Systematic review

Comparative analysis of the effectiveness of carotid endarterectomy operations with stenting of the carotid arteries: a systematic review

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Abstract

More than ten international randomized trials have been conducted to determine the effectiveness and safety of carotid artery stenting and comparing the latter with the results of carotid endarterectomy. However, some of them obtained conflicting data confirming both the advantage of carotid stenting (SAPPHIRE) and carotid endarterectomy (EVA-3S), as well as the equivalence of the two treatments (CAVATAS, SPACE, CREST). Also, unsatisfactory results of both single-stage and staged surgical approaches were shown in the treatment of patients with combined atherosclerotic lesions of the coronary and carotid arteries. The lack of clear international guidelines for the management of patients with lesions of several vascular beds makes it necessary to look for new methods of surgical treatment based on minimally invasive endovascular technologies.

This review article analyzes the results of randomized trials comparing the results of carotid endarterectomy and carotid stenting in patients with carotid atherosclerosis.

Key words: carotid endarterectomy, carotid stenting, multifocal atherosclerosis, stroke, hemodynamically significant stenosis, internal carotid artery

(Heart Vessels Transplant 2023; 7: doi: 10.24969/hvt.2022.413)

Introduction

Multifocal atherosclerosis (MFA) is one of the main causes of stenotic lesions of the carotid arteries, an urgent problem of modern medicine due to its high medical and social significance. The choice of the optimal surgical tactics for the treatment of patients with MFA is difficult as a result of the involvement of several vascular beds with a high risk of adverse events in each of them (1). Hemodynamically significant brachiocephalic artery (BCA) stenoses are verified in 20% of patients with indications for coronary bypass surgery (CABG). Determination of the method of revascularization, associated with the need to minimize the risk of adverse cardiovascular events in this group of patients, improve the results of surgical treatment of patients with a hybrid surgical approach (2, 3). Carotid artery stenoses occur in 15-20% of all patients who have had acute cerebrovascular accident/transient ischemic attack (CVA/TIA) (3).

Clinical studies have shown that carotid endarterectomy (CEE) reduces the absolute risk of ischemic stroke by 50% in patients with severe atherosclerosis of the BCA (3). An important aspect of the effectiveness and safety of interventions in the carotid pool is the assessment of the likelihood of cardiovascular events, in particular myocardial infarction (MI). However, in the postoperative period, the likelihood of developing MI increases, which has been noted in many randomized controlled trials (odds ratio (OR) = 2.23, 95% confidence interval (CI) - 6 studies, 5725 patients). Despite the fact that CVA/TIA are frequent complications of surgical treatment of patients with MFA, MI is an equally important cause of disability and mortality in this group of patients. This conclusion has been reflected in many clinical studies, while the risk factors for the development of MI remain not fully understood (4-11).

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Received: 06.06.2023 **Revised:** 14.08.2023 **Accepted:** 15.08.2023

Several international randomized trials have been conducted to determine the effectiveness and safety of carotid artery stenting and comparing the latter with the results of carotid endarterectomy (4-11). However, some of them obtained conflicting data. . The lack of clear international guidelines for the management of patients with lesions of several vascular beds makes it necessary to look for new methods of surgical treatment based on minimally invasive endovascular technologies.

We aimed to analyze the results of randomized trials comparing the results of carotid endarterectomy and carotid stenting in patients with carotid atherosclerosis.

Methods

We have used the PUBMED database to search articles. Key words used were: carotid endarterectomy; carotid stenting; multifocal atherosclerosis, hemodynamically significant stenosis.

Exclusion criteria. The number of patients is less than 200; high mortality or stroke re-occurrence after the surgery (>50%).

Results

We have decided to make a comparative analysis of the literature data, the results of CEE and carotid stenting (CS) in the treatment of carotid artery stenosis. In the course of data analysis, we analyzed the results of CAVATAS (Carotid and Vertebral artery Transluminal Angioplasty Study), SAPPHIRE (Stenting and Angioplasty with Protection in Patients at High Risk for Endarterectomy), SPACE (Stent-Protected Angioplasty versus Carotid Endarterectomy), and CREST (Carotid Revascularization Endarterectomy versus Stent Trial (4, 6, 12, 13) (Table 1).

Table 1. Study parameters included in the analysis

Condition	Study design	Author, year	N	Statistically significant?	Quality of study (Jadad score)	Magnitude of benefit
Stenosis and occlusion of carotid arteries	CAVATAS RCT	(13)	504	yes	4	medium
Stenosis and occlusion of carotid arteries	SAPPHIRE RCT	(6)	306	yes	4	medium
Stenosis and occlusion of carotid arteries	SPACE RCT	(12)	1214	yes	5	large
Stenosis and occlusion of carotid arteries	CREST RCT	(4)	2522	yes	5	large

RCT – randomized controlled study

Randomized clinical trials conducted over the past two decades have shown that CEE in combination with medical therapy reduces the absolute risk of stroke or death in the long-term period after surgery. So, in the works of Rothwell et al. (7) it has been demonstrated that in symptomatic patients with carotid artery narrowing from 70 to 99%, the risk of stroke or death within five years after CEE is reduced by 16% (95% CI - 10–21%), in symptomatic patients with carotid stenosis, 50–69% - by 8% (95% CI- 3-12%) (7), and in asymptomatic patients with a narrowing of 60-99% - by 5% (8). However, CEE is only preferred if the requirements of the American Heart Association's CEE Committee are met. According to these requirements, the incidence of perioperative hemolateral stroke should not exceed 3% in asymptomatic patients, 5% in patients with TIA, and 7% in patients after a stroke. The overall mortality in each of the listed groups should be no more than 2%. (9).

In the CAVATAS study (1997) (5), the combined incidence of stroke and mortality was 9.9% after CEE and 10% after stenting (did not differ significantly). The incidence of ipsilateral stroke and mortality over a three-year period in both groups were equally low. Of the 504 patients included in the study, stenting was performed in 55 (11%) patients (5).

The ability to repair internal carotid artery (ICA) stenosis in high surgical risk patients was proven in the SAPPHIRE study, which was conducted from 1998 to 2002 at 29 centers in the United States, and was prematurely suspended due to the clear advantage of carotid artery stenting using devices that protect brain from a distal embolism. The study included 306 patients with symptomatic (>50%) and asymptomatic (>80%) carotid artery narrowing. In 156 cases, ICA stenting was performed, in 151 cases CEE was performed. The cumulative complication rate (stroke, MI, mortality) after stenting was 4.4%, and after CEA - 9.9% (p=0.06). In the group of symptomatic patients, this indicator after stenting was 2.1%, and after CEA - 9.3% (p=0.18); in asymptomatic patients - 5.4% and 10.2%, respectively (p=0.2). A year later, the total complication rate in symptomatic patients in the stenting group was 16.8%, and in the CEE group it was 16.5% (P=0.95); in asymptomatic patients - 9.9% and 21.5%, respectively (p=0.02). During the first year after surgery, the incidence of ipsilateral stroke and mortality was 12.0% in the stent group and 20.1% in the CEE group (p=0.048). In addition, the incidence of cranial nerve damage (4.9% and 0%, p=0.004) and the number of repeated revascularizations (4.3% and 0.6%, p=0.04) after CEE were significantly higher than after stenting of the ICA (6). After 3 years, 260 (77.8%) patients were examined. The combined incidence of stroke, MI and mortality over 3 years was 24.6% in the stent group and 26.9% in the CEA group (p=0.71) (6).

In general, the combined incidence of stroke, mortality and MI, as well as such indicators as the frequency of damage to the cranial nerves, the number of repeated revascularizations and the duration of hospitalization of patients were lower after ICA stenting. It should be noted that the results obtained in this study (i.e., in high-risk patients) should not be generalized with the results of studies in patients with low surgical risk (10).

Of particular interest in the analysis of studies is the CREST study (14), comparing the results of carotid stenting with CEE. The study included 2522 patients with symptomatic and asymptomatic lesions of the carotid arteries. The primary endpoints of the study were: the incidence of stroke, myocardial infarction and mortality in the perioperative period and the incidence of ipsilateral stroke within 4 years after randomization. In the perioperative period, in asymptomatic patients, no significant difference was obtained for any end-point of the study. In symptomatic patients, the incidence of stroke in the peri- and postoperative periods was 3.2% in the CEE group and 5.5% in the stenting group (p=0.04). However, the cumulative incidence of stroke, MI and mortality in symptomatic patients did not differ significantly (CEE-5.4%, ICA-stenting-6.7%, p=0.3).

In the long-term period, the incidence of perioperative complications (stroke, MI, mortality) and ipsilateral stroke in symptomatic patients in the CEE group was 8.4%, in the stenting group 8.6% (p=0.69), in asymptomatic patients 4.9% and 5.6%, respectively (p=0.56).

According to the study, it was also noted that the results of ICA stenting did not depend on the gender of patients. In patients older than 80 years, the incidence of perioperative complications was 12.1%, which is significantly higher than in patients in the age group from 60 to 69 years (1.3%) and in patients whose age ranged from 70 to 79 years (5.3%; P =0.0006).

However, restenosis rate was higher in carotid stenting as compared to CEE as report in EVA 3S study (14).

The systematic review (Cochrane Systematic Review)(15), including the results of 10 studies (3178 patients), also deserves attention, the incidence of stroke and mortality during the immediate postoperative period after CEE was less than after stenting (RR 1.35; p=0.02). However, the cumulative complication rates (stroke, MI, and mortality) at 30 days postoperatively (RR 1.12) and the incidence of stroke and mortality at 24 months (RR 1.26) did not differ significantly. It was noted that damage to the cranial nerves (RR 0.15) and MI in the perioperative period (RR 0.34) was significantly less common during ICA stenting. In Table 2, we summarize the results of the four randomized trials mentioned above.

Table 2. Outcomes of carotid stenting and carotid endarterectomy

Study	Carotid stenting	Carotid endarterectomy
	Cumulative complication rate (MI+Stroke)	Cumulative complication rate (MI+Stroke)
CAVATAS	10%	9,9%
SAPPHIRE	4,4%	9,9%
SPACE	9,5%	8,8%
CREST	6,7%	5,4%
Mean	8%	9%

MI – myocardial infarction

As can be seen from Table 2, the incidence of perioperative stroke is approximately equal with stenting of the carotid arteries and with carotid endarterectomy.

Conclusion

Thus, today stenting is an alternative treatment for atherosclerotic lesions of the carotid arteries, mainly in patients with high surgical risk. In a number of randomized clinical trials, the risk of ipsilateral stroke during the follow-up period was low (<1% per year) after both carotid endarterectomy and after stenting, confirming the effectiveness of ICA stenting in the prevention of ipsilateral stroke, at least during the first 4 years after procedures. It should be noted that in everyday practice, carotid endarterectomy and ICA stenting are complementary, rather than competing, treatment methods that require joint decisions by cardiologists, neurologists, vascular and endovascular surgeons, taking into account the clinical and anatomical features of the patient in each case.

The results of this systematic review will undoubtedly play a fundamental role in determining the indications for carotid artery stenting in symptomatic and asymptomatic patients.

Peer-review: External and Internal
Conflict of interest: None to declare
Authorship: A.A.A., F.A.M., S.N.S., O.A.M., S.A.T., O.S.S. contributed equally to the study and preparation of manuscript
Acknowledgement and funding: None to declare

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