SPONTANEOUS RECANALIZATION OF CHRONIC OCCLUSION OF THE INTERNAL CAROTID ARTERY

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Described in the article is a rare case concerning spontaneous recanalization of the extracranial portion of the internal carotid artery (ICA) eleven months after occlusion. Only few publications have been dedicated to recanalization of ICA chronic occlusion. Spontaneous recanalization of the ICA is more common than it is generally understood.

The authors have analysed all available articles about this problem from PubMed (1958 to 2014), reviewing the mechanisms of recanalization of the ICA, methods of diagnosis and treatment. The purpose of this case report is to emphasize the importance of ICA spontaneous recanalization and consequences thereof.

Key words: *internal carotid artery, occlusion, recanalization, carotid endarterectomy, color examination.*

INTRODUCTION

Stenosis of carotid arteries appears to be a cause of ischaemic stroke in 26-30% of cases [1, 2]. Pathogenesis, risk factors and methods of treatment of patients with carotid arteries stenosis have been well described, however the course of the disease in occlusion has not yet been sufficiently studied [1, 3]. Unilateral or bilateral occlusion of the internal carotid artery (ICA) is revealed in 6–15% of cases in stroke [4]. The mortality rate in occlusion in the acute period amounts to 16–55% [5, 6].

Despite reports on the development of ipsilateral stroke, it has for a long time been considered that occlusion is a stable condition in which embolism into the distal bed is impossible [7]. Therefore, there has been no long-term follow up of patients presenting with ICA occlusion. Recurrent neurological deficiency in the basin of the occluded ICA was explained by extension of thrombosis to the circle of Willis, by cerebral hypoperfusion, embolism from the common and external carotid arteries, from the proximal and distal stumps of the ICA or from the contralateral carotid artery along collateral vessels [7–9].

It has long been considered until recently that recanalization does not occur in chronic occlusion of the ICA, with only few published cases of spontaneous recanalization in the remote period. However, the conducted studies demonstrated that ICA recanalization is more common than it is generally assumed and according to the findings of various authors its incidence amounts to 2.3–11% [10, 11].

We may now consider including dynamic follow up of the occlusion zone into the protocol of treatment of patients with ICA occlusion. Spontaneous recanalization of the ICA with high degree of residual stenosis of the bifurcation of the common carotid artery makes it possible to perform carotid endarterectomy or stenting. Currently, a possibility and necessity of surgical management of such patients are discussed.

Case report

A 55-year-old male patient was examined at the Department of Neurosurgery of the Saratov Scientific Research Institute of Traumatology and Orthopaedics in October 2013. He presented with complaints of dizziness, headache and tinnitus with elevated arterial pressure. According to the patient's words and his case history the above mentioned complaints developed after endured in December 2012 stroke which was accompanied by right-sided pyramidal insufficiency and dysarthria. Color duplex scanning (CDS) performed in February 2013 at the Federal Centre of Cardiovascular Surgery (city of Astrakhan) revealed extended occlusion of the left ICA from the ostium. Findings of magnetic resonance tomography (MRT) of the brain revealed cystic-gliotic changes in the left hemisphere of the brain and confirmed occlusion of the left ICA to the supraclinoid segment. The patient received antiaggregate, antihypertensive therapy

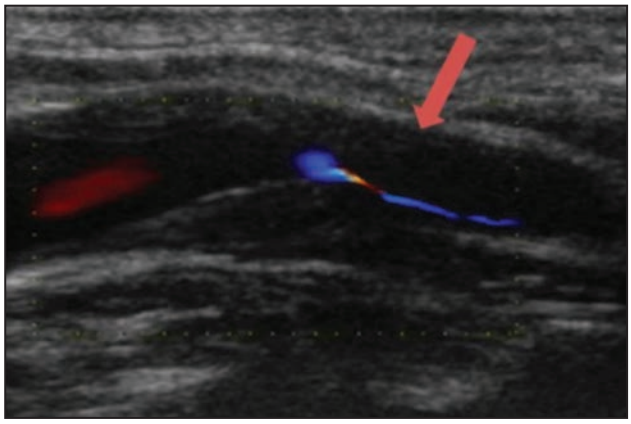

Fig. 1. Color duplex scanning with colour mapping of blood flow in the patient with recanalization of the left internal carotid artery, showing a heterogeneous plaque of the left common carotid artery with transition to the ICA ostium, ICA stenosis – 95–99%. A threadlike lumen (indicated by the arrow) is traced along 2–3 cm. No blood flow detected in the distal portion of the ICA. The examination was performed on the Siemens ACUSON S2000 unit with linear transducer 8 MHz.

and statins. He suffered from hypercholesterolemia, degree III arterial hypertension and type 2 diabetes mellitus in the stage of subcompensation of metabolic processes.

The examination carried out in October 2013 – eleven months after stroke – revealed no signs of pronounced neurological deficit (0 – 1 according to the modified Rankin scale). Critical stenosis of the left ICA was suspected on color duplex scanning (Fig. 1).

CT angiography was carried out in order to specify lesions of carotid arteries, revealing a threadlike lumen in the left internal carotid artery from the ostium to the supraclinoid segment (Fig. 2). The obtained findings were interpreted as recanalization of the left ICA. Given the presence of an extended lesion from the ostium to the supraclinoid segment, no surgical intervention was performed. The patient was advised to undergo follow up of a neurologist and dynamic color duplex scanning 2 times a year.

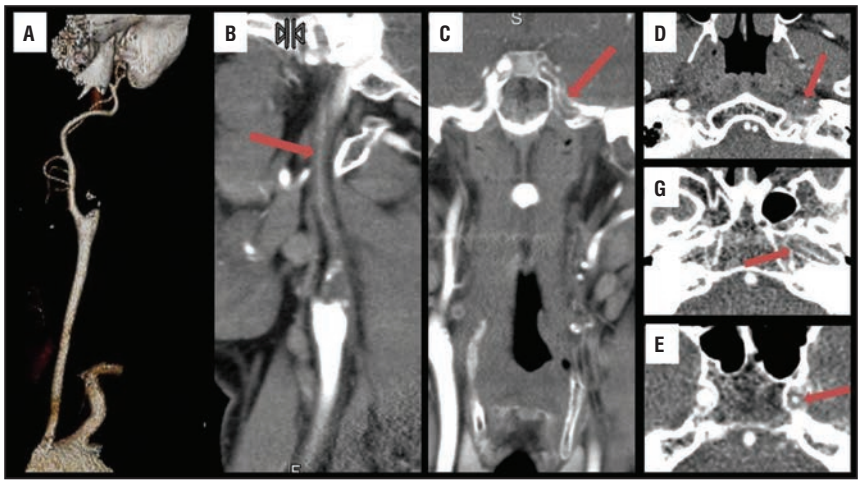

Fig. 2. CT angiography of the patient with recanalization of the left internal carotid artery. On 3D reconstruction of the images (a) no lumen of the left internal carotid artery is determined. The multiplanar reconstructions (b, c) show a threadlike lumen ("string sign") of the left ICA, the axial slices (d–g) show various levels of the ICA from the ostium to the supraclinoid segment, with the arrows indicating the threadlike lumen with graduate dilatation in the area of the temporal bone. The examination was performed using multislice (64-slice) computer tomograph Aquilion-64 Toshiba.

DISCUSSION

In 1958 G.M. Lehrer was the first to describe a case of spontaneous recanalization of arteries of the brain [12]. Since that time a great number of similar cases have been published. Spontaneous recanalization of the ICA supraclinoid segment and the middle cerebral artery in the acute period after occlusion (from 1–2 hours to 2 weeks) is encountered with a frequency of 17–67% [13]. In traumatic or spontaneous dissection ICA recanalization the in acute period is observed in 57–69% of cases [14], amounting to 85% three months after dissection [15]. In atherosclerotic lesion and embolism early recanalization occurs considerably less often [16]. Spontaneous recanalization of the ICA in the remote period has been described in sporadic studies (Table). Probably, this is related to the fact that vascular surgeons neglect follow up of ICA occlusion in the remote period due to the opinion on unpromising results of surgical treatment and presumably asymptomatic course of this pathology [6, 17].

We analysed all published cases of spontaneous chronic occlusion of the ICA from the PubMed from 1958 to 2014. All in all, we found a total of 60 cases of ICA recanalization revealed one month and more after occlusion. The majority of publications deal with a description of one or several cases. However, there were studies of the natural course of the disease in patients with ICA occlusion, in which the incidence rate of recanalization was determined. According to the data of various authors it ranges from 2.3 to 11%. Analysing all case reports, the average incidence rate of recanalization amounted to 3.6% (938/1045). The largest study was carried out by Morris-Stiff, et al. [11], who performed color duplex scanning in 2367 people, revealing 764 patients presenting with carotid artery stenosis more than 70% and 153 patients with ICA occlusion. Secondary examination was performed in 77 patients with ICA occlusion, with 8 of them (10.3%, 8/77) having developed recanalization during 53 months (median).

The data concerning the terms of early and late recanalization vary widely, which is very likely related to different intervals of secondary examinations. Analysing

the published data, recanalization was revealed in 73.7% of cases 12 and more months following occlusion. However, it is necessary to take into consideration that there is no interrelationship of the interval between the examinations and the time of recanalization onset.

In order to explain the mechanism of recanalization several hypotheses were suggested, including transient vasospasm, temporary oedema of the arterial wall, distal migration of the thrombus from the zone of occlusion, spontaneous intravascular lysis of the thrombus, thrombus fragmentation and resorption of haematoma in haemorrhage into the plaque [13, 16, 21, 36]. Besides, there exists a theory explaining the process of recanalization by the development of vasa vasorum [37]. Vasa vasorum originate directly from the ICA or the superior thyroid artery and ascending pharyngeal artery. In thickening of the vascular wall at the expense of atherosclerosis, intimal hyperplasia or medial hypertrophy there occurs growth of vasa vasorum [20, 37]. Colon, et al. presented 4 cases where the vasa vasorum became the source of collateral circulation after ICA occlusion on the background of an atherosclerotic plaque [38].

A series of factors may influence the rate of recanalization, including the side of occlusion, development of collateral circulation, extent of occlusion, structure and aetiology of the thrombus. Hypoechogenic occlusions of the ICA in the acute period are more often recanilized [16]. Extended thrombi are more resistant,

Table

Data on spontaneous recanalization of chronic occlusion of the internal carotid artery presented in PubMed from 1958 to 2014

Authors	Year	No cases	Sex	Age, years	Frequency	Side	Occlusion cause	Recanalization period, months	Treatment
Lehrer [12]	1958	1	m	45		R	nd	1	CT
Sindermann [18]	1974	2	f	43		L	embolization	48	CT
			f	50		R	embolization	24	CT
Markwalder [19]	1980	1	f	33		L	nd	84	CT
Kemeny [20]	1998	1	m	60		L	nd	18	CT
Manganaro [21]	2002	1	nd	nd		nd	nd	nd	CT
Nguyen-Huynh [13]	2003	1	m	70		R	after CEA	1	CEA
Paciaroni [22]	2005	10	nd	nd	5,6% (10/177)	nd	atherosclerosis – 2 embolization – 3 dissection – 5	21	nd
Klonaris [5]	2006	1	nd	nd		nd	nd	12	CEA
Kim [23]	2006	1	m	56		L	atherosclerosis	1	CAS
Saes [24]	2007	1	m	73		L	nd	24	CEA
Cheema [9]	2007	2	m/f	69,5	11% (2/30)	R – 2	nd	27/19	CT – 2
Gohel [25]	2008	1	m	71		L	nd	120	CEA
Binning [26]	2009	1	m	54		R	atherosclerosis	2	CEA
Matic [27]	2009	1	nd	nd		nd	nd	nd	CEA
Shah [28]	2010	1	m	75		L	nd	8	CEA
Som [29]	2010	1	nd	58		L	atherosclerosis	4	CEA
Tuskan-Mohar [30]	2010	1	m	51		R	dissection	1	CT
Vicenzini [31]	2010	1	m	52		L	dissection	16	CT
Camporese [10]	2011	16	m – 9	66,2 (52-77)	2,3% (16/696)	L – 9	atherosclerosis	5 – 98	CT
			f – 7			R – 7			
Buslovich [32]	2011	3	m – 3	85,67,75		L – 3	atherosclerosis – 2 nd – 1	11, 36, 39	CEA – 2 CT – 1
Kniemeyer [33]	2012	1	nd	nd		L	nd	24	CEA
Mohammadian [34]	2012	2	m – 2	55, 70	3,1% (2/65)	L – 2	nd	8	CAS – 2
Morris-Stiff [11]	2013	8	nd	nd	10.3% (8/77)	nd	atherosclerosis	53 (35-114)	CEA – 7 CN –1
Nozaki [35]	2014	1	m	54		R	atherosclerosis	6 months	CT
Total	1958 – 2014	60	м: 70,2% (26/37)	64,6 (33-85)	3,6% (38/1045) (2,3-11%)	L: 61,5% (24/39)	atherosclerosis 65,8% (25/38)	1-6 months 12,3% (7/57)	CT 58% (29/50)
							embolization 13,1% (5/38)	6-12 months 14,0% (8/57)	CAS+CEA 42% (21/50)
							dissection 18,4% (7/38)	>12 months 73,7% (42/57)	

nd – no data, m – male, f – female, R – right, L – left, CEA – carotid endarterectomy, CAS – carotid artery stenting, CT – conservative therapy

which may be the cause of rare recanalization of the occlusion of the extracranial portion. Occlusions in atherothrombotic lesion are recanalized considerably less often than in thromboembolism [16]. Also an effect is exerted by the time elapsed from thromboembolism: "old" emboli are more resistant. High haematocrit theoretically decreases the possibility of recanalization and reperfusion, and, accordingly, in this case therapeutic agents (antiaggregants, anticoagulants) may exert a favourable effect on the process of recanalization [13].

The majority of patients with ICA recanalization were men (70.2%), mean age 64.6 years (Table). Occlusion was predominantly caused by thrombosis on the background of an atherosclerotic lesion of carotid arteries (65.8%), dissection was encountered in 18.4% of cases and embolism in 13.1%. Hence, in the remote period, recanalization was detected in the majority of cases in atherosclerotic lesions, whereas early recanalization of the ICA is encountered more often in dissection and embolism [39].

An interesting fact revealed is predominant ICA recanalization on the left (61.5%). Although the incidence of atherosclerotic lesions of carotid arteries is encountered with similar frequency on the right and left sides, large studies showed that stroke develops more often in the left cerebral hemisphere [40], and carotid endarterectomy is more frequently performed on the left [41]. One of the causes of this may be difference in haemodynamics between the right and left carotid arteries. The left common carotid artery originates directly from the aorta and accordingly the average blood flow rate is higher in it than in the right one, since there is no transitional portion, i. e., the brachiocephalic trunk. Increased blood flow velocity is accompanied by increased hydrodynamic impact on the vascular wall, thus leading to adaptive thickening of the intima. Although the intimal thickening itself does not influence the process of atherosclerosis it may however enhance atherogenesis in the distally located vessels. Besides, high velocity of blood flow may lead to more frequent embolism in ulceration of the plaque [40].

Another explanation may be the interhemispheric asymmetry: the left hemisphere is dominant in the majority of people. 95% of right-handers and about 70% of left-handers have localization of the speech centre in the left hemisphere. Patients with the lesion of the left hemisphere demonstrate concern in the perception of their disease and a desire to correct the existing impairments, whereas patients with lesions of the right hemisphere are indifferent to their condition. Stroke in the left hemisphere induces greater social disadaptation of patients, which may exert influence on the increased rate of detection and surgical treatment. A more detailed study of this problem requires further investigations.

There emerges an obvious question of whether there occurs recanalization of the true occlusion, or pseudoocclusion has been missed due to an error or technical difficulties while diagnosis? CDS is the most common method of primary diagnosis of lesion of carotid arteries. There were several studies on CDS sensitivity in diagnosis of ICA occlusion [42, 43].

Positive prognostic value of CDS is less than that of CT angiography, varying from 86 to 98%. According to the findings of other authors, CDS even in near-occlusion of carotid arteries possesses high sensitivity (95%) and specificity (100%) [44, 45]. Possibilities of CDS are limited in diagnosis of occlusion on the background of pronounced calcification of vascular wall or in the presence of anatomical peculiarities of angioarchitectonics. However analysis of echogenicity in CDS may help in revealing patients requiring regular control in order to detect ICA recanalization [46].

In order to minimize errors while carrying out CDS in case of pronounced ICA stenosis and to detect pseudo-occlusion most authors insist on performing angiographic examination. During angiography it is necessary to wait for the complete venous phase when retrograde filling of the occluded ICA is possible [13, 16]. However angiography of carotid arteries is an invasive method and accompanied by complications in more than 5% of cases and the risk for the development of stroke exceeding 0.5% [47].

MR angiography is a safe method of diagnosis of ICA stenos and may help reveal recanalization [29]. And though MR angiography does not possess high sensitivity in sharp abrupt decrease of blood flow in the zone of near-occlusion, the use of this method in clinical practice is justified [45].

Computed tomography angiography proved its high sensitivity, safety and is an alternative to angiography in diagnosis of pronounced stenosis or occlusion of the ICA [48]. This method of study possesses high accuracy in detecting the "string sign" of the ICA and makes it possible to distinguish pseudo-occlusion from true occlusion [13].

In our case report, ICA occlusion was revealed by CDS and MRT. CDS performed 11 months later made it possible to suspect the presence of the so-called string sign in the occluded ICA. The findings of CT angiography confirmed recanalization of the lumen. It is important to note that on the processed in reconstruction 3D images the lumen was not identified, therefore while analysing the CT data in patients suspected for ICA occlusion it is necessary to study the axial slices of vessels at various levels.

Amongst the presented cases of ICA recanalization surgical intervention (carotid endarterectomy and stenting) was performed in 42% of patients (Table). The remaining patients were found to have complete

recanalization of the lumen and received medicamentous antiaggregant and/or anticoagulant therapy.

The use of anticoagulants for treatment of acute-stage stroke has limited efficacy and elevated risk for haemorrhage and is not recommended for conventional use [49]. In the remote period surgical treatment for ICA occlusion did not reveal advantages over medicamentous treatment [17]. However, taking into consideration the possibility of recanalization of ICA chronic occlusion, there arises a question of advisability and the terms of anticoagulant therapy and surgical treatment in this cohort of patients. According to the findings of Morris-Stiff, et al., ICA recanalization resulted in considerable neurological complications in 25% of cases and 22.6% of lethal outcomes were related to impaired circulation in the ipsilateral hemisphere of the brain [11]. The obtained findings allowed the authors to insist upon surgical correction of the residual ICA stenosis for prevention of possible neurological complications. According to Camporese, et al., in 31.2% of cases ICA recanalization manifested itself as transitory ischaemic attacks, stroke and transient blindness [10]. However, considering a favourable course of the disease in these patients the authors came to a conclusion on groundlessness of attempts to enlarge the lumen of the recanalized vessel. In our clinical case, despite the presence of recanalization, operative intervention was not performed, taking into consideration the minimal lumen of the ICA distal segment.

CONCLUSIONS

Spontaneous recanalization of ICA chronic occlusion may occur in the remote period after stroke, which was previously considered impossible. The causes of recanalization of the ICA extracranial portion have still been debated. It is already clear that patients with ICA occlusion require dynamic follow up. CDS makes it possible to reveal recanalization, however, performing angiography or CT angiography is mandatory in order to confirm the diagnosis. In patients with ICA recanalization due to high incidence of recurrent cerebral circulation impairment in the basin of the affected artery it is appropriate to perform carotid endarterectomy. However, considering a small number of cases, treatment policy has not yet been definitely defined, with further prospective studies necessary.

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