Comparing Carotid Artery Stenting and Carotid Endarterectomy in Symptomatic and Asymptomatic Carotid Stenosis

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Abstract

Objective: In patients with symptomatic and asymptomatic carotid artery stenosis, this retrospective observational study compared the clinical outcomes and side effects of carotid endarterectomy (CEA) with carotid artery stenting (CAS). The study took patient-specific risk variables into account and concentrated on major adverse cardiovascular events (MACE), such as myocardial infarction (MI), stroke, readmission, and death.

Material and Method: This was a retrospective observational study carried out at Vascular Surgery Department and Interventional Radiology department of two tertiary care hospitals in Rawalpindi, from Jan 2022 to March 2023. With a 30-day follow-up, 60 patients from two Pakistani tertiary care centres underwent either carotid end arterectomy and carotid artery stenting were included. Patient having asymptomatic and symptomatic carotid disease were selected for the procedure. The impact of risk factors on procedural success and development of major adverse cardiovascular events (MACE) was examined in the study. Data regarding 30-day postoperative parameters of the procedure were collected and evaluated. $p< 0.05$ is considered significant.

Results: The majority of patients in our series were males 46(77%) compared to 14(23%) females in the study. There were no intraoperative mortalities in our patients. The mortality rate of CAS alone was 1(1.66%). Four patients developed complications. Three in CAS group and 1 in CEA group. Comorbidities were present in 46(77%).

Conclusion: Compared to CEA, CAS is linked to a greater risk of stroke or mortality in patients with symptomatic carotid stenosis within 30 days of treatment. Patients' unique characteristics, age, comorbidities, and previous surgical experiences should guide the choice of treatment.

Keywords: carotid stenting, carotid stenosis, carotid artery disease, stroke

How to cite: *Khan R, Mughal UJ, Bhatti AM, Saif AB, Badshah A, Nofal S. Comparing Carotid Artery Stenting and Carotid Endarterectomy in Symptomatic and Asymptomatic Carotid Stenosis. Esculapio - JSIMS 2023;20(01): 61-66.*

DOI: https://doi.org/10.51273/esc24.251320112

Introduction

Stroke is the third leading cause of mortality. Approximately 80 to 85% strokes are ischemic due to carotid artery stenosis (CAS). The prevalence of significant CAS is 7% in women and 9% in men.[1] Ischemic stroke is the most common type of cerebrovascular disease; 15–20% of ischemic strokes are caused by atherosclerotic carotid artery stenosis, especially in the internal artery. About 0.5% of people between the ages of 60 and 79 and 10% of patients 80 years of age and older have significant carotid artery stenosis. The majority of patients don't exhibit any symptoms. The term "symptomatic carotid artery stenosis" refers to internal carotid artery stenosis that is accompanied by ipsilateral carotid lesions and cerebral symptoms. Patients with symptomatic carotid artery stenosis have an elevated risk of recurrent cerebrovascular episodes, and it is a significant

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Submission Date:	14-01-2024
1st Revision Date:	05-02-2024
Acceptance Date:	07-03-2024

cause of ischemic stroke. For almost 60 years, the most effective treatment for symptomatic severe carotid artery stenosis has been carotid endarterectomy. Because carotid artery stenting (CAS), also known as carotid artery stent implantation, is less intrusive than carotid endarterectomy and has a lower risk of cardiac damage and fewer surgical complications, it has grown fast over the past 30 years and is becoming more common.[2]

An alternative to carotid revascularization is carotid artery stenting (CAS), particularly for patients who are at high risk of carotid endarterectomy (CEA). Despite the fact that numerous research have tried to assess the safety and effectiveness of CAS, there is variation in the incidence of perioperative stroke and death in these trials, given the variations in the 30-day even or in-hospital rates reported.[3] As people age, the predicted prevalence of stroke rises. About 2.8% of people over the age of 18 in the general population had experienced a stroke in 2014. In addition, 795,000 or more Americans experienced a new or recurrent stroke per year, with ischemic stroke accounting for approximately 87% of all stroke cases in the US. Globally, 6.5 million people died from strokes.[2] Reduced rates of myocardial infarction (MI) and cranial nerve damage were noted with CAS, but there was no significant difference in the 30-day stroke and death rates linked to CAS and CEA, according to a new meta-analysis. A very large registry's findings indicated that younger patients had the best benefits from CAS when they had severe stenosis and were at high surgical risk.[4] Several studies have reported that CAS is associated with greater risk of stroke or death within 30 days of treatment than that with CEA.[5]

Significant correlations have been shown between congestive heart failure (CHF), cardiac mortality, cardiac arrhythmias, and myocardial infarction (MI). These are known as major adverse cardiac events, or MACEs. Due to the systemic nature of atherosclerosis, patients who have had a CEA are therefore at greater risk of long-term mortality and perioperative cardiovascular risk in comparison to the general population.[6]

Asghar U, calculated mean rate of stroke for CEA group was 3.24±2.35 and average rate of stroke in CAS was 5.32±4.09. The average length of stay was 2.86±1.32 and 2.74±1.98 (p= 0.823). The results of the studies have shown that in angioplasty group the odds of restenosis were 1.8 times higher as compared to endarterectomy.[7] There is very limited data available comparing the incidence of MACE in symptomatic and asymptomatic patients of carotid artery stenosis undergoing carotid endarterectomy and carotid artery stenosis in Pakistan. The rationale of the study is to compare the incidence of MACE including MI and stroke in post-operative period (30 days after the procedure) in patients with symptomatic and asymptomatic carotid artery stenosis undergoing either carotid endarterectomy (CEA) or carotid artery stenting (CAS).

Material and Method

This was a retrospective observational study carried out at Vascular Surgery Department and Interventional Radiology department of two tertiary care hospitals in Rawalpindi, from Jan 2022 to March 2023. The study was commenced after approval from institution ethical committee. Sample collection was done by non-probability consecutive method.

Inclusion Criteria: All the patients aged between 40 and 90 years with symptoms of transient ischemic attacks with concurrent stenosis of more than 50% ICA on ipsilateral side confirmed by ultrasound doppler or Computed tomography angiogram warranting any intervention were included in the study. Moreover, patients who had no symptoms of TIA with stenosis of more than 60% and referred by neurologist owing to high risk of future strokes were also included.

Exclusion criteria. Patients with debilitating strokes, bed bound or those with auto-immune disorders or prior neck radiation exposure were excluded from study. The patient records were analyzed in retrospect. Presenting symptoms or those asymptomatic but had been discussed in MDT and deemed to benefit from intervention were recorded. In addition co-morbid conditions and time of onset of symptoms were also seen. Moreover, demographic data as age, percentage stenosis and other co-morbids were noted. Data was extra plotted in predesignated Performa. The surgical procedure or stenting were performed by a team of trained vascular surgeons and interventional radiologists under Local or regional anaesthesia. Post operatively patients were closely followed for 1 month to assess the complications during that period. Major cardiovascular adverse events were noted at end of 1 month. Statistical Package for Social Sciences (SPSS) version 21 was used for data analysis. Descriptive statistics were used to calculate mean and standard deviation for age, frequencies, and percentages for gender. Chi square test was applied to ascertain significance in of weather conditions on ALI presentation keeping p-value<0.05.

Results

A total of 60 cases participated in the study 30 in each group. The mean age of participants was 68.45 ± 6.5 years ranging from 56 to 82 years. There were 46 (76.7%) males and 14 (23.3%) females in study. The mean stenotic percentage based on NASCET classification of all patients was 69.35 ± 10.72 % with minimum stenosis 55% and maximum 95%. Co morbidities were present in 46 (76.6%) patients. The most common co-morbid in patients was diabetes 25 (41.7%), hypertension in 21(35%), Ischemic heart disease in 16 (26.7%), chronic obstructive pulmonary disease in 8 (13.3%), Chronic kidney disease in 8 (13.3%) and anemia in 10 (16.7%) patients. A total of 12 (20%) patients were asymtomatic and 48 (80%) were symptomatic. The further distribution of these variables in groups is shown in table I.

Table 1: *Demographic characteristics between different groups (n=60)*

S. no	Variable	CAS Group n= 30	CEA Group n=30	p value
1	Age	68.03±6.32	68.87±6.756	0.624
2	Gender			
	Male	23(76.7%)	23(76.7%)	1.000
	Female	7(23.3%)	7(23.3%)	
3	Percent stenosis	78.87±10.523	67.83±10.88	0.277
4	Co-Morbidities			
	No	6(20%)	8(26.7%)	0.542
	Yes	24(80%)	22(73.3%)	
5.	Diabetes Mellitus			
	No	16(53.3%)	19(63.3%)	0.432
	Yes	14(46.7%)	11(36.7%)	
6.	Hypertension			
	No	17(56.7%)	22(73.3%)	0.176
	Yes	13(43.3%)	8(26.7%)	
7.	Ischemic heart disease			
	No	23(76.7%)	21(70%)	0.488
	Yes	7(23.3%)	9(30%)	
8.	COPD			
	No	26(86.7%)	26(86.7%)	1.000
	Yes	4(13.3%)	4(13.3%))	
9.	Chronic Kidney Diseas			
	No	26(86.7%)	26(86.7%)	1.000
	Yes	4(13.3%)	4(13.3%)	
10.	Anemia			
	No	24(80%)	26(86.7%)	0.488
	Yes	6(20%)	4(13.3%)	
11.	Symtomatic			
	No	7(23.3%)	5(16.7%)	0.748
	Yes	23(76.7%)	25(83.3%)	

There was no per-operative mortality or complication during the study. However, post-operatively there were a total of 4 (6.7%) patients in whom there were complications and one patient of CAS group died (1.66%). There were 3 (10%) complications in CAS Group and 1(3.3%) in CEA Group. This difference was insignificant (p value= 0.612). Further distribution of various complications is given in figure 1. The patients were closely followed for a month after discharge and there were no re-admissions. One mortality was due to massive stroke post operatively and his age was 79 years. The patient himself opted for stenting and had hypertension and chronic kidney disease. All patients who had complications were over 70 years of age.

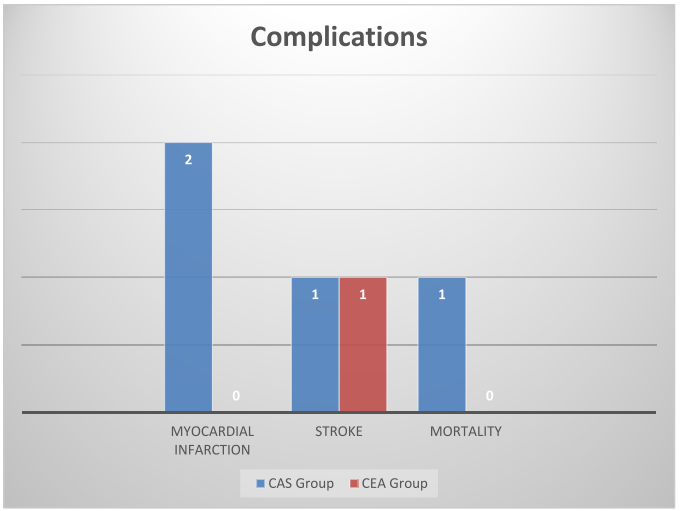

Figure 1: *Showing proportion of various complications in the two groups throughout study (n=4)*

Discussion

The rate of bleeding complications post operatively was nearly same in both the procedures 1.667% and 1.667% in CEA and CAS respectively. The rate of cranial nerve palsy was lesser in CEA 1.667% as compared to CAS being 3.33% post operatively that showed the CEA being superior in this particular area. Kakkos SK In our meta-analysis, CNI at 30 days was significantly lower for CAS compared with CEA (0.11% vs 3.21%, respectively), which has been also observed in a meta-analysis of mainly symptomatic patients.[8] The duration of hospital stay was however longer in CEA mean being 3.33days and compared to hospital stay for CAS being 3.133days on average for each patient owing to invasive nature of carotid endarterectomy.

Post op stroke rate was higher in CAS patients i.e. 10% as compared to 0% in CEA. While post op MI rate is 9.09% in CAS patients as compared to only 10% in

CEA, which proves that in patients with lacunar strokes Endarterectomy should be opted for as a more beneficial procedure. According to Vouyouka et al., compared to women who had CEA, CAS patients had a 2.39-fold greater rate of in-hospital postoperative stroke or death following risk adjustment.[9]

In case of CEA the rate of MI within 24 hours of procedure was 3.33%in CEA, in case of CAS it was 3.33%, evaluated on the basis of series of ECG clinical symptoms and trend of cardiac markers, which is same. The rate of stroke within 24 hours was 3.33% in CEA and 3.33% in CAS evaluated on the basis of series of CT brain for detection of minute strokes by neurology team. The rate of MI within 30 days was 3.33% and 6.667% in CEA and CAS respectively which is higher in case of CAS. Cremonesi A study showed that among 2397 patients, 31% of them being symptomatic, the 30-day rate of composite stroke, MI, or death was 2.25%. Stroke, MI, and death were encountered in 1.71, 0.02, and 0.40%, respectively.[10]

The rate of stroke within 30 days was 3.33% and 6.66% in CEA and CAS respectively. Which is again higher in case of CAS. Kyla M. Bennett the 30-day combined incidence of stroke, death, or MI for women undergoing CAS in this analysis was 6.8% compared with an incidence of 3.8% in women undergoing CEA[11]. Mandy D. Muller in symptomatic carotid stenosis, CAS was associated with a higher risk of death or stroke within 30 days of treatment (periprocedural period; OR, 1.70 [95% CI, 1.31–2.19]; P<0.0001, I2=5%; 10 trials, 5396 participants) compared with CEA.[12] According to Yuan G, CAS is associated with higher risk of stroke but lower risk of MI than those with CEA. Both procedures appeared equivalent in terms of the risk of death. Unlike our study which shows more mortality rate in case of CAS.[13]

In younger age groups mortality rate of CEA is lower as compared to older age groups. As the age progresses the success rate of carotid endarterectomy is showing a decreasing trend so it should be preferred in patients of younger age group where it gives better and long lasting results. Voeks GH study shows patients 70 years and older, the risk of events in CAS-treated patients was approximately twice that for CEA-treated patients (hazard ratio, 2.04; 95% CI, 1.48 –2.82) which is similar to our study.[14]

Out of total 60 patients,27 patients were diabetic and 13 patients underwent CEA and 15 patients underwent CAS. The mortality rate in these CEA patients was 7.69 and in case of CAS was 6.67, stroke rate in CEA patients was 7.69and CAS was 6.67, MI rate in CEA patients was 0% and CAS patients was 0%.This clearly shows that CAS proved to have somewhat better outcomes as compared to CEA in this particular scenario. Cremonesi A study shows age and diabetic status were found to be the only significant independent risk predictors and stroke rates below 2.6%were found in all subgroups, including symptomatic octogenarians[10].

Out of total 60 patients,25 patients were hypertensive and 10patients underwent CEA and 15 patients underwent CAS. The mortality rate in these CEA patients was 10%and in case of CAS was 6.66%, stroke rate in CEA patients was 10%and CAS was 6.66%,MI rate in CEA patients was 0%and CAS patients was 0%.This also has better statistical outcomes for CAS as compared to CEA in terms of development of Major adverse cardiovascular events.

Out of total 60 patients, 6 patients were having either chronic Renal disease, chronic liver disease or chronic obstructive pulmonary disease and 2 patients underwent CEA and 4 patients underwent CAS. The mortality rate in these CEA patients was 50%and in case of CAS was 25%,stroke rate in CEA patients was 50% and CAS was 25%,MI rate in CEA patients was 0% and CAS patients was 0%.This also shows that CAS should be procedure of choice if patient has comorbids in addition to carotid artery stenosis. Out of total 60 patients, 7 patients were having heart disease and 3 patients underwent CEA and 4 patients underwent CAS. The mortality rate in these CEA patients was 33.3%and in case of CAS was 25%, stroke rate in CEA patients was 0% and CAS was 25%, MI rate in CEA patients was 33.3% and CAS patients was 0%.This also shows that CAS should be procedure of choice if patient has some heart issue because development of major adverse cardiovascular events is slightly more in case of CEA as compared to CAS if patient has some heart disease.

Out of total 60 patients,25 patients were having BMI more than 25 and 10 patients underwent CEA and 15 patients underwent CAS. The mortality rate in these CEA patients was 10% and in case of CAS was 6.67%, stroke rate in CEA patients was 0% and CAS was 6.66, MI rate in CEA patients was 10%and CAS patients was 0%.This indicates that in case of obese patients the success rate of both the procedures is comparable in terms of Major adverse cardiovascular events. Out of total 60 patients,19 patients were having Hb less than

10 and 6 patients underwent CEA and 13 patients underwent CAS. The mortality rate in these CEA patients was 16.66 and in case of CAS was 15.38, stroke rate in CEA patients was 16.66 and CAS was 15.38, MI rate in CEA patients was 0%and CAS patients was 0%. The results of both the procedures at compareable in terms of major adverse cardiovascular events.

The higher rates of post op complications like nerve palsies and readmission may be attributed to the fact that the patients allocated for CAS were to a greater extent high risk candidates, having multiple co morbids and declared unsuitable for surgery by pre anaesthesia assessment except for certain cases where CAS was delibrately chosen in surgically fit patients owing to non invasive nature.

Conflict of Interest *None*

Funding source *None*

Conclusion

Compared to CEA, CAS is linked to a greater risk of stroke or mortality in patients with symptomatic carotid stenosis within 30 days of treatment. Because many MAEs happen after discharge after CAS, particularly for symptomatic patients, this study highlights the need of disclosing 30-day outcomes in assessing postoperative MACEs after CAS. The patients who had uncontrolled diabetes or uncontrolled hypertension had more frequent MI, ipsilateral strokes and consequent deaths when subjected to carotid endarterectomy as compared to carotid artery stenting so in such patients carotid stenting should be considered preferable to avert the dangers general anesthesia and later ICU management, therefore decreasing the mortality post operatively.

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Authors Contribution

AMB, RK: Conceptualization of Project
UJM, SN, AB: Data Collection
UJM, ABS: Literature Search
AMB, RK, ABS: Statistical Analysis
UJM, AMB, RK: Drafting, Revision
UJM, RK: Writing of Manuscript