

## Carotid endarterectomy and carotid angioplasty: Where are we now?

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### Introduction

Atherosclerosis is a degenerative disease of the cardiovascular system that affects approximately half of the world population [1]. When this disorder affects the carotids, it is responsible for about 25% of strokes, which are the second main cause of death around the world. It is also a cause of total or partial neurological impairments, mainly in the elderly [2]. The World Health Organization (WHO) predicts that smoking, diabetes mellitus, hypertension and obesity tend to greatly increase the number of atherosclerosis cases [3].

At the beginning of the 20<sup>th</sup> century, the relation between carotid atherosclerosis and cerebral ischemia was proved through thromboembolism. Fifty years later, Carrea, Molins and Murphy proposed the first surgery for endarterectomy [4]. Endarterectomy is an incision in the obstructed vessel for removing the atherosclerotic plaque, the thrombus with its vascular endothelium. When this procedure is concluded, the artery is sutured, the blood flow is released and bleeding is controlled.

Several studies have proved that surgical treatment is superior to clinical treatment in patients with severe stenosis. The most important trials in this field were the European Carotid Surgery Trial, the North American Symptomatic Carotid Trial (which included symptomatic patients), and The Veterans Administration Asymptomatic Trial (which included the asymptomatic ones) [4]. Endarterectomy was for the asymptomatic ones, whose stenosis  $\geq 70\%$ , according to WHO. Thus, about a million of endarterectomies were performed only between 1974 and 1985 [5].

Angioplasty procedures have recently been considered to have the advantage of being less interventionist. Carotid angioplasty is based on the insertion of a guidewire into the vessel. This wire is used to conduct a self-expandable metal stent which is positioned and deployed in the stenotic area. It is preferably introduced through the femoral artery so that it does not interfere with neurovascular structures which might be susceptible to injury during surgery.

### Advantages

There are several advantages when we use angioplasty instead of the classic surgical procedure. In order to perform angioplasty, only local anaesthetic is usually used, so it could be a better choice within higher risk patients that could have problems with deeper sedation; it requires only a short period of recovery; patient is discharged from the hospital usually within 24 to 48 hours; less risk of cranial nerve damage; less risk of post procedure infection; less risk of surgical related haematomas;

it makes the monitoring of the clinical and neurological status of the patient more reliable. Thus, this has been the procedure of choice for patients with severe comorbidities and with a high risk for endarterectomy. High-risk patients are considered those with contralateral carotid occlusion, post endarterectomy restenosis, radiation-induced stenosis, previous cervical dissection or surgically inaccessible injuries. This procedure has shown good postoperative results, especially after the development and systematic use of distal protection filters that prevent post-operative strokes due to thromboembolism caused by the manipulation of the atherosclerotic carotid plaque [6].

Many studies have been made which compare the two therapeutics methods. The biggest of these is the CAVATAS (Carotid and Vertebral Artery Transluminal Angioplasty Study), a randomized multicentre study which involved 504 patients; 253 of these were submitted to surgical treatment and 251 to endovascular treatment (most of them without stents). Eighty-eight per cent of the endovascular group and 91% of the surgical group were symptomatic patients. The incidence of stroke or death was 9.9% in the endarterectomy group and 10% in the angioplasty group. So, this first big study about the technique showed excellent results, once the use of stents and filters were minimum [7].

The SAPPHERE, another multicentre study utilized only procedures of angioplasty with stents and cerebral distal protection filters. A total of 334 patients were enrolled, 167 in the endovascular group and 159 in the surgical group. The 30-day complication rate was 12.2% and 20.1% in the angioplasty and surgery groups respectively. This trial showed the superiority of endovascular therapy in relation to endarterectomy associated with stents and cerebral protection [8].

### Statistical Analysis

A recent meta-analysis of five studies showed that in a total of 1,157 randomized patients, there was no significant difference in the rate of stroke and death between the two techniques: 8.6% in the endovascular group versus 7.1% in the surgical group. Of the three studies that provided information regarding stroke evolution, 6.0% of patients treated with stents died or had severe sequelae versus 5% in the surgical group. When AMI was included, there was no statistically significant difference between the two groups [9]. Nerve damage occurred in 7.2% of the surgery group and zero percent in the stent group.

But possibly the most recent and important trial was the CREST study which, like other studies, demonstrated inexpressible differences between the stent group and the endarterectomy one, in relation to unfavourable cardiovascular outcomes. This study involved 2502 patients at 117 centres in the USA and Canada.

The incidence of primary endpoint at a mean follow-up of 2.5 years did not differ significantly (7.2% for angioplasty versus 6.8% for surgery). However, the 30-day incidence of stroke or death was 4.4% and 2.3% for endovascular and endarterectomy-treated (symptomatic and asymptomatic patients), respectively, a difference that was significant. The incidence of myocardial infarction was significantly higher in endarterectomy than in angioplasty treated patients (2.3% vs 1.1%). Thus, the increase in stroke incidence with angioplasty may be offset by an increase in acute myocardial infarction with endarterectomy [10]. In 2016, with a 10-year follow-up, it could be seen that the similarity between the groups was maintained, demonstrating the safety of angioplasty intervention [11]. It should also be noted that economic reason should not be a determining factor for choosing the procedure, since the differences between the two are insignificant [12].

Currently, new studies have been published showing that the carotid stent is effective not only in large trials, but also in the clinical practice of experienced centres in general [13].

## Conclusion

In conclusion, it can be stated that since the first comparative studies of the two techniques, there has been a significant evolution of the techniques and devices used in carotid angioplasty with stent implantation. Carotid angioplasty with stent implantation has, today, similar results to those of endarterectomy surgery in terms of mortality and occurrence of stroke in the near, medium and distant future.

Thus, the best treatment choice nowadays should be based not only on the results of the previous studies described here, but also on the analysis of individual factors such as those of patient's preference, patient's profession (and need of a natural voice) comorbidities, age and surgical risk, bleeding risks, previous radiotherapy applied to the neck, previous surgical treatment of the cervical region, presence of contralateral carotid permeability, degree of contralateral collateral flow, degree of carotid tortuosity (both pre- and post-injury), degree of carotid calcification, presence of thrombus at the level of the lesion, degree of obstruction, possibility of adequate use of embolic protection devices and, especially, adequate surgical or vascular access to perform the procedure.

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