Miller's cuff (47%), and very soon, they proposed their technique of venous cuff – St. Mary's boot.

The results of numerous studies prove that a technique with a composite PTFE-vein cuff graft should be useful for below-knee reconstruction when the GSV is not available. The disadvantage of this method is that it significantly extends the duration of the operation. In femoropopliteal bypass with a synthetic graft, the operation lasted on average 60–90 min, and in vein cuff femoropopliteal bypass, the duration of the operation was 120–150 min. Vein's tissue creates a "biological defensive zone" and reduces stimulation of factors responsible for neointimal hyperplasia [16]. During the follow-up period of 6–24 months, the most common reason for dysfunction of anastomosis was neointimal hyperplasia, and after 2 years of follow-up, it was the progression of atherosclerosis. Femorodistal bypass on tibioperoneal trunk with synthetic graft and vein patch for critical lower extremity ischemia has good long-term results comparable to those reported for bypasses without vein patch. Some authors have one-year results proving that the primary patency of below-knee bypasses with a vein patch is 62% and for synthetic graft (PTFE) 52%. After two years of follow-up, bypasses with a vein patch have primary patency of 49%, but for synthetic grafting primary patency is 42%. Furthermore, lower limb amputation is reduced by 82% using a vein patch instead of PTFE grafting, which is at 62% [14]. Meta-analyses results reported that after five years of following patients with the below-knee bypass with synthetic graft, only 31% had primary patency [17]. After four years of follow-up, 49% of patients with below-knee venous bypass had patent grafts, and 12% with synthetic graft below-knee bypass had patent grafts. Moreover, lower limb amputation is more often necessary after using synthetic grafts [18]. The new studies are guiding the development and betterment of the quality of synthetic (PTFE) grafts by covering them with anticoagulant substances (Propaten®). For the first year of follow-up with these grafts for below-knee revascularization, primary patency was 80% [19]. Patients with below-knee bypasses need to continue the double antithrombotic therapy, but in some cases, anticoagulant therapy is necessary. In addition, following their blood pressure and lipid status is important [20].

Given the small number of patients and the absence of a control group in this study, it is necessary to compare patients operated on with this method with patients operated on with an autovenous graft because many studies recommend saphenous graft as the method of choice [21, 22].

The disadvantages of this study, in addition to the above, are the retrospective design and the absence of a control group, and to some extent, the surgical technique, considering that there are possible differences in relation to the surgeons. Our results point to better primary patency in patients with bellow-knee bypass, created with synthetic graft and venous cuff.

Conclusion

Femorodistal arterial bypass with synthetic graft and venous cuff in patients with critical limb ischemia has good long-term results. It is an optimal treatment when the venous conduit is not available in the appropriate length. The optimal venous cuff technique is St Mary's boot, with better results of primary patency of grafting. Using those techniques, the time of operation is prolonged, but the results are better. A longer monitoring period with a more detailed assessment and comparison with the autovenous bypass is necessary.

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