Results of brain transcatheter laser revascularization in the treatment of the consequences of ischemic stroke

Ivan V Maksimovich

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ABSTRACT

INTRODUCTION: The research focuses on the degree of blood supply restoration in the brain by means of transcateter laser revascularization in patients after ischemic stroke.

MATERIALS AND METHODS: 874 patients 29-81 years old (average age 74) after ischemic stroke were examined: 647 men (74.03%), 227 women (25.79%).

The examination included CDR, MMSE, IB, cerebral CT, MRI, MRA, scintigraphy (SG), rheoencephalography (REG), cerebral MUGA. Test Group was comprised of 533 (60.98%) patients undergoing transcatheter interventions. Control Group included 341 (39.11%) patients receiving conservative treatment. High-energy and low-energy lasers were used for cerebral revascularization.

RESULTS:

Test Group:

• Good clinical outcome was achieved in 323 (60.60%) cases;

INTRODUCTION

The number of patients who underwent ischemic stroke increases every year (1). Ischemic stroke often leads to pronounced neurological deficit, which is accompanied by a 30% mortality rate in the acute period, with 12-15% more patients die in the following 12 months (2). The remaining patients acquire severe disability with marked motor and speech disorders, dementia and cognitive impairment (3-5). In the United States, about 800,000 strokes are recorded each year (6).

The leading cause of stroke is atherosclerotic lesion of the cerebral vascular system (7,8). Atherosclerosis affects not only extracranial and intracranial arterial branches, but also the cerebral capillary bed (5,9,10). Brain tissues greatly suffer from blood supply disorders; the progression of hypoperfusion quickly leads to ischemia and neurodegenerative lesions (8). The more pronounced the hypoperfusion zone is and the more it spreads to various cerebral parts, the harder the stroke and its consequences are (2). The severity of the stroke heavily depends on the development of the cerebral collateral channel (5,10). Stroke treatment, regardless of its timing, should first be aimed at restoring cerebral blood supply (5,6,11).

Since cerebral atherosclerosis multiply affects vessels in the overwhelming majority of cases and is accompanied by severe hemodynamic disorders, conservative methods of treatment do not always allow to seriously improve the cerebral blood supply (5,12).

Reconstructive surgical interventions are well-proven on extracranial sections of brachiocephalic branches (13). However, surgery in patients with intracranial lesions is fairly difficult (14).

Transcatheter operative interventions have also proven themselves well on extracranial vessels (15). However, interventions on the proximal sections of intracranial vessels require the use of small-diameter stents and miniature

- Satisfactory clinical outcome was acquired in 136 (25.52%) cases;
- Relatively satisfactory clinical outcome was procured in 74 (13.88%) cases;
- Relatively positive clinical outcome was not gained in any case.

Control group:

- Good clinical outcome 51 (21.07%) cases;
- Satisfactory clinical outcome 72 (21.11%) cases;
- Relatively satisfactory clinical outcome 123 (36.07%) cases;
- Relatively positive clinical outcome 95 (27.86%) cases.

CONCLUSION: Transcatheter laser revascularization is much more effective in the treatment of ischemic stroke consequences than conservative methods of treatment are. When intracerebral blood flow is restored, it reduces the level of mental, cognitive, and motor disorders and helps to quickly bring patients back to their active daily life.

Key Words: Ischemic stroke; Transcatheter laser Revascularization; Cerebrovascular insufficiency; Dementia

distal protection means. Conducting such manipulations is often associated with a high risk of complications and of stent thrombosis (16). Stenting of the distal sections of the intracerebral arterial bed is not possible yet. Consequently, there is a necessity to work out new, sparing transcatheter methods that allow working on both proximal and distal sections of the intracranial vascular bed.

The present research focuses on the degree of recovery of blood supply in the brain by means of transcatheter laser revascularization in patients after ischemic strokes. It also investigates how to reduce these patients' mental, intellectual, and motor disorders in the near and distant future.

MATERIALS AND METHODS

The Ethics Committee gave their approval of the examination and transcatheter surgery. The patients and their relatives gave their consent to all the medical procedures.

We examined 874 patients from 29 to 81 years old (average age 74) who had predominant intracerebral atherosclerosis and who underwent ischemic stroke in the period from 6 months to 6 years before the examination and treatment: 647 men (74.03%), 227 women (25.79%).

The examination included CDR, MMSE, IB assessment, as well as CT, MRI, MRA, scintigraphy (SG), rheoencephalography (REG), cerebral MUGA:

- Macrofocal strokes were found in 118 (13.50%) cases.
- Medium focal strokes were discovered in 229 (26.20%) cases.
- Microfocal strokes were revealed in 527 (60.30%) cases.

533 (60.98%) patients who went through transcatheter surgery comprised the Test Group.

Clinic of Cardiovascular Diseases named after Most Holy John Tobolsky, Moscow, Russia.

Correspondence: Dr. Ivan V. Maksimovich, Clinic of Cardiovascular Diseases named after Most Holy John Tobolsky, Moscow, Russia. Telephone +7 903 7240277, e-mail: carvasc@yandex.ru

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This open-access article is distributed under the terms of the Creative Commons Attribution Non-Commercial License (CC BY-NC) (http:// creativecommons.org/licenses/by-nc/4.0/), which permits reuse, distribution and reproduction of the article, provided that the original work is properly cited and the reuse is restricted to noncommercial purposes. For commercial reuse, contact reprints@pulsus.com High-energy pulsed lasers were used to perform transcatheter laser revascularization in the case of major intracerebral artery lesions; low-energy continuous lasers equipped with light-guide instruments of small diameters were used to perform transcatheter revascularization in the case of distal intracerebral branches lesions (5,17,18). If MUGA showed bilateral atherosclerotic changes, transcatheter interventions were performed not only in the area of the developed stroke, but also on the contralateral side (8). Conservative treatment, including disaggregant, anticoagulant, vasodilating, antioxidant and nootropic therapy, was performed in 341 (39.02%) cases - Control Group.

RESULTS

Test group

522 (97.94%) patients showed good immediate outcome after the laser surgery, the cause being the restored patency and lumen of the vessels affected, along with collateral revascularization.

12-24 months after the treatment, the results obtained depended on the size of the ischemic lesion and on when the intervention was made after the stroke:

- Good clinical outcome (total recovery of mental and motor functions IB 90-100) 323 (60.60%) patients (Table 1);
- Satisfactory clinical outcome (incomplete recovery of mental and motor functions - IB 75-85) - 136 (25.52%) patients (Table 1);
- Relatively satisfactory clinical outcome (partial recovery of mental and motor functions - IB 60-70) - 74 (13.88%) patients (Table 1);
- Relatively positive clinical outcome (absence of negative dynamics with insignificant restoration of mental and motor functions - IB below 60) was not achieved in any case (Table 1).

There were neither complications nor negative dynamics observed in any case after the treatment.

Example: Patient S., man, aged 57, massive stroke in the right hemisphere which resulted in marked left-sided hemiparesis and incomplete sensorymotor aphasia. 12 months after the stroke: dementia severity - CDR-3, daily living activities level - 40 IB points (Figures 1-7).

TABLE 1

Clinical results of the treatment.

Signs	Test Group	Control Group	P (chi- square)
Number of patients	533	341	
Macrofocal strokes (in total):	81	37	
Good clinical outcome	17	0	
Satisfactory clinical outcome	31	0	p<0.01
Relatively satisfactory clinical outcome	33	6	
Relatively positive clinical outcome	0	31	
Medium focal strokes (in total):	167	62	
Good clinical outcome	55	0	
Satisfactory clinical outcome	76	12	p<0.01
Relatively satisfactory clinical outcome	36	15	
Relatively positive clinical outcome	0	35	
Microfocal strokes (in total):	285	242	
Good clinical outcome	251	51	
Satisfactory clinical outcome	29	60	p<0.01
Relatively satisfactory clinical outcome	5	102	
Relatively positive clinical outcome	0	29	

Using Pearson's chi-square test, relevant contingency tables were analyzed to identify the differences between the two groups. The p-values achieved are given in the right-hand column of the table. P-value=0.05".



Figure 1) Brain CT. Before the intervention: a large postischemic cyst of $7.5 \times 4.8 \times 6.2$ cm in the area of the right middle cerebral artery







Figure 3) Right-sided carotid MUGA. After the intervention: Complete restoration of permeability and lumen of the trunk of the right internal carotid artery.



Figure 4) CT of the Brain. 12 Months after laser revascularization: Significant decrease in the size of the post-ischemic cyst with the sings of brain tissue regeneration.

Twelve months after transcatheter laser revascularization, there was pronounced positive dynamics, no left-sided hemiparesis and incomplete sensory-motor aphasia, no signs of dementia, MMSE-28 points, IB-100 points. In the subsequent observation period (5 and 10 years) the condition is stable, there are no signs of dementia, MMSE - 28 points, IB-100 points.

Control group

Good clinical outcome was obtained in 51 (21.07%) patients (Table 1).

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Figure 5) Right-sided carotid MUGA 5 Years after the intervention: The permeability and lumen of the right internal carotid artery trunk completely preserved, further progression of collateral revascularization



Figure 6) MRI of the brain 10 Years after the intervention: Further regression of the postischemic cyst with the symptoms of the structure of cerebral tissue restoration



Figure 7) MR angiography of the brain. 10 Years after the intervention: The lumen and permeability of the right internal carotid artery are preserved

- Satisfactory clinical outcome was obtained in 72 (21.11%) patients (Table 1).
- Relatively satisfactory clinical outcome was obtained in 123 (36.07%) patients (Table 1).
- Relatively positive clinical outcome was obtained in 95 (27.86%) patients (Table 1).

DISCUSSION

To identify the causes of the stroke, it is necessary to investigate both the extracranial and intracranial basins, as well as assess the condition

J Vas Dis Treat Vol 1 No 1 October 2017

of collateral and capillary beds (8,10,11). Intracranial and mixed types of atherosclerotic lesion occur in the vast majority of cases (5).

Along with progression of microfocal or medium focal ischemic strokes, the severity of mental and motor disorders does not always depend on the size of the main ischemic focus. It is often linked to stroke localization, ischemia duration and atherosclerotic lesions extensiveness, both in the area of the stroke and in other arterial basins, which in some cases requires bilateral transcatheter intervention (5,8).

In the case of macrofocal ischemic strokes, various parts of the brain are included in the lesion zone, which leads to pronounced neurologic deficit and neurodegenerative processes (4,5,6,11). In the situation of this kind, conservative treatment is not effective enough to restore cerebral hemodynamics. The resulting clinical effect is due to partial improvement in cerebral metabolic processes, but this is not sufficient for the functional recovery of cerebral tissue (14,17).

When deciding whether to apply this or that method of treatment, it is necessary to consider the severity of the patient's somatic and neurological state and the effectiveness of the chosen method (4,8,13).

Transcatheter laser treatment allows the restoration of cerebral blood flow and, by stimulating natural angiogenesis, the improvement of collateral and capillary blood supply in the ischemic region and surrounding tissues (5). Simultaneously, laser energy, penetrating into the surrounding cerebral tissues, stimulates regenerative processes in them (8,18). It is supported by the data of plenty of authors conducting experimental and clinical research aimed at transcranial laser effects in ischemic strokes and dementia (19-21).

CONCLUSION

When treating the consequences of ischemic stroke with predominant intracerebral atherosclerotic lesion, transcatheter laser revascularization is much more effective than conservative treatment. The method helps to restore the cerebral blood supply; it is low-traumatic, does not require distal protection and is easily endured by patients. When intracerebral blood flow is restored and metabolic processes in neurons are stimulated, it reduces the level of mental, cognitive, and motor disorders and quickly brings patients back to their active daily life. The obtained result remains stable for a long time.

DECLARATION OF CONFLICTING INTERESTS

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Maksimovich

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