СПИСАНИЕ НА МАКЕДОНСКОТО ЛЕКАРСКО ДРУШТВО
Мак. мед. преглед, 2021; 75(2)

JOURNAL OF THE MACEDONIAN MEDICAL ASSOCIATION
Mac. Med. Preview, 2021; 75(2)

UDK: 61+061.231=866=20 CODEN: MKMPA3 ISSN: 0025-1097

Македонски Медицински Преглед

Macedonian Medical Review

Основано 1946
Founded 1946

www.mld.mk

2/21 MMP

Мак Мед Преглед

Списание на Македонското лекарско друштво

Journal of the Macedonian Medical Association

Наслов на Редакцијата и издавачот / Address of the Editorial Office and Administration:
1000 Скопје, Даме Груев 3, Градски ѕид блок 2
тел. 02/3162 577
www.mld.org.mk / mld@unet.com.mk
Жиро сметка / Bank Account
300000000211884 - Komercijalna banka Skopje

Печати: Бранко Гапо графичко производство - Skopje

Македонски медицински преглед се печати три пати годишно. Претплатата за списанието изнесува 10 евра за лекари, 50 евра за установа, странство 80 евра.

Основано 1946 Founded 1946

Мак Мед Прегled 2021; 75(2): 60-63

ММР

Original article

ARTERIALIZATION OF GREAT SAPHENOUS VEIN IN SITU FOR LIMB SALVATION: OUR CLINICAL EXPERIENCES

АРТЕРИЈАЛИЗАЦИЈА НА V. SAPHENA MAGNA ПРИ КРИТИЧНА ИСХЕМИЈА НА НОГАТА: НАШИ КЛИНИЧКИ ИСКУСТВА

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Abstract

Introduction. Critical lower limb ischemia in the absence of distal arterial circulation presents an urgent situation, which must be treated immediately if we want to save the foot or limb from amputation.
Approximately 14%-20% of patients with critical lower limb ischemia are unsuited for distal arterial reconstruction and face major distal amputation [1]. Arterialization of great saphenous vein is a unique procedure in which the venous bed is used as an alternative conduit for perfusion of peripheral tissues of lower limb.
Methods. We present our clinical experience in 6 patients who underwent *in situ* arterialization of great saphenous vein for treatment of critical below- and above-knee ischemia.
Maintaining the great saphenous vein *in situ* allows the arterialization with one anastomosis without removing the vein of its original bed. All patients were diagnosed with color Doppler ultrasound and with CT angiography.
Results. In all 6 patients we managed to safe the limb or foot from amputation in the first 6 months after the procedure. Postoperative color Doppler ultrasound was performed to assess arterial inflow and arterialized flow in the graft, the anastomosis and venous run-off.
In all patients with significant intraoperative reverse flow in upper and below the knee part of great saphenous vein the procedures were initially successful.
Conclusion. Distal revascularization of the limb with critical ischemia, by creating a reverse flow with *in situ* saphenous vein arterialization must be seriously considered as an attempt for salvage of the foot or below-knee without distal arterial run-off.

Keywords: arterialization of vein, great saphenous vein, critical limb ischemia, end-stage peripheral artery disease, gangrene

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Абстракт

Вовед. Критична исхемија на ногата настанува при отсуство на артериска циркулација на било кое ниво на ногата и претставува ургентна состојба кој мора веднаш да се лекува со цел да се спаси екстремитетот од ампутација. Приближно 14-20% од пациентите со критична исхемија на ногата не се погодни за дистална артериска реконструкција и се соочуваат со ампутација [1]. Артеријализацијата на v. saphena magna претставува единствена процедура во која се користи вената како пат за обезбедување на артериска крв во периферните ткива на ногата.
Методи. Во оваа студија ги презентираме нашите клинички искуства од изведувањето на артеријализацијата на v. saphena magna во третман на критична исхемија на ногата кај 6 пациенти. Кај оваа процедура се изведува само една анастомоза со задржување на v. saphena magna во нејзината анатомска положба. Пациентите вклучени во оваа студија беа дијагностицирани со Колор доплер ехотомографија и КТ ангиографија.
Резултати. Кај ниту еден пациент во првите 6 месеци после интервенцијата немаше потреба од ампутација. Процедурата за артеријализација на вената беше окарактеризирана како успешна кога со колор доплер ехотомографија се верифицира интраоперативен и постопретивен т.н. обратен крвен проток во стеблото на v. saphena magna. Постоперативно колор доплер ехотомографија се врши за да се прикаже иницијалниот артериски крвен проток во употребената v. saphena magna, процена на состојбата на местото на анастомозата и венскиот повраток низ длабокиот венски систем.
Заклучок. Реваскуларизација на ногата со критична исхемија преку создавање на обратен крвен проток во v. saphena magna преку нејзина артеријали-

зација треба да се земе како сериозен обид во клиничката пракса за зачувување на екстремитетот.

Клучни зборови: артеријализација на вена, голема сафенска вена, критична исхемија на екстремитет, краен стадиум на периферна артериска болест, гангрена

Introduction

Critical limb ischemia (CLI) is the clinical end-stage of peripheral artery disease (PAD) and is associated with high amputation and mortality rates, and poor quality of life [2].
It is estimated that 5-10% of patients with peripheral artery disease who are older than 50 years will develop severe or critical limb ischemia (CLI) within 5 years [3].
Critical lower limb ischemia in the absence of distal arterial circulation presents an urgent situation, which must be treated immediately if we want to save the foot or limb from amputation.
The reduced arterial flow in these situations is not adequate to provide metabolic requirements of lower limb even in rest.
According to Fountain these patients are classified in Class III or in Class IV.
Approximately 14%-20% of patients with critical lower limb ischemia are unsuited for distal arterial reconstruction and face major distal amputation [1].
In critical ischemia without arterial run-off, one of the treatment options to enable revascularization is to turn the course of the flow reversely through the venous system to treat rest pain, to promote healing of the ulcers or to salvage the limb from amputation [4].
Distal venous arterialization is a unique procedure in which the venous bed is used as an alternative conduit for perfusion of peripheral tissues of lower limb.
Patients with critical lower limb ischemia can be treated by arterialization of great saphenous vein.
Atherosclerosis obliterans (AO), especially associated with diabetes mellitus, thromboangiitis obliterans (TO) in most cases and popliteal artery aneurysms with distal bed thrombosis are conditions that justify the indication of this procedure [4].

Material and methods

Thise study was designed as a controlled, randomized, prospective, clinical study with predetermined protocol, which was conducted in the Private General Hospital "Remedika" in the period from January 2016 to July 2021.
All patients had stage IV Fontaine critical lower limb ischemia due to unreconstructable arterial disease and were considered unfit for endovascular or surgical reconstructive procedures. All patients had severe, persistent rest pain without gangrene.
Conventional treatment would have resulted in major amputation.
All 6 patients initially underwent color Doppler ultrasound for investigation of arterial and venous systems of both legs.
All patients also underwent CT angiography with 3D reconstruction.
The primary outcome measure was postoperative limb salvage at 6 months.
The secondary outcome measures were postoperative control with color Doppler ultrasound on the second postoperative day, 6 weeks after surgery, at 3-month intervals in the first year and at 6-month intervals in the second year, walking with or without orthopedic device one year after surgery, surgical site occurrence rate and need of amputations in the follow-up period after performing this surgical procedure.

Preoperative preparation

Preoperatively laboratory examination was made with the following analyses:

- Blood counts
- Protein status
- Urea and creatinine
- Liver function
- Electrolytes levels
- D-dimmers
- Blood group and Rh factor
- Screening for infectious disease transmissible through blood

Preoperative anesthesiology evaluation was performed in all patients.
Three patients were operated under general anesthesia and 3 patients underwent surgery in spinal anesthesia.
Once again preoperatively in the operating room, we performed color Doppler ultrasound of the venous system in order to recheck both venous systems for presence of thrombus and to perform mapping of collateral branches of great saphenous vein in the leg that would undergo a surgical procedure.
We intravenously administered 5000 IU heparin intraoperatively in all patients.

Surgical technique

We start all the procedures with separation of confluence of great saphenous vein into femoral vein on the leg that is to undergo surgery.
We create small separate incisions of the limb to identify previously mapped collateral branches and we perform ligation and resection of these branches.
We ligated and resected all collateral branches within three incisions in 3 patients of this group of treated patients and within 4 incisions in the remaining 3 patients.

The point of the beginning of great saphenous vein near medial malleolus was identified and at this point we opened the great saphenous vein.
In order to ensure arterial flow via vein, at this point we inserted a valvulotome in great saphenous vein and we destroyed all valves from the point of entrance to previous ligated entrance of great saphenous vein into femoral vein.
During destruction of great saphenous vein valves, we did not verify any large thrombotic masses to evacuate with valvulotome from the vein as we previously double checked the peripheral and deep venous system with color Doppler ultrasound.
In order to ensure the arterial flow on the dorsal part of the foot, we completed the destruction of valves at the level of the first interdigital space and ensured the exit point from dorsal venous arch via the system of small saphenous vein.
After preparing the vein, we continued the procedure with preparation of the place for anastomosis of the common femoral artery.
We created the anastomosis between great saphenous vein and the artery using continuous 6.0 polypropylene sutures.
Peroperatively we noticed presence of pulse and trill in the dorsal venous arch as well as weakened pulsation in proximal part of small saphenous vein.

Postoperative care

Patient (koj pacient) was admitted in Intensive care unit and we administered continuous heparin therapy with 25000 IU/24 hours in first four with targeted APTT over 60 seconds.
After four days patient was transferred to the surgical department and we switched the anticoagulant therapy on low molecular weight heparin at a dose of 1 mg/kg body weight.

Results

We succeed in our primary goal in all patients and postoperatively we saved all of the operated limbs from amputation in the first 6 months after surgery.
The follow-up period of 1.5 years showed an excellent quality of life in 4 patients. These patients could walk more than 1.5 kilometres without the help of orthopedic devices.
In 2 patients the follow-up period of 1 year a good quality of life was achieved and they could walk more than 1 km with one crutch.
Postoperatively color Doppler ultrasound was performed to assess arterial inflow and arterialized flow in the graft, the anastomosis, and venous run-off.
The waveforms appeared to behave analogously to those in hemodialysis grafts, with a mono- to biphasic arterial spectrum in the conduit to the anastomosis and low-resistance monophasic waveforms in the draining venous system.
The velocities in the postanastomotic venous system were typically high due to the small caliber of the venous arch or vena comitans. Follow-up color Doppler ultrasound was part of a regular surveillance program consisting of imaging performed after 6 weeks, at 3-month intervals in the first year, at 6-month intervals in the second year, and yearly thereafter at the discretion of the consultant vascular surgeon.
On the second postoperative day as per our postoperative protocol we performed a control color Doppler ultrasound with satisfactory arterial circulation in the great saphenous vein and in dorsal venous arch of the operated limb.
One patient required a postoperative intervention since residual venous valve in below the knee part of great saphenous vein was postoperatively noticed on color Doppler ultrasound. This patient underwent a local valvulectomy with Fogarty catheter.
In three patients we noticed subcutaneous hematoma at the place of anastomosis between the artery and the vein as well as few hematomas on the skin incision where we had cut the veins branches.
Two fingers of the foot were amputated in one patient one year after the surgical procedure.

Discussion

In 2006, Lu *et al.* performed a meta-analysis on the effectiveness of venous arterialization for limb salvage in critical limb ischemia [5].
They included seven studies comprising a total of 228 patients and found a pooled limb salvage rate of 71% at 12 months. The authors concluded that venous arterialization can be a viable option to save the limb when no arterial reconstruction is possible.
Not all patients are candidates for venous arterialization and even without intervention a proportion of patients with CLI will keep their limb. There is a lack of comparative studies, although Matzke *et al.* showed that wound care and pain relief led to 50% limb salvage after 12 months, which suggests that not all patients need revascularizsation [6].
In the studies by Djoric *et al.* 13% limb salvage was observed in those patients treated by conservative means, while 83% and 93% limb salvage was obtained in the venous arterialization group [7,8].
These findings and the differences in limb salvage rates in the studies included here suggest that patient selection might be important. Unfortunately, there are no data robust enough to support any recommendation on how to appropriately select patients for either venous arterialization or conservative treatment or amputation.

Conclusion

Decision for performing arterialization of great saphenous vein for limb salvation in patients with critical ischemia should be considered as necessary and adequate option for treatment in patients when other techniques will not provide good postoperative results.

A small number of performed procedures of venous arterialization in literature is not a limitation to draw conclusions and give strong recommendations.

Every performed procedure should obtain adequate follow-up of patients in order to measure the results from the surgical procedure and to collect necessary information so as to improve the technique and to share information on global level.

Arterialization of the venous system of the foot should be considered as first choice for salvage of the limbs where the absence of distal arterial bed leads to critical ischemia.

Conflict of interest statement. None declared.

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