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*Witold Raciborski, Adam Lewszuk, Zbigniew Kwietniak, Walerian Staszkiwicz, Grzegorz Madycki

An assessment of microcirculation after endovascular treatment of upper limb ischaemia – preliminary results

Ocena mikrokrążenia po leczeniu wewnątrznaczyniowym niedokrwienia kończyny górnej – wyniki wstępne

Department of Vascular Surgery and Angiology, Centre of Postgraduate Medical Education, Bielany Hospital, Warsaw
Head of Department: Professor Walerian Staszkiwicz, MD, PhD

Keywords

upper limb ischemia, intervascular procedures, microcirculation, laser-doppler flowmetry, infra-red spectroscopy

Słowa kluczowe

niedokrwienie kończyny górnej, leczenie wewnątrznaczyniowe, mikrokrążenie, przepływy laserowo-dopplerowskie, spektroskopia w bliskiej podczerwieni

Conflict of interest Konflikt interesów

None
Brak konfliktu interesów

Address/adres:

*Witold Raciborski
Department of Vascular Surgery and Angiology
Centre of Postgraduate Medical Education
Bielany Hospital
ul. Ceglowska 80, 01-809 Warszawa
tel. +48 (22) 569-02-85
w.raciborski@wp.pl

Summary

Introduction. The treatment of the upper limb ischemia with narrowing or the obstruction of arteries, is based mainly on the intravascular treatment at present. The therapeutic effect of interventions values oneself on the basis of changes in doppler flowmetry, return or the improvement of perceptible pulse and normalization of the arterial blood pressure.

Aim. It is not known changes in microcirculation and correlation these changes with the clinical effect and as they oneself will provide for long. Such investigations can answer on these unknown quantities how laser-doppler flowmetry and infrared spectroscopy.

Material and methods. In Department of Vascular Surgery and Angiology, Centre of Postgraduate Medical Education in Warsaw, in the period January 2014 – February 2016, 49 percutaneous intravascular revascularisations and balloon angioplasty of subclavian arteries and brachiocephalic trunks were made. 40 procedures ended the full success, in 9 the cases of long obstructions (>50 mm) it did not pretend to restore the patency.

Results. Changes did not noted down in these cases in microcirculation, and in 37 different cases the significant improvement of laser-doppler flowmetry and in infrared spectroscopy in, Positive results correlated with clinical state of the upper limb for oneself minimum by 3 months. In remaining 2 the cases of the positive effect of the revascularisation, changes in microcirculation were not significant and the clinical improvement was not satisfactory (the blood-flow improved and the pulse returned on the distal arteries but the clinical symptoms of upper limb ischaemia were detected and her weakness kept).

Conclusions. Authors suggest, on the basis of preliminary result, that investigations of the microcirculation (by laser-doppler flowmetry and infrared spectroscopy) can be in the future the expression of effectiveness of intravascular procedures of revascularisation of upper limb ischaemia. This study and in the longer period of the observations of the patients will be continued.

Streszczenie

Wstęp. Leczenie niedokrwienia kończyny górnej ze zwężeniem lub niedrożnością tętnic aktualnie opiera się głównie na leczeniu wewnątrznaczyniowym. Efekt terapeutyczny zabiegów ocenia się na podstawie zmian w przepływach dopplerowskich, powrocie lub poprawie wyczuwalnego tętna na obwodzie i normalizacji ciśnienia tętniczego krwi.

Cel. Nie wiadomo, jakie zmiany zachodzą w mikrokrążeniu i czy te zmiany korelują z efektem klinicznym i jak długo się będą utrzymywać. Na te niewiadome mogą odpowiedzieć badania takie jak przepływy laserowo-dopplerowskie i spektroskopia w bliskiej podczerwieni.

Materiał i metody. W Klinice Chirurgii Naczyniowej i Angiologii w Warszawie, w okresie styczeń 2014 roku – luty 2016 roku, wykonano 49 udrożeń i angioplastyk tętnic podobojczykowych i pnia ramiennie-głowego. 40 zabiegów zakończyło się pełnym powodzeniem, w 9 przypadkach długich niedrożności (> 50 mm) nie udało przywrócić drożności.

Wyniki. W tych przypadkach nie zanotowano zmian w mikrokrążeniu, a w 37 innych przypadkach uzyskano znaczącą poprawę przepływów lasero-dopplerowskich i wzrost poziomów hemoglobiny w spektroskopii w bliskiej podczerwieni. Uzyskane wyniki korelowały ze stanem klinicznym kończyny górnej, który utrzymywał się minimum przez 3 miesiące. W pozostałych 2 przypadkach dobrego efektu zabiegu rewaskularyzacji zmiany

w mikrokrążeniu nie były znaczące i poprawa kliniczna nie była zadowalająca (poprawiło się ukrwienie i powróciło tętno na obwodzie, ale utrzymywały się objawy chromania ręki i jej osłabienie).

Wnioski. Na podstawie wstępnych wyników można sugerować, że badania mikrokrążenia (laserowo-dopplerowskie i spektroskopii w bliskiej podczerwieni) mogą w przyszłości być wykładnikiem skuteczności rewaskularyzacyjnych zabiegów wewnątrznaczyniowych. Badania będą dalej prowadzone celem potwierdzenia wstępnych wyników na większej grupie chorych i w dłuższym okresie obserwacji.

INTRODUCTION

Treatment of patients with upper limb ischemia is still a major therapeutic problem (5). Conventional methods for surgical reconstruction of arteries are also of limited value as they are often contraindicated due to the nature of vascular lesions or concomitant internal diseases (5, 9, 13). Recent endovascular methods allow to restore the patency/dilate the stenotic/occluded arteries and improve the blood flow in the extremity, thus avoiding amputation (5, 9, 13). Endovascular treatment is currently the primary therapeutic modality for the management of upper limb ischaemia. The assessment of perfusion is mainly based on the return of warmth in the limb, blood pressure normalisation, Doppler flowmetry and a return of normal peripheral pulse (9). Microcirculatory assessment methods (4, 8) (laser Doppler flowmetry and near-infrared spectroscopy) allow for an objective evaluation of changes following revascularisation (8) and may be a predictor of clinical improvement.

AIM

The aim of the study was to assess upper limb microcirculatory changes prior to and after endovascular treatment involving recanalisation/dilatation of the subclavian arteries or the brachiocephalic trunk as well as to verify whether microcirculatory improvement (capillary flow and tissue oxygenation) results in an improved clinical condition of the upper limb and for how long it is maintained.

MATERIAL AND METHODS

A total of 49 procedures of endovascular revascularisation and subclavian artery/brachiocephalic trunk balloon angioplasty were performed in 32 females and 17 males aged between 47 and 81 years (mean age 61.8 years) in the Department of Vascular Surgery and Angiology of the Medical Centre of Postgraduate Education between January 2014 and February 2016. Hemodynamically significant stenosis of the left and right subclavian artery was diagnosed in 39 (27 females and 12 males) and 7 (5 males and 2 females) patients, respectively; stenosis of the brachiocephalic trunk was diagnosed in 3 females. Occlusion of the left and right subclavian artery was reported in 6 (3 females and 3 males) and 2 (1 female and 1 male) patients, respectively. Arterial recanalisation and angioplasty were performed using the femoral artery access. The procedures were performed by an experienced medi-

cal team in a hybrid operating room. All patients were informed on the type and the course of procedures, their potential complications and effects, the type of performed medical evaluations as well as gave their informed written consent to undergo the procedure. Microcirculatory assessment was based directly on laser Doppler flowmetry and, indirectly, on the levels of haemoglobin and cytochrome A oxidase measured by the near-infrared spectroscopy. Before surgery, optodes for the measurement of haemoglobin levels using near-infrared spectroscopy were placed on the appropriate arm of each patient. The measurements were performed before, during and up to 30 minutes after procedure. Optodes were placed on the dorsal side of the hand. NIRO 200 apparatus was used. Laser Doppler flowmetry was performed (in microcirculation laboratory) the day before, on the day of surgery and the day after. Furthermore, preoperative vascular diagnosis (CT angiography of the arteries branching from the aortic arch, blood pressure measurement, colour duplex-Doppler – CDD) of the arteries branching from the aortic arch) was performed for each patient. The subclavian steal syndrome was found in 7 patients (5 females and 2 males), mainly affected by arterial occlusion. Patients were asked to complete a life quality questionnaire before surgery, the day after the surgery and 3 months later. A subjective assessment of peripheral artery pulse in the upper extremity as well as its temperature and mobility was performed. CDD of the upper limb arteries and bilateral blood pressure measurements were performed 3 months after surgery.

RESULTS

A very good direct effect of endovascular treatment involving arterial recanalisation or dilatation was achieved in 40 patients, as confirmed by intraoperative angiography. Balloon angioplasty alone was performed in 12 patients, while additional implantation of an appropriate stent was performed in the other 28 patients in this group. This group included 30 patients with subclavian steal syndrome with retrograde blood flow in the vertebral artery. A rapid, nearly two-fold increase in the levels of oxygenated and total haemoglobin, as well as cytochrome A oxidase was observed in 37/40 patients. A rapid, significant increase in microcirculatory blood flow was also observed in laser Doppler flowmetry. This correlated with ultrasound imaging, patient's perceptions, well-palpable peripheral pulse and an increased temperature in the limbs. This

effect was still maintained after 3 months, as confirmed by a follow-up. Blood pressure increase or normalisation in both extremities was also observed in these patients, however, differences in systolic blood pressure between both arms still persisted in 4 patients (about 15-20 mmHg). Upper limb claudication virtually resolved, which was also confirmed after 3 months.

Interestingly, a microcirculatory follow-up in 3 patients, who achieved clinical improvement and had good subclavian arterial recanalisation and dilatation outcomes, showed only a minor improvement. These patients (2 females and 1 male) suffered from a chronic left subclavian artery occlusion with mild symptoms. They were able to perform basic arm and hand movements, showed reduced muscle strength and impalpable peripheral pulse. Despite an improved flow in large and medium arteries (as shown by left upper limb CCD) and an increased temperature in the arm following recanalisation and stenting, differences in blood pressure of about 15 mmHg between both arms, periodic tingling, skin paleness and reduced muscle strength were still observed immediately after surgery as well as 3 months later. Near-infrared spectroscopy revealed a minor increase in total and oxygenated haemoglobin levels. Virtually the same levels of cytochrome A oxidase were maintained. Laser Doppler flowmetry also showed only minor microcirculatory flow improvement. Perhaps chronic subclavian artery occlusion and upper limb ischaemia had caused irreversible changes in microcirculation and small-caliber arterioles, and

therefore the effect was unsatisfactory. Additional, previously unknown systemic diseases, such as scleroderma or other rheumatoid diseases or diabetes, can be another cause. These patients require further diagnosis and a follow-up.

In the remaining nine cases of left subclavian artery and brachiocephalic trunk occlusion, arterial patency was not restored, as reflected in both macrocirculatory and microcirculatory assessment as well as patient's perception and the clinical condition of the upper limb. Near-infrared spectroscopy revealed no significant differences in haemoglobin levels. Laser Doppler flowmetry showed no changes in blood flow.

CONCLUSIONS

1. The obtained microcirculatory findings correlated with the clinical condition of the upper limb, which was maintained for at least 3 months, in most cases.
2. Methods for the assessment of microcirculation (laser Doppler flowmetry, near-infrared spectroscopy) allow for an objective evaluation of changes following revascularisation and may be a predictor of long-term clinical improvement.
3. Further studies are necessary to confirm the preliminary findings in a larger group of patients and in a longer follow-up period as well as to evaluate the causes of discrepancies between the clinical condition of the upper limb and microcirculatory flows.

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received/otrzymano: 11.10.2016
accepted/zaakceptowano: 02.11.2016