

## Critical analysis of indications and outcomes of surgical treatment for carotid disease

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### ABSTRACT

Treatment of carotid disease has been in focus over the past years, especially with the advent of the endovascular technique, which supports use of carotid angioplasty and stenting (CAS) in "high-risk" patients for carotid endarterectomy (CAE). We analyzed current outcomes of the treatment for carotid disease using both techniques. Furthermore, we performed some comments based on data from the literature, particularly in high-risk patients. We conclude that, up to the present moment, there is no evidence and justification for large use of CAS in patients with carotid disease, even in high-risk patients, such as in octogenarians. However, we believe that CAS could be useful in the treatment of a small number of patients with carotid disease (less than 4%), such as those with hostile neck, previous cervical radiation and in some cases of high carotid stenosis. When performed using the required technical skills, CAE is still the best choice for patients with carotid disease.

Keywords: Carotid endarterectomy, carotid angioplasty/stenting.

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### RESUMO

O tratamento da doença carotídea tem ganhado enfoque nos últimos anos, principalmente com o advento da técnica endovascular, que defende o emprego da angioplastia e *stent* de carótida (CAS), principalmente em pacientes considerados de "alto risco" para a endarterectomia carotídea (ECA). Através da revisão bibliográfica, analisamos os resultados do tratamento da lesão carotídea em ambas as técnicas, realizando comentários embasados na experiência pessoal e nos dados da literatura, sobretudo nos pacientes de alto risco. Até o presente momento, não há evidência e justificativa para o emprego da CAS em larga escala nos pacientes com doença carotídea, inclusive

nas situações de alto risco, tais como nos octogenários. No entanto, acreditamos que a CAS possa ser um coadjuvante no tratamento de pequeno número de pacientes com lesão carotídea (até 4% dos casos), como na presença de pescoço hostil, radioterapia prévia e alguns casos de estenose carotídea alta. Quando realizada com os cuidados técnicos necessários, a ECA ainda continua a melhor opção terapêutica aos doentes com lesão carotídea.

Palavras-chave: Endarterectomia carotídea, angioplastia carotídea com *stent*.

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## Introduction

Carotid revascularization for the treatment of brain ischemia – a transposition from the internal to the external carotid artery – was performed for the first time in Argentina, in 1951, by Carrea et al. However, it was published only in 1955.<sup>1</sup> Although others had tried, it was De Bakey who successfully performed the first carotid endarterectomy (CEA) in 1953. His seminal work, however, was only published in 1975.<sup>2</sup> A reason for great repercussion was the case reported by Eastcott et al., who published what they believed to be the first case of brain revascularization – resection of the atheromatous segment followed by terminoterminal anastomosis of the common with the internal carotid artery, under moderate hypothermia, in 1954.<sup>3</sup> In the 1950's and 1960's, that procedure was widely diffused, to the extent of reaching the 1970's with more than 100,000 annual procedures in the USA. That scenario made the American Society of Vascular Surgery hire an independent medical auditing led by the neurologist H. Barnett, who concluded that about 60% of carotid surgeries had questionable or inadequate indication. With the aim of defining indications and results of CEA, two studies were conducted, *North American Symptomatic Carotid Endarterectomy Trial* (NASCET) and *European Carotid Surgery Trial* (ECST), well consolidated trials that defined indication of carotid procedures.<sup>4,5</sup>

After confirmation of good CEA outcomes in those studies, compared with the clinical treatment (patients submitted to control of risk factors and use of platelet antiaggregating agents), the number of surgeries grew again in the 1990's.

Over the past years, with the advent of the endovascular technique, carotid angioplasty and *stenting* (CAS) has been increasingly indicated. The industrial complex has encouraged comparative studies, with the aim of justifying use of this technique for the treatment of carotid disease, especially in patients characterized as "high risk," in whom there might be a competitive advantage in favor of this new technique.

There already are eight studies comparing both techniques: LEICESTER, WALLSTENT, CAVATAS, LEXINGTON I and II, SAPPHIRE, EVA-3S and SPACE. However, so far there has been no evidence of CAS superiority over CEA.<sup>6-13</sup>

In Brazil, practice of carotid surgery has more than 40 years, and a survey has been published about indications and about who would indicate that procedure: neurologists, cardiologists or vascular surgeons.<sup>14</sup> Increased interest on this theme is shown by the publication of more than 10 papers in *Jornal Vascular Brasileiro*, and an issue has recently received two editorials: one of them justifying indication of the endovascular technique<sup>15</sup> and another basically performing a description of comparative studies, with comments on both techniques by the author at the end of the paper.<sup>16</sup>

This analysis aims at describing comparative data between both techniques, based on facts taken from a wide literature review, associated with considerations, comments and positions about the

treatment of atherosclerotic carotid disease.

## Indications of carotid endarterectomy

It is worth stressing that CEA is a procedure that has been performed for more than 50 years. Therefore, there has been enough time to analyze its benefits and limitations in the short, medium and long term. It is likely that any other surgical procedure has been so much discussed and audited over the past years.

Indications for CEA were established by classical studies, such as NASCET, ECST and *Veterans Affairs Study* (VA) in symptomatic patients and by the trials *Executive Committee for the Asymptomatic Carotid Atherosclerosis Study* (ACAS) and *Asymptomatic Carotid Surgery Trial* (ACST) in asymptomatic patients.<sup>5,14,17-19</sup> Global surgical risk of stroke and death was 5.5% in NASCET, 7.5% in ECST and 1.1% in VA,<sup>4,5,20</sup> whereas in ACAS and ACST it was 2.3 and 3.1%, respectively.

Considering the different criteria to measure the degree of stenosis by the studies NASCET and ECST, the *Carotid Endarterectomy Trialists Collaboration* (CETC) analyzed the results of the three main studies in symptomatic patients, showing a maximum benefit in symptomatic patients with stenosis between 70-99% (NNT = 6, meaning that only six patients submitted to surgery would be needed to avoid a negative outcome – stroke).<sup>19</sup> In addition, certain groups of patients have a greater benefit with CEA: males; presence of contralateral occlusion; aged over 75 years; hemispheric symptoms; irregular plaque; and associated intracranial disease.<sup>21</sup>

Many critics stress that such studies do not reliably illustrate CEA results in daily practice. In this context, it was demonstrated through the analysis of the American Medicare data that, from 1985 to 1996, rates of stroke and death were 3% in 61,273 procedures performed in 1985, and 1.6% in 108,275 procedures in 1996.<sup>22</sup> In that same study, the authors also demonstrated that stroke and death rates were associated with number of procedures performed per surgeon – 1.9% for surgeons with more than 50 annual procedures and 2.5% for surgeons with less than 20 annual surgeries.

With regard to studies involving asymptomatic individuals, the ACAS demonstrated benefits of the surgery in male patients without significant comorbidities, with carotid stenosis equal or higher than 60%.<sup>17</sup> The ACST, published in 2004, basically demonstrated that CEA reduced risk of fatal stroke in half, and both men and women were benefited by the surgery.<sup>19</sup> The clinical implications of those two studies were stressed by Naylor, from England: "men with asymptomatic stenosis between 60-99% and with good clinical conditions and aged less than 75 years are benefited by prophylactic CEA, and such benefit is smaller in women."<sup>23</sup>

Next, situations considered as high risk are presented, in which choice between both procedures can be proposed based on data published over the past 10 years.

## Residual or recurrent stenosis

Residual stenosis, although rare, characterizes a form of patient undertreatment, since the atheromatous plaque was not completely removed. The previous surgeon maintained a portion of the distal plaque, or performed a plaque dissection in superficial section, inadequate for the surgery objective, i.e., complete removal of the lesion. An example of that can be seen in Figure 1. Arteriography represents the tissue lesion of a patient that had been submitted to CEA, around 30 days before, in another service. In this case, we identified presence of tissue lesion in the internal

carotid artery, performing endarterectomy with complete removal of residual plaque (Figure 2). The patient had good postoperative course and is currently with 5 years of follow-up and no late complications.



Figure 1 - Residual stenosis in a patient submitted to surgery 30 days ago



Figure 2 - Plaque removed from a patient submitted to previous incomplete endarterectomy

Recurrent stenosis can be caused by myointimal hyperplasia or by recurrent atheromatous plaque. Myointimal hyperplasia is characterized by exuberant fibrous proliferation. It is usually early, commonly between 6 months and 2 years after the procedure, characterized by smooth superficial

layer, with minimal potential of embolization. Diagnosis is generally performed by auscultation of carotid murmur and by color-flow Doppler ultrasound or angiographic tomography. Surgical treatment is rarely required, although this indication has been exaggerated over the past years.

Recurrent atheromatous plaque usually has late presentation (usually after 5 years of surgery). It can be located in the area previously submitted to endarterectomy, in the proximal portion of the common carotid or in the distal portion of arteriorrhaphy. This has been one of the indications for endovascular treatment, but it should be considered that, in recurrent arteriorrhaphy lesion, surgical indication can also be well supported when performed by an experienced surgeon, since the degree of technical demand is higher.

Personally, in cases of recurrent stenosis due to atheromatous plaque, we use conventional access, avoiding direct dissection of the distal portion of the internal carotid artery, before obtaining control of retrograde flow using a Fogarty catheter. That maneuver allows us to avoid exaggerated and more traumatic dissection in an area with fibrosis, which makes the procedure more difficult. If the late lesion is a stenosis of the common carotid artery ostium, we can use proximal endarterectomy using the RIFIFI technique (retrograde endarterectomy using Vollmar ring occluding the common carotid artery emergence with a Fogarty catheter).<sup>24</sup> It demands more experience by surgeons. In the last 250 cases we treated, that technique was necessary in five patients (2%), who had proximal common carotid artery lesion. There were no deaths or strokes in the perioperative period (unpublished data).

## Previous cervical radiation

The lesion usually has a difficult access due to diffuse fibrosis and longer extension, generating difficulties in dissection and procedure performance. It can cause a higher number of cranial nerve lesions. For some authors, CEA outcomes in patients previously submitted to radiotherapy have been encouraging, such as inexistent neurological morbidity perioperative mortality rates.<sup>25,26</sup>

However, CAS can be considered the first option, although its medium-term outcomes are not well known.

## Presence of *kinking* in the internal carotid artery

Existence of a hemodynamically significant and symptomatic *kinking*, usually associated with atheromatous plaque of the proximal internal carotid artery, can require treatment. Its anatomical characteristics may limit endovascular technique. However, *kinking* can be corrected using the technique of endarterectomy with eversion, since there is usually proximal atheromatous plaque and, after endarterectomy, reimplantation of the internal carotid artery at the bifurcation level, with or without resection of the redundant artery segment, has very good results.<sup>27,28</sup> Figure 3 shows a perioperative image, and Figure 4 shows the control of a patient 10 years after the procedure, with excellent outcome. In our 250 most recent cases, there was presence of *kinking* in 40 patients (16%). Of these, there was one transient ischemic attack (2.5%) and one perioperative death (2.5%).

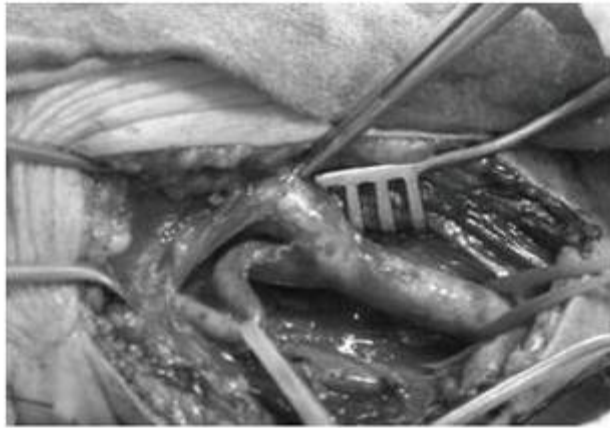


Figure 3 - Kinking of the right internal carotid artery (perioperative)

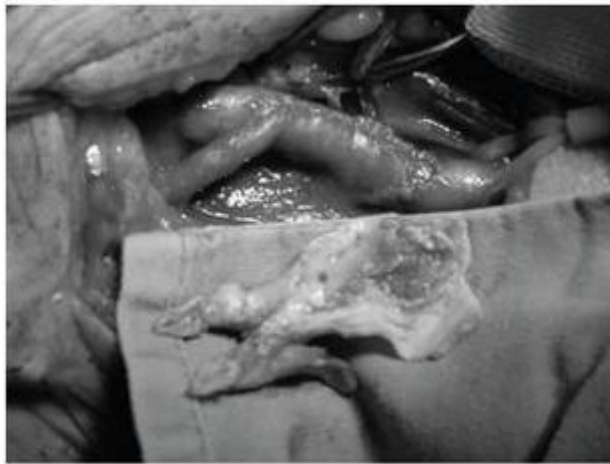


Figure 4 - Outcome after endarterectomy with eversion and reimplantation of the internal carotid artery (aspects of removed plaque)

## Distal stenosis

Presence of distal stenosis of the internal carotid artery is not a common situation, and it can be detected in less than 5% of cases submitted to surgery.<sup>29</sup> It is being currently indicated for endovascular treatment, since CEA results in higher incidence of cranial nerve lesion.<sup>30</sup> To avoid that problem, we have used conventional access and intraluminal control of reflux, using a Fogarty catheter placed in distal position. Thus, there are conditions of a high dissection of the plaque and its consequent removal, with good outcome. Other surgical maneuvers, such as section of the digastric muscle and mandibular subluxation, may also be needed.<sup>30,31</sup>

Distal lesions can be an indication for endovascular treatment, especially if the surgeon has little experience with the conventional procedure.

## Old age

Patients older than 80 years have been suggested as risk factor for the conventional technique, CAS being recommended in that situation.<sup>32</sup> The literature, however, has demonstrated that such conduct is wrong, since exactly the opposite has been observed. Many studies have demonstrated extremely high stroke and death rates, between 9.2-25% in the endovascular treatment in patients older than 80 years.<sup>33-35</sup> This fact can be due to several factors, such as presence of more extensive atherosclerotic lesions, with higher calcification degree in the bifurcation, associated with presence of ulcers and thrombi. There may also be proximal ostial stenoses, which make catheter passage difficult, or ulcerated lesions at the aortic arch level, which facilitate mobilization of fragment of plaques or thrombi by passing catheters and devices used in carotid angioplasty.

As to the conventional technique, since the treatment is direct, the surgeon can adopt some cares that are essential and that benefit the patient. If performed with excellent technique, it can avoid intravascular manipulation, resulting in stroke and death percentages around 1.9-4.8%, as shown in Table 1.<sup>36-39</sup>

Table 1 - Outcomes of CEA and CAS in octogenarians

Author, year	Technique	n	Stroke and death (%)
Chastain et al., 1999 <sup>33</sup>	CAS	24	25%
Roubin et al., 2001 <sup>32</sup>	CAS	66	16%
Hobson et al., 2004 <sup>35</sup>	CAS	99	12.1%
Stanziale et al., 2006 <sup>34</sup>	CAS	87	9.2%*
Perler et al., 1994 <sup>36</sup>	CEA	63	4.8%
Van Damme et al., 1996 <sup>37</sup>	CEA	129	3.1%
O'Hara et al., 1998 <sup>38</sup>	CEA	161	1.9%
Rockman et al., 2003 <sup>39</sup>	CEA	182	3.3%

CAS = carotid angioplasty and *stenting*; CEA = carotid endarterectomy.

\* Includes acute myocardial infarction.

It can be concluded that, from the practical perspective, in patients aged 80 years or more, the endovascular treatment should be contraindicated, since the conventional treatment (carotid endarterectomy) has better short- and medium-term outcomes.

## Contralateral occlusion

The treatment of carotid stenosis in patients with contralateral occlusion (CLO) has been stigmatized as a high-risk procedure. A citation from the results of the NASCET study has been wrongly used, showing an approximate 14% rate of perioperative morbidity and mortality in a restricted group of 21 patients.<sup>4</sup> However, recent studies have demonstrated good outcomes of CEA in patients with CLO, with mortality and neurological complications close to 5% (Table 2).<sup>40-49</sup>

**Table 2 - CEA outcomes in patients with contralateral occlusion of the carotid artery**

Author, year	n	stroke (%)	Death (%)
Mackey et al., 1990 <sup>40</sup>	63	4.8	0
Mattos et al., 1992 <sup>41</sup>	66	3.0	1.5
Meyer et al., 1993 <sup>42</sup>	357	1.7	1.1
Deriu et al., 1994 <sup>43</sup>	61	1.7	0
Coyle et al., 1996 <sup>44</sup>	116	4.3	2.6
Samson et al., 1998 <sup>45</sup>	67	1.5	1.5
Pulli et al., 2002 <sup>46</sup>	82	2.4	0
Rockmann et al., 2002 <sup>47</sup>	338	3.0	0.6
Bonamigo et al., 2004 <sup>48</sup>	61	1.6	4.9
Grego et al., 2005 <sup>49</sup>	144	0.7	0

CEA = carotid endarterectomy.

By analyzing NASCET data, it is possible to observe some causes that might have been important for the poor outcomes in this group of patients. The sample of patients with CLO was small (n = 21) and the neurological events occurred in the immediate postoperative period. This is usually due to a technical problem more associated with the surgeon, and not to disease severity. An intraluminal *shunt* was not used in two out of three patients who progressed with stroke after the surgery, which could have been avoided if intraoperative brain protection had been used. We believe that use of *shunt* is a crucial issue in carotid surgery, especially for patients with CLO. Not using it because one thinks it is dangerous may characterize a form of undertreatment. In a recently published study, we used *shunt* in almost 90% of patients with CLO. There was one stroke (1.6%) and three deaths, two of them due to acute myocardial infarction (AMI) and another resulting from postoperative stroke (4.9%). One of the patients who had a fatal AMI was submitted to associated myocardial revascularization (MR).<sup>48</sup> Samson et al.,<sup>45</sup> through the analysis of 27 articles on carotid endarterectomy in patients with CLO, observed that occurrence of stroke in patients in whom the *shunt* was not used (6.2%) was practically the double than in patients in whom the device was routinely used (3%).

Another interesting aspect to obtain good outcomes in patients with CLO is medical team experience. Bonamigo et al.<sup>48</sup> identified that, in studies reporting less than 50 patients submitted to surgery, mortality and stroke rates were 6.5 and 9.9%, respectively, whereas in studies reporting more than 50 patients, those rates were 1.6 and 4.1%, respectively.

## Associated myocardial revascularization

Patient with carotid and coronary disease with indication of MR have also been considered as high risk.<sup>50</sup>

Through a compilation of outcomes in 49 studies about this theme, rates of postoperative stroke, AMI and death were 4.3, 2.2 and 4.2%, respectively, in a total of 4,788 patients studied.<sup>51</sup> Naylor et al.<sup>52</sup> published a systematic review of 94 articles, finding stroke, AMI and death rates of 4.6, 3 and 4.6%, respectively. Similarly, Rizzo et al.<sup>53</sup> found stroke, AMI and death rates of 5.6, 3 and 4.8% in 1,815 patients analyzed. Table 3 shows those outcomes.<sup>51-55</sup>



**Table 3 - Outcomes of carotid surgery concomitant to MR in recent published studies**

Author, year	n	stroke (%)	AMI (%)	Death (%)
Rizzo et al., 1992 <sup>53</sup>	1,815	5.6	3.0	4.8
Naylor et al., 2003 <sup>52</sup>	7,863	4.6	3.6	4.6
Kolh et al., 2006 <sup>54</sup>	311	3.8	2.2	6.1
Byrne et al., 2006 <sup>55</sup>	702	0.92	-	3.1
Lucas et al., 2005	4,788	4.3	2.2	4.2

AMI = acute myocardial infarction; MR = myocardial revascularization.

With those data, it is possible to conclude that CEA associated with MR can be performed with adequate results if the cardiologic status is reasonable and the carotid lesion is significant and symptomatic. In exceptional cases, such as MR due to unstable angina or extensive coronary lesion associated with critical carotid lesion with CLO, it is obvious that the percentage of stroke/death/AMI will be higher.

## High-risk patients for carotid endarterectomy

Over the past years, many authors have indicated the endovascular treatment for patients characterized as high risk. The SAPPHIRE, published by Yadav et al. in 2004, was the study that insisted the most in that, justifying indication of the endovascular treatment with 30-day stroke and death rates of 4.8%, compared with 9.8% rates in the surgical group ( $p = 0.09$ ).<sup>11</sup> Opposed to that position, Mozes et al.,<sup>56</sup> at Mayo Clinic, published a series of 323 cases with patients considered as high risk and, therefore, suitable for endovascular treatment as proposed by the SAPPHIRE study. Mozes et al., using the conventional technique, had stroke and death rates of only 1.4 and 0.3%, respectively. The results of the surgical group in the SAPPHIRE study and in other comparative studies show a significant difference between historic series of CEA and the results reported by such comparative studies, as shown in Table 4.<sup>57-59</sup>

**Table 4 - CEA results in many reference services**

Author, year	Service	n	Stroke	Death
Sundt et al., 1986 <sup>57</sup>	Mayo Clinic	1,935	1.8%	1.3%
Riles, 1994 <sup>58</sup>	New York	3,062	2.1%	1.4%
Hertzer et al., 1997 <sup>59</sup>	Cleveland	1,924	1.8%	0.5%

CEA = carotid endarterectomy.

If one questioned that reference centers do not represent global experience, we could bring data from Medicare, published by Hsia et al., in which stroke/death rates were 3% in 1985 and 1.6% in 1996.<sup>22</sup>

Other authors published studies about the definition and conduct in high-risk patients.<sup>60-62</sup> Gasparis et al.<sup>60</sup> defined high risk in two groups: physiological risk and anatomic risk. In the former, they included 80 patients older than 80 years, 11 with AMI over the past 6 months, 16 with heart failure, chronic pulmonary occlusive disease and 13 with serum creatinine levels above 3 mg/dL. In anatomic risk, they included 66 patients with contralateral occlusion, 29 cases of reoperations, three

patients with previous radiotherapy and 53 with distal lesion.<sup>60</sup> Those authors possibly published the best study to demonstrate the mystification created with the widespread use of the "high risk" classification. They were careful enough to offer the 560 low-risk patients the same cares provided to the group of 228 high-risk patient, namely *patch* in 86 and 84% of cases, internal *shunt* in 93 and 97% of cases and general anesthesia in 98% of cases. Thus, they had a very similar stroke and death rate, that is, 1.1% for the low-risk group and 1.3% for the so-called high-risk group.

It can be concluded that the high-risk factor, as reported and accepted by many, sometimes is more associated with how the procedure is performed than to the patient's comorbidity.

## Limitations of the endovascular technique

Studies aiming at supporting indication of endovascular treatment are comparative, funded by the industry with the purpose of being approved by the *Food and Drug Administration* (FDA) for commercialization of devices in the USA. Since the FDA demands, at least, non inferiority to the results obtained with conventional technique, it is easy to understand how the study is designed and how patients are selected in the surgical branch. They have demonstrated surgical results that are much different from what is observed in other reference services, as well as from the results of general experience with patients at Medicare (Table 5).<sup>11-13,56,60,63</sup>

**Table 5 - Comparative results of the treatment of carotid lesion using CEA and CAS**

Authors, year (n)	Endovascular technique (stroke/death)	Carotid endarterectomy (stroke/death)
Ecker et al., 2003 <sup>63</sup> (1,000)	-	1.9%
Gasparis et al., 2003 <sup>60</sup> (560)	-	1.1%
Mozes et al., 2004 <sup>56</sup> (323)	-	1.7%
SAPPHIRE, 2004 <sup>11</sup> (334)	4.8%	9.8%*
EVA-3S, 2006 <sup>12</sup> (527)	9.6%	3.9%
SPACE, 2006 <sup>13</sup> (1,183)	6.8%	6.3%

CAS = carotid angioplasty and *stenting*; CEA = carotid endarterectomy.

\* Includes chemical AMI (elevation of troponin) in the postoperative period.

By acting like that, the studies SAPPHIRE and SPACE showed very similar results, certainly due to reasons explained above.<sup>11,13</sup> The EVA-3S study, funded by the French Department of Health and performed in university centers, showed extremely favorable results regarding endarterectomy (3.9% in the CEA group and 9.6% in the CAS group), the reason why the ethics committee determined its suspension, since the evidence had already been confirmed.<sup>12</sup>

Another interesting aspect is identification of selection criteria of patients for CEA or CAS, proposed by Becquemin, a French surgeon experienced in both techniques.<sup>64</sup> In Table 6, there are 11 indications for CEA and only three for CAS, showing that the anatomic aspects is also a limiting factor of using CAS. If this detail is not considered critically, it is almost certain that many endovascular procedures will not be concluded and, if so, they will have a high rate of complications after the procedure. Becquemin concluded the chapter claiming that: "There is neither evidence nor consensus regarding selection of patients for carotid angioplasty. Before choosing between surgery or angioplasty with *stenting*, procedure risks should be carefully examined, including general, local and neurological risks. In addition, risk of technical failure due to anatomic peculiarities should also be taken into account".<sup>64</sup>

**Table 6 - Selection criteria of patients for CEA or CAS, according to Becquemin, 2004<sup>64</sup>**

	CEA	CAS
Severe coronary disease	?	?
Aortic valve calcification	+++	+/-
Renal failure	++	+
Age > 80 years	+++	+
Aortic arch disease	+++	-
Tortuosity or <i>kinking</i>	+++	+
Aortoiliac disease	+++	+
Unstable plaque	+++	+
Echolucent plaque	+++	+
Circular calcium plaque	+++	+
Atheromatous plaque	+++	+++
Fluctuating thrombus	+++	+
Recurrent stenosis	+	+++
Previous radiotherapy	+	+++

CAS = carotid angioplasty and *stenting* ; CEA = carotid endarterectomy.  
 Source: Becquemin.<sup>64</sup>

We believe it is important to include in this text conclusions of a systematic review recently performed by Biasi et al.<sup>65</sup> Those authors published an important review about indications of CEA and CAS, focusing on prevention of brain embolization. After a long discussion of this theme, based on the analysis of classical studies, such as NASCET, ECST and ACAS, and studies comparing both techniques, such as CaRESS,<sup>66</sup> SAPPHERE,<sup>11</sup> SPACE,<sup>13</sup> ARCHER<sup>67</sup> and EVA-3S,<sup>12</sup> concluded by listing 10 recommendations or comments, as follows:

The premise that surgical risk is higher in patients excluded from the NASCET and ACAS study or adequate for the ARCHER study has not been confirmed.

There is no accepted criterion to definitely identify high-risk patients for CEA.

Indications of CAS as an alternative for CEA in high-risk patients are questionable.

The definition of high-risk patients should not be considered as reasonable to abandon CEA in favor of CAS.

Due to the low risk associated with CEA, CAS should be restricted to studies of records or to randomized clinical trials (RCT).

If there is a high-risk group, it is small and restricted to recurrent stenosis, hostile neck due to radiotherapy and only corresponds to 4% of series.

The series discussed in this analysis show that high-risk patients can be submitted to CEA with stroke rates equivalent to those observed in low-risk patients. It is unlikely that CAS offers any improvement in risk of stroke, compared with CEA.

Patients older than 80 years have increased risk of stroke during CAS, but an acceptable risk for CEA.

Much care should be given to asymptomatic individuals with multiple risk factors, in whom a predictable long-term benefit by CEA can be markedly reduced by survival of only 5 years.

Patients who are really high risk have short life expectancy and are better treated without intervention.

The authors also studied risk of brain embolization by both techniques and concluded that risk of brain embolization using the endovascular technique is eight times more frequent than using carotid endarterectomy.<sup>65</sup>

That aspect had already been reported by other authors.<sup>68,69</sup> Occurrence of early dementia was reported by Vermeer et al.<sup>70</sup> Even brain infarctions considered silent can be associated with a major cognitive decline and dementia, in the follow-up of patients submitted to endovascular treatment.

## Conclusion

CEA is a well established procedure with good short-, medium- and long-term outcomes. It is still the predominant indication for most situations involving atherosclerotic carotid disease, presenting good outcomes, even in situations considered as high risk, as long as it is performed by an experienced and well trained surgeon. CAS may have a complementary role in the treatment of carotid disease, such as in cases of hostile neck due to previous radiotherapy and recurrent stenosis of a very distal lesion. Therefore, in our opinion, it is a procedure limited to a small number of patients (approximately 4% of cases).

This issue is still polemical and obviously has many interpretations and criticisms. A thorough discussion of this theme, involving all related aspects (ethical, medical and economic) can and should be encouraged. The patient's interest should prevail and the best treatment must be provided. Finally, it is important to remember that "light can result from a thorough and open debate."

## References

1. Carrea R, Molins M, Murphy G. Surgical treatment of spontaneous thrombosis of the internal carotid artery in the neck. Carotid-carotideal anastomosis. Report of a case. Acta Neurol Latinoamer. 1955; 1: 71-8.
2. DeBakey ME. [Successful carotid endarterectomy for cerebrovascular insufficiency](#). Nineteen-year follow-up. JAMA 1975; 233: 1083-5.
3. Eastcott HH, Pickering GW, Rob CG. [Reconstruction of internal carotid artery in a patient with intermittent attacks of hemiplegia](#). Lancet. 1954; 267: 994-6.
4. [Beneficial effect of carotid endarterectomy in symptomatic patients with high grade stenosis](#) . North American Symptomatic Carotid Endarterectomy Trial Collaborators. N Engl J Med. 1991; 325: 445-53.
5. European Carotid Surgery Trialists Collaborative Group. [MRC European Carotid Surgery Trial: interim results of symptomatic patients with severe \(70-99%\) or with mild \(0-29%\) carotid stenosis](#). Lancet. 1991; 337: 1235-43.

6. Naylor AR, Bolia A, Abbott RJ, et al. [Randomized study of carotid angioplasty and stenting versus carotid endarterectomy: a stopped trial.](#) J Vasc Surg. 1998; 28: 326-34.
7. Alberts MJ. [Results of a multicenter prospective randomized trial of carotid artery stenting versus carotid endarterectomy.](#) Stroke. 2001; 32: 325.
8. CAVATAS investigators. [Endovascular versus surgical treatment in patients with carotid stenosis in the Carotid and Vertebral Artery Transluminal Angioplasty Study \(CAVATAS\): a randomized trial.](#) Lancet. 2001; 357: 1729-37.
9. Brooks WH, McClure RR, Jones MR, Coleman TC, Breathitt L. [Carotid angioplasty and stenting versus carotid endarterectomy: randomized trial in a community hospital.](#) J Am Coll Cardiol. 2001; 38: 1589-95.
10. Brooks WH, McClure RR, Jones MR, Coleman TC, Breathitt L. [Carotid angioplasty and stenting versus carotid endarterectomy for treatment of asymptomatic carotid stenosis: a randomized trial in a community hospital.](#) Neurosurgery. 2004; 54: 318-24.
11. Yadav JS, Wholey MH, Kuntz RE, et al. [Protected carotid-artery stenting versus endarterectomy in high-risk patients.](#) N Engl J Med. 2004; 351: 1493-501.
12. EVA-3S Investigadors. [Endarterectomy versus stenting in patients with severe symptomatic stenosis.](#) N Engl J Med. 2006; 355: 1660-71.
13. ACE Collaborative Group; Ringleb PA, Allenberg J, et al. [30 days results from the SPACE trial of stent-protected angioplasty versus carotid endarterectomy in symptomatic patients: a randomised non-inferiority trial.](#) The SPACE Collaborative Group. Lancet. 2006; 368: 1239-47.
14. Bonamigo TP, Nienchenski A, Copal A. Cirurgia carotídea no Brasil no ano de 1989. Relato de estudo cooperativo. Rev Angiol Cir Vasc. 1992; 1: 146-52.
15. Karakhanian W. [Estenose de carótida: por que defendo o tratamento endovascular.](#) J Vasc Bras. 2006; 5: 174-6.
16. Pereira AH. [Angioplastia da carótida versus endarterectomia: o velho e o novo.](#) J Vasc Bras. 2006; 5: 169-73.
17. Executive Committee for the Asymptomatic Carotid Atherosclerosis Study. [Endarterectomy for asymptomatic carotid artery stenosis.](#) JAMA. 1995; 273: 1421-8.
18. Halliday A, Manfield A, Masso J et al. The MRC Asymptomatic Carotid Surgery Trial (ACST). [Prevention of disabling and fatal strokes by successful carotid endarterectomy in patients without recent neurologic symptoms: randomised controlled trial.](#) Lancet. 2004; 363: 1491-502.
19. Rothwell PM, Eliasziw M, Gutnikov AS, et al. [Analysis of pooled data from the randomised controlled trials of endarterectomy for symptomatic carotid stenosis.](#) Lancet. 2003; 361: 107-16.
20. Mayberg MR, Wilson SE, Yatsu F, et al. [Carotid endarterectomy and prevention of cerebral ischemia in symptomatic carotid stenosis.](#) Veterans Affairs Cooperative Studies Program 309 Trialist Group. JAMA. 1991; 266: 3289-94.
21. Rothwell PM, Eliasziw M, Gutnikov SA, Warlow CP, Barnett HJ; Carotid Endarterectomy Trialists Collaboration. [Endarterectomy for symptomatic carotid stenosis in relation to clinical subgroups and timing of surgery.](#) Lancet. 2004; 363: 915-24.

22. Hsia DC, Moscoe LM, Krushat WM. [Epidemiology of carotid endarterectomy among Medicare beneficiaries:1985-1996 Update](#). Stroke. 1998;29:346-50.
23. Naylor AR. An update of the randomized trials of interventions for symptomatic and asymptomatic carotid artery disease. J Vasc Endovasc Surg. 2006;13:111-20.
24. Vollmar J, Laubach K, Gruss JD. [\[The technique of thrombendarterectomy \(spiral ring disobliteration\)\]](#). Bruns Beitr Klin Chir. 1969;217:678-90.
25. Hassen-Khodja R, Sala F, Declémy S, Lagrange J-L, Bouillane P-J, Batt M. [Surgical management of atherosclerotic carotid artery stenosis after cervical radiation therapy](#). Ann Vasc Surg. 2000;14:608-11.
26. Kashyap VS, Moore WS, Quinones-Baldrich WJ. [Carotid artery repair for radiation-associated atherosclerosis is a safe and durable procedure](#). J Vasc Surg. 1999;29:90-6.
27. Ballotta E, Thiene G, Baracchini C, et al. [Surgical vs medical treatment for isolated internal carotid artery elongation with coiling or kinking in symptomatic patients: a prospective randomized clinical study](#). J Vasc Surg. 2005;42:838-46.
28. Grego F, Lepidi S, Cognolato D, Frigatti P, Morelli I, Deriu GP. [Rationale of the surgical treatment of carotid kinking](#). J Cardiovasc Surg (Torino). 2003;44:79-85.
29. Hans SS, Shah S, Hans B. [Carotid endarterectomy for high plaques](#). Am J Surg. 1989;157:431-4.
30. Frim DM, Padwa B, Buckley D, Crowell RM, Ogilvy CS. [Mandibular subluxation as an adjunct to exposure of the distal internal carotid artery in endarterectomy surgery](#). Technical note. J Neurosurg. 1995;83:926-8.
31. Simonian GT, Pappas PJ, Padberg FT Jr., et al. Mandibular subluxation for distal internal carotid exposure: technical considerations. J Vasc Surg. 1999;30:1116-20.
32. Roubin GS, New G, Iyer SS, et al. [Immediate and late clinical outcomes of carotid artery stenting in patients with symptomatic and asymptomatic carotid artery stenosis: a 5-year prospective analysis](#). Circulation. 2001;103:532-7.
33. Chastain HD 2nd, Gomez CR, Iyer S, et al. [Influence of age upon complications of carotid artery stenting](#). UAB Neurovascular Angioplasty Team. J Endovasc Surg. 1999;6:217-22.
34. Stanziale SF, Marone LK, Boules TN, et al. [Carotid artery stenting in octogenarians is associated with increased adverse outcomes](#). J Vasc Surg. 2006;43:297-304.
35. Hobson RW 2nd, Howard VJ, Roubin GS, et al. [Carotid artery stenting is associated with increased complications in octogenarians: 30-day stroke and death rates in the CREST lead-in phase](#). J Vasc Surg. 2004;40:1106-11.
36. Perler BA, Williams GM. [Carotid endarterectomy in the very elderly: is it worthwhile?](#) Surgery. 1994;116:479-83.
37. Van Damme H, Lacroix H, Desiron Q, Nevelsteen A, Limet R, Suy R. [Carotid surgery in octogenarians: is it worthwhile?](#) Acta Chir Belg. 1996;96:71-7.
38. O'Hara PJ, Hertzner NR, Mascha EJ, Beven EG, Krajewski LP, Sullivan TM. [Carotid endarterectomy](#)

in octogenarians: early results and late outcome. J Vasc Surg. 1998;27:860-9.

39. Rockman CB, Jacobowitz GR, Adelman MA, et al. The Benefits of carotid endarterectomy in the octogenarian: a challenge to the results of carotid angioplasty and stenting. Ann Vasc Surg. 2003;17:9-14.

40. Mackey WC, O'Donnell TF Jr, Callow AD. Carotid endarterectomy contralateral to an occluded carotid artery: perioperative risk and late results. J Vasc Surg. 1990;11:778-83.

41. Mattos MA, Barkmeier LD, Hodgson KJ, Ramsey DE, Sumner DS. Internal carotid artery occlusion: operative risks and long term stroke after contralateral carotid endarterectomy. Surgery. 1992;112:670-9.

42. Meyer FB, Fode NC, Marsh WR, Piepgras DG. Carotid endarterectomy in patients with contralateral carotid occlusion. Mayo Clin Proc. 1993;68:337-42.

43. Deriu GP, Franceschi L, Milite D, et al. Carotid artery endarterectomy in patients with contralateral carotid artery occlusion: perioperative hazards and late results. Ann Vasc Surg. 1994;8:337-42.

44. Coyle KA, Smith RB 3rd, Salam AA, Dodson TF, Chaikof EL, Lumsden AB. Carotid endarterectomy in patients with contralateral carotid occlusion: review of a 10-year experience. Cardiovasc Surg. 1996;4:71-5.

45. Samson RH, Showalter DP, Yunis JP. Routine carotid endarterectomy without a shunt, even in presence of a contralateral occlusion. Cardiovasc Surg. 1998;6:475-84.

46. Pulli R, Dorigo W, Barbanti E, et al. Carotid endarterectomy with contralateral carotid artery occlusion: is this a higher risk subgroup? Eur J Vasc Endovasc Surg. 2002;24:63-8.

47. Rockman C, Su W, Lamparello PJ, et al. A reassessment of carotid endarterectomy in the face of contralateral occlusion: surgical results in symptomatic and asymptomatic patients. J Vasc Surg. 2002;36:668-73.

48. Bonamigo TP, Weber EL, Lucas ML, Bianco C, Cardozo MA. Carotid endarterectomy in patients with contralateral occlusion: a 10-year experience. J Vasc Bras. 2004;3:197-205.

49. Grego F, Antonello M, Lepidi S, et al. Is contralateral carotid artery occlusion a risk factor for carotid endarterectomy? Ann Vasc Surg. 2005;19:882-9.

50. Chiariello L, Tomai F, Zeitani J, Versaci F. Simultaneous hybrid revascularization by carotid stenting and coronary artery bypass grafting. Ann Thorac Surg. 2006;81:1883-5.

51. Lucas ML, Bonamigo TP, Weber EL, Lucchese F. [Combined carotid endarterectomy and coronary artery bypass grafting]. Analysis of the results. Arq Bras Cardiol. 2005;85:412-20.

52. Naylor R, Cuffe RL, Rothwell PM, Loftus IM, Bell PR. A systematic review of outcome following synchronous carotid and coronary artery bypass: influence of surgical and patients variables. Eur J Vasc Endovasc Surg. 2003;26:230-41.

53. Rizzo RJ, Whittemore AD, Couper GS, et al. Combined carotid and coronary revascularization: the preferred approach to the severe vasculopath. Ann Thorac Surg. 1992;54:1099-08.

54. Kolh PH, Comte L, Tchana-Sato V, et al. Concurrent coronary and carotid artery surgery: factors

[influencing perioperative outcome and results](#). Eur Heart J. 2006;27:49-56.

55. Byrne J, Darling RC 3rd, Roddy SP, et al. [Combined carotid endarterectomy and coronary artery bypass grafting in patients with asymptomatic high-grade stenoses: an analysis of 758 procedures](#). J Vasc Surg. 2006;44:67-72.

56. Mozes G, Sullivan TM, Torres-Russotto DR, et al. [Carotid endarterectomy in SAPHIRE-eligible high-risk patients: implications for selecting patients for carotid angioplasty and stenting](#). J Vasc Surg. 2004;39:958-65.

57. Sundt TM Jr., Ebersold MJ, Sharbrough FW, Piegras DG, Marsh WR, Messick JM Jr. [The risk-benefit ratio of intraoperative shunting during carotid endarterectomy. Relevancy to operative and postoperative results and complications](#). Ann Surg. 1986;203:196-204.

58. Riles TS. [Surgical management of internal carotid artery stenosis: preventing complications](#). Can J Surg. 1994;37:124-7.

59. Hertzner NR, O'Hara PJ, Mascha EJ, Krajewski LP, Sullivan TM, Beven EG. [Early outcome assessment for 2228 consecutive carotid endarterectomy procedures: the Cleveland Clinic experience from 1989 to 1995](#). J Vasc Surg. 1997;26:1-10.

60. Gasparis AP, Ricotta L, Cuadra SA, et al. [High-risk carotid endarterectomy: fact or fiction](#). J Vasc Surg. 2003;37:40-6.

61. Reed AB, Gaccione P, Belkin M, et al. [Preoperative risk factors for carotid endarterectomy: defining the patient at high-risk](#). J Vasc Surg. 2003;37:1191-9.

62. Pulli R, Dorigo W, Barbanti E, et al. [Does the high-risk patient for carotid endarterectomy really exist?](#) Am J Surg. 2005;189:714-9.

63. Ecker, RD, Pichelmann MA, Meissner I, Meyer FB. [Durability of Carotid Endarterectomy](#). Stroke. 2003;34:2941-4.

64. Becquemin J-P. Endovascular treatment of carotid disease. In: Hallett JW Jr, Mills JL, Earnshaw JJ, Reekers JA, editors. Comprehensive vascular and endovascular surgery. Edinburgh: Mosby; 2004. Chapter 37.

65. Biasi GM, Froio A, Deleo G, Lavitrano M. [Indication for carotid endarterectomy versus carotid stenting for the prevention of brain embolization from carotid artery plaques: in search of consensus](#). J Endovasc Ther. 2006;13:578-91.

66. CaRESS Steering Committee. [Carotid revascularization using endarterectomy or stenting systems \(CaRESS\) phase I clinical trial: 1-year results](#). J Vasc Surg. 2005;42:213-9.

67. Gray WA, Hopkins LN, Yadav S, et al. [Protected carotid stenting in high-surgical-risk patients: the ARCHeR results](#). J Vasc Surg. 2006;44:258-69.

68. Jaeger HJ, Mathias KD, Hauth E, et al. [Cerebral ischemia detected with diffusion-weighted MR imaging after stent implantation in the carotid artery](#). AJNR Am J Neuroradiol. 2002;23:200-7.

69. Schluter M, Tubler T, Steffens JC, et al. [Focal ischemia of the brain after neuroprotected carotid artery stenting](#). J Am Coll Cardiol. 2003;42:1007-13.

70. Vermeer SE, Prins ND, den Heijer T, Hofman A, Koudstaal PJ, Breteler MM. [Silent brain infarcts](#)



and the risk of dementia and cognitive decline. N Engl J Med. 2003;348:1215-22.

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