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Journal of Surgery: Open Access

ISSN 2470-0991 | Open Access

RESEARCH ARTICLE

Volume 7 - Issue 6

Strategy of Selective Shunting for Carotid Endarterectomy in Patients with Recent Stroke

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Received: 12 Oct, 2021 | **Accepted:** 06 Jan, 2022 | **Published:** 14 Jan, 2022

Citation: Sharma V, Diaz T, Vang S, Hans S (2022) Strategy of Selective Shunting for Carotid Endarterectomy in Patients with Recent Stroke. J Surg Open Access 7(6): dx.doi.org/10.16966/2470-0991.256

Abstract

Objectives: The aim of this study is to evaluate the safety of selective shunting in patients with a recent stroke (<8 weeks since incident) undergoing Carotid Endarterectomy (CEA).

Methods: Two cohorts of patients undergoing CEA at two teaching hospitals from January 2000 to February 2020 were compared. Group A included all patients undergoing CEA after a recent stroke (NIH score between 1 and 15, <8 weeks from event). All patients in the group had a middle cerebral artery stroke with =/>70% ipsilateral Internal Carotid Artery (ICA) stenosis. Group B included all patients undergoing CEA for other indications including remote stroke (=/>8 weeks from event), focal transient ischemic attack, and asymptomatic >80% stenosis of the Internal Carotid Artery (ICA). Selective shunting was utilized in both cohorts based on the presence of neurological ischemic symptoms after carotid cross-clamping or ischemic EEG changes. The incidence of postoperative stroke, myocardial infarction (MI), cranial nerve palsy, and mortality were compared between both Groups.

Results: Overall, 1263 patients were included in the study. Group A included 107 patients and Group B included 1156 patients. Selective shunting was utilized in both cohorts: 16% in Group A, and 9.8% in Group B. Incidence of postoperative major stroke (NIHSS>5) was similar between Groups A and B (3.7% *vs* 1.4%). Mortality was higher in Group A (3.7%) as compared to Group B (0.9%). Incidence of postoperative seizure, MI, cranial nerve palsy, and hematoma was similar between both groups.

Conclusion: Selective shunting in patients undergoing CEA who have recently experienced a stroke (<8 weeks) is safe. Mortality after CEA in patients with a recent stroke (<8 weeks) was slightly increased in this study.

Introduction

Carotid endarterectomy (CEA) has been shown to most effectively reduce a patient's risk of recurrent stroke when it is completed approximately 2 weeks after they suffer a stroke, and delaying this procedure longer than this time frame does not reduce risks [1,2]. There is evidence that some perioperative strokes are due to inadequate cerebral perfusion during carotid clamping [3]. This has led to the practice of selective shunting, which seeks to identify and treat these patients that are at risk of intraoperative cerebral hypoperfusion. Although selective shunting has been well-established to be safe, there exists a subset of surgeons who routinely shunt patients undergoing CEA after a recent stroke [4]. This practice is based on the theory of protecting the post-stroke ischemic penumbra in the brain. This study will examine the safety of selective shunting in patients with a recent stroke undergoing CEA.

Methods

Data was collected from electronic medical records of patients that underwent CEA at two teaching hospitals from January 2000 to February 2020. All procedures were performed by one experienced vascular surgeon with little variability between each procedure. All patients with a severe stroke (NIH stroke scale >15) were excluded. Demographics and all other pertinent data such as age, gender, history of nicotine abuse, associated medical conditions, current medications and duration of symptoms prior to an emergency room visit in symptomatic patients were recorded. All symptomatic patients were evaluated by a neurologist and after 2006 by a stroke neurologist. Both hospitals have primary stroke certification.

Group A includes all patients undergoing CEA after a recent stroke (NIH score between 1 and 15, <8 weeks from event). All patients in the group had a middle cerebral artery stroke with >/=70% internal carotid artery (ICA) stenosis. Group B included all patients undergoing CEA for other indications including remote stroke (=/>8 weeks from event), focal Transient Ischemic Attack (TIA), and asymptomatic >80% stenosis of the ICA. Selective shunting was utilized in both groups depending on the anesthetic given. Patients received either a cervical nerve block (CBA) or General Anesthetic (GA). In patients receiving a CBA, the appearance of neurologic deficits after carotid

cross clamping warranted carotid shunting. In patients receiving GA, stump pressures were measured after carotid clamping, with 40 mmHg used as a cutoff for placement of the shunt. A Sundt shunt (Integra Neurosciences, Plainsboro, New Jersey) was the shunt used if deemed necessary. All patients were admitted for postoperative monitoring. A new postoperative neurological deficit was determined as minor (NIH stroke scale <5) or major (NIH stroke scale =/>5). Cranial nerve palsy was diagnosed clinically and considered to be permanent if hoarseness of the voice, swallowing difficulties, tongue deviation or lip deformity persisted longer than three months following CEA. Postoperative myocardial infarction was determined clinically and by 12-lead EKG, 2D echocardiogram, and serum biomarkers (Table 1).

A follow-up was conducted in surviving patients with carotid duplex imaging at one month, six month, and yearly intervals. Study endpoints included postoperative stroke, mortality, myocardial infarction, neck hematoma requiring re-exploration, permanent cranial nerve palsy and seizures. Statistical analysis was performed using SPSS12.01 software (SPSS Incorporated Chicago, Illinois). Fisher exact test and Chi-square test was used for comparison and significance was presumed at a p-value of equal or less than 0.05.

Results

Overall, 1263 patients were included in the study. Group A included 107 patients and Group B included 1156 patients. Within Group A, 61 experienced a minor stroke and 46 experienced a major stroke. 74 (68%) of the CEAs occurred within 2 weeks of the stroke, and 33 of the procedures (30%) occurred after two weeks from the stroke. Within Group B, 34 underwent CEA for remote stroke, 368 for TIA, and 754 for asymptomatic ICA stenosis. Selective shunting was utilized in both groups: 17(16%) in Group A, and 113(9.8%) in Group B. Further breakdown of selective shunting in Group B is shown in table 2.

Postoperative complications are recorded in table 3. Incidence of major stroke was 4(3.7%) and 16(1.4%) in Groups A and B, respectively. Incidence of minor stroke was 0(0%) and 8(0.7%). The mortality for groups A and B are 4(3.7%) and 10(0.9%), respectively. Four patients (3.4%) in Group A suffered postoperative seizures and none in group B (p=<0.0001). Out of these four patients, one had a CEA within two weeks of their stroke and three between two and eight weeks. All four patients responded to anti-seizure medications. Three out of four patients had fronto-parietal infarcts demonstrated on CT scan of the head or MRI of the brain. All four patients did not show any evidence of a new infarct on repeat imaging studies. After one year of follow up, all four patients are seizure-free. Three patients in Group B experienced permanent cranial nerve palsy, while none in Group A. Postoperative myocardial infarction was not seen in Group A but did occur twice in Group B. Zero patients in group A required re-exploration for postoperative hematoma while 9 patients in group B did.

Table 1: Age, gender, timing of Carotid Endarterectomy (CEA), and neurological status in patients with recent stroke (Group A).

Gender	Average Age
Male	68
Female	39
Timing of CEA	
<2 weeks	74(68.2%)
>2 weeks	33(30.8%)
NIH Stroke Scale	
Minor (1-4)	61 (57)

Table 2: Shunt requirement during Carotid Endarterectomy (CEA).

	Patients	(N=1263) Shunt placement
Recent stroke, <8 weeks	107	17(15.9)
Remote stroke, >8 weeks	34	4 (11.8)
Focal TIA	368	36 (9.8)
Asymptomatic (>80% stenosis)	754	73 (9.7)
Moderate (5-15)	0	46 (43)
Moderate to severe (16+)	0	0 (0.0)

Table 3: Postoperative complications in patients undergoing CEA.

	Group A (N=107)	Group B (N=1156)	P value
Major stroke	4 (3.7)	16 (1.4)	0.082
Minor stroke	0 (0.0)	8 (0.7)	1.000
Mortality	4 (3.7)	10 (0.9)	0.025
Seizures	4 (3.7)	0 (0.0)	0.000
MI	0 (0.0)	2 (0.2)	1.000
Permanent CN palsy	0 (0.0)	3 (0.3)	1.000
Hematoma requiring re-exploration	0 (0.0)	9 (0.8)	1.000

Discussion

Selective shunting in patients with a recent stroke did not result in any significant increase in postoperative stroke (P=0.082). This is concordant with other studies' observations regarding selective shunting as a whole [5].

Postoperative seizures appear to be more common after CEA following a recent stroke, which was also demonstrated in a similar prior study [5]. The pathophysiology behind this remains unclear but we suspect this is due to cerebral hyperperfusion in the presence of an acute infarct. Seizures following CEA can also be attributed to Cerebral Hyperperfusion Syndrome (CHS), a rare but neurologically devastating condition. It is defined as the triad of headache, seizure, and evidence of neurologic deficit seen after CEA without cerebral ischemia, which is typical of a stroke. Early CEA after a stroke has a documented increased risk of CHS in some studies [6]. CHS was not documented in this study, but it may have been the source of increased postoperative seizures and mortality seen in Group A.

The anesthetic given during cases was not controlled. Most cases were done using a cervical block, which has a documented lower rate of selective shunting when compared to EEG monitoring done under general anesthesia (7-12% *vs* 14-18%) [7,8]. This likely leads to a reduced rate of shunting (107/1263 or about 8%) with this particular surgeon due to his preference to perform CEA with a cervical block.

There was a slight increase in mortality (P=0.025), which is not well-explained in this review. There were four mortalities in Group A: three from ischemic strokes and one from a hemorrhagic stroke. Incidence of postoperative MI was very low or non-existent for both groups. Perhaps one explanation could be regarding the exact timing of the CEA. Studies have shown that early CEA (two weeks after stroke) has similar postoperative risk to delayed CEA but improved

stroke prevention [1]. CEA performed within 1-2 weeks of an acute stroke have an increased morbidity and mortality, and Group A did not segregate between those who had an intervention before or after 2 weeks from the event. This could have contributed to the increased mortality that we observed.

Contralateral ICA occlusion was not documented in the cohort. It is well-known that this is a risk factor for intraoperative cerebral ischemia [7] and postoperative neurological morbidity [9]. It is also associated with a higher incidence of shunt usage [10] and likely influenced that metric in this study.

Conclusion

Selective shunting in patients undergoing CEA who have recently experienced a stroke (<8 weeks) is safe. Mortality after CEA in patients with a recent stroke (<8 weeks) was slightly increased in this study.

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