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Synchronous CEA and CABG in asymptomatic carotid artery stenosis: A case study

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In the United States, there were 213,700 coronary artery bypass grafting (CABG) surgeries and 102,700 carotid endarterectomies (CEA) in 2011. Combined CEA and CABG surgeries are lower than either CEA or CABG, with an estimated 1,370 surgeries in 2012. There is some literature which supports that the surgeries can be performed safely together (referred to as combined, synchronous, tandem, or concomitant procedures). The purpose of this article is to describe the merits and potential complications involved with undergoing synchronous carotid artery and coronary artery bypass procedures. This purpose will be addressed by examining a case study of a patient who completed a synchronous procedure and by also reviewing the literature which addresses the benefits versus the risks associated with the synchronous procedures. Some studies found an increased incidence of perioperative and postoperative risks such as stroke, myocardial infarction, and death with the combined procedures, whereas some studies found no difference in the risks when the operations were performed sequentially. Combined or synchronous coronary artery bypass and carotid artery endarterectomy may be a safe surgical option for a specific subset of patients. (J Vasc Nurs 2019;37:194-198)

Carotid artery disease results from the buildup of plaque in the carotid arteries, which leads to a hardening and narrowing within arterial walls.[1] Health risks associated with the narrowing of the arterial walls or carotid stenosis arise from decreased blood perfusion to the brain. These health risks include cerebrovascular accident also known as stroke and other complications which may include long-term residual dysfunction, disability, and death.[1]

Carotid stenosis is diagnosed with the assistance of diagnostic studies inclusive of ultrasounds and or angiography. An important part of the diagnosis of the stenosis is grading or identifying the extent of the narrowing within the vessel. The degree of stenosis within the carotid arteries is generally classified as one of three categories—mild, moderate, and severe. The North American Symptomatic Carotid Endarterectomy Trial criteria defines mild- or low-degree stenosis as generally stenosis of less than 50% within the vessel, moderate stenosis falls between 50 and 69% range, whereas severe stenosis is greater than 69% within the vessel.[2] The amount of stenosis is usually identified using diagnostic studies such as ultrasounds and/or angiography.

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Patients may experience stenosis on one side of the body (unilateral) or on both sides (bilateral) of the body. In addition to this, they may also have the same or different amounts of stenosis on each side of the body. Finally some patients may be symptomatic, that is, they experience symptoms associated with their carotid stenosis such as dizziness, amaurosis fugax (the temporary loss of vision in one or both eyes), transient ischemic attacks, strokes or may be asymptomatic (experience no symptoms).

Coronary artery disease (the most common type of heart disease in the United States) develops in a similar manner as carotid artery disease, with a buildup of plaque in the coronary arteries and varying degrees of blockages in these arteries.[3] The blockage in the coronary arteries can lead to decreased blood flow resulting in complications including decreased coronary perfusion, arrhythmias, angina, heart failure, myocardial infarction, and death.[3,4]

Carotid endarterectomies (CEA) and coronary artery bypass grafting (CABG) are two surgical treatment options that are used to either remove the plaque (in the carotids) or bypass the blockage in the coronary arteries. CEA is done mainly to reduce the risk of stroke,[5] whereas CABG is done to reduce the risk of heart failure and heart attacks.[6] Some patients may have atherosclerosis in either the carotid or the coronary vessels but concurrent coronary and carotid disease is frequently seen.[7,8] Although not all patients with carotid artery stenosis will need any type of intervention, it has been reported that up to 22% of individuals with coronary artery disease also had carotid stenosis that requires intervention.[7,9,10] Although established protocols are in place for the surgical management of isolated coronary artery or carotid artery disease, the management of concomitant carotid and coronary artery disease is still emerging, is challenging for providers, and continues to be debated.[5,10,11,12] The purpose of this article is to present a case study of an asymptomatic high-grade carotid artery stenosis

patient who underwent combined CEA and CABG. A mini review of the literature about three separate surgical approaches to management of concomitant carotid artery and coronary artery disease is also presented.

THE CASE

Mr. S., a 60-year old male, presented to his primary care physician for routine follow-up for a 5-year history of benign hypertension and type 2 diabetes. He takes Glucophage 1,000 mg twice daily and Glucotrol 5 mg daily with self-monitored glucose readings between 80 and 110 mg/dL. Mr. S. takes Lisinopril 10 mg daily and Metoprolol 50 mg daily which adequately maintain his blood pressure around 130/66 mmHg. His surgical history includes multiple surgeries on his right ankle for a fracture sustained as a child. His last ankle surgery that included an ankle fusion was performed 5 years ago.

Mr. S. has no history of tobacco use. He exercises by walking 30 minutes daily and is physically active around the community as a handyman. Family history includes his father's death at age 70 years from complications of type 2 diabetes mellitus. There is a strong family history of diabetes but no known history of carotid artery disease. One younger brother who is alive has coronary artery disease and type 2 diabetes mellitus.

Mr. S.'s review of systems is negative. Vital signs include blood pressure 125/62 mmHg, pulse 65, respirations 16, weight 165 lbs, height 6′2″, and BMI: 21.2 kg/m2. A review of his previous laboratory work, completed 3 months prior, resulted a hemoglobin A1C of 5.1%, fasting blood glucose 90 mg/dL, blood urea nitrogen 20 mg/dL, creatinine 1.08 mg/dL, hemoglobin 14.7 g/dL, hematocrit 42.9%. Lipid panel was last performed approximately 1 year prior and results show high density lipoprotein 42 mg/dL, low density lipoprotein 80 mg/dL, very low density lipoprotein 30 mg/dL, cholesterol 150 mg/dL, triglycerides 185 mg/dL.

During the physical examination, the primary care physician auscultated a right carotid bruit. Mr. S. denied symptoms associated with carotid artery stenosis, such as dizziness, weakness, difficulty speaking, visual or hearing disturbance. He was referred to a vascular surgeon by his primary care physician for further evaluation. A carotid duplex ultrasound ordered by the vascular surgeon revealed severe blockage of more than 80% in the right internal carotid artery. The vascular surgeon recommended a CEA, pending clearance from cardiology, which was due in part to his comorbidities of high blood pressure and diabetes. The cardiologist ordered a treadmill stress test. During the test, Mr. S. experienced chest pain and his electrocardiogram was abnormal. He subsequently had a cardiac catheterization, which revealed a significant narrowing in the left main coronary artery, the proximal left anterior descending coronary artery, and the right coronary artery.

The cardiologist and vascular surgeons decided to perform synchronous CEA + CABG surgeries. The decision to intervene surgically on this asymptomatic patient was based on the degree of stenosis in both his right internal carotid and coronary arteries, which placed him at an increased risk for either myocardial infarction or stroke. Mr. S. had the surgeries performed on the same day as one continuous operation under the same anesthesia, beginning with CEA and followed by a four vessel CABG. There were no perioperative or postoperative complications or events. He was released to home from the hospital 9 days after his operations with a referral to the visiting nurse for home health care. The visiting nurse service monitored his incisions and vital signs, assisted with medication management, and personal care. He also received rehabilitative services in the form of physical and occupational therapies. His recovery at home was uncomplicated, and he eventually completed outpatient cardiac rehabilitation. He was able to return to his normal activities and continued to see his primary care physician for medical management.

This patient was uniquely fortunate in that he had cardiac surgery but suffered no damage to his heart before the surgery. This is because the blockages in the arteries in his heart were found during routine workup for his CEA. Mr. S. at the 1-year and 5-year anniversaries continued to be free of any complications including stroke and heart attack after cardiac rehabilitation.

SURGICAL MANAGEMENT OF SIMULTANEOUS SEVERE CAROTID ARTERY AND CORONARY ARTERY DISEASE

The following CEA and CABG combinations of surgical procedures have emerged for managing concomitant carotid and coronary artery disease: staged CEA preceding CABG (CEA-CABG), reverse-staged CABG preceding CEA (CABG-CEA), and simultaneous CEA and CABG (CEA + CABG).[11] The debate surrounding surgical treatment, particularly the timing and order of the surgical procedures, for concomitant coronary and carotid artery disease is entrapped in the multifactorial etiology and subsequent prevention strategies of operative stroke.[13,14] Therefore, major considerations must include the timing, type, and order of the procedure(s), as well as risks versus benefits of surgical intervention to increase the patient benefits and decrease the associated risks.

Staged CEA-CABG and reverse-staged operations

A CEA-CABG is a staged procedure in which the CEA precedes the CABG. It generally involves scheduling each surgery on different days during the same hospital stay.[15,16] A CEA-CABG is favored for stable coronary patients, as it carries the associated risk of myocardial infarction.[13] Prospective patients must be expected to withstand a CEA procedure, recover from the procedure, and then undergo the sequential CABG.[17] This approach also decreases the elaborate process associated with two surgical procedures, such as operating time.[17]

A CABG-CEA is a reverse-staged procedure, in which the CABG precedes the CEA. This procedure carries the associated risk of stroke and is the least favorable combination for this reason.[11,13] Overall staged procedures are associated with increased risk of surgical complications including increased morbidity, respiratory, cardiac, wound and renal complications, as well as an overall increase of more than $23, 000 in hospital charges.[16] In a recent study that retrospectively examined patient outcomes for 3,173 patients who had staged or synchronous carotid procedures along with coronary artery bypass graft, the authors found higher rates of postoperative neurological complications such as transient ischemic attack and delirium in the group with the synchronous procedure.[18] These surgeries

took place from 2011 to 2016, and based on these outcomes, the authors concluded that staged procedures might be slightly better than synchronous ones for patients with significant carotid artery stenosis with planned coronary artery revascularization.[18]

Concomitant/synchronous/combined operations

The third option for the surgical management of patients with significant carotid and coronary artery disease is for the surgeries to be performed on the same day, under the same anesthesia. This is known as synchronous, combined, concomitant, tandem, or simultaneous operations.

Naylor et al completed a systematic review involving a comparison of 7,863 combined CEA + CABG, 917 staged CEA–CABG, and 302 reverse-staged CABG–CEA procedures.[14] For this study, the rate of perioperative stroke, myocardial infarction, or death for combined CEA + CABG was 11.5%, and for staged CEA–CABG, it was 10.2%.[14] Increased risks of death and stroke were linked with increased carotid and coronary artery disease in the individual, but several studies did reveal better outcomes with "off-bypass" CABG procedures.[14] A more recent study supported concomitant CEA + CABG procedures, in comparison with earlier studies which looked at staged or reverse-staged procedures.[11] A meta-analysis of observational studies of staged versus combined CEA and CABG resulted in comparable outcomes for both procedures.[10] There were more than 17,000 patients in the combined surgical group and nearly 8,000 in the staged group from 12 different studies included in this meta-analysis.[10] The outcomes from this analysis showed no difference in the primary endpoints of early mortality, postoperative stroke, and combined endpoints of myocardial infarction or stroke in the two different surgical groups.[10] Oz et al. also found comparable outcomes for patients who had staged and combined approaches for patients who needed both carotid and coronary artery surgeries.[19] Oz et al. did note that the staged approach had better neurological outcomes in the short term (30 days), but long-term outcomes were similar.[19]

Several authors reported improved outcomes with concomitant procedures, especially among patients with asymptomatic carotid artery stenosis.[11,20] In the Nationwide Inpatient Sample database from 1998 to 2007, 16,639 patients had the combined CEA + CABG procedures, without an increase in neurologic complications or mortality.[16] When looking at patients with both symptomatic and asymptomatic carotid stenosis, long-term complications of combined operations have been less frequently documented in the literature when compared to staged procedures.[11]

THE SAFETY AND EFFICACY OF SYNCHRONOUS CAROTID AND CORONARY ARTERY REVASCULARIZATION

The safety and efficacy of synchronous carotid and coronary artery surgeries continues to be investigated. Several recent publications from single-center studies have concluded that synchronous CEA + CABG are safe and effective for the management of concomitant carotid and coronary artery disease.[21-23] Abdurakhmanov et al. reported that combined CEA + CABG is a safe and effective strategy for the management of patients with severe carotid and coronary artery disease based on results from 18 patients over a 4-year period.[21] Garg et al also conducted a retrospective study at one medical center that examined the records of 47 patients who had undergone synchronous CEA + CABG procedures in a 24-month period.[22] Tirilomis et al. conducted a retrospective medical record review of 100 patients at their center who had also undergone synchronous CEA + CABG and concluded that this was a safe treatment option for patients with concomitant carotid and coronary artery disease.[23]

A randomized controlled multicenter study conducted in Germany and the Czech Republic sought to find the best operative approach for the management of patients with a planned CABG who also had severe carotid disease.[24] The safety and efficacy of combined (synchronous, concomitant, or simultaneous) CABG + CEA as opposed to CABG alone were the primary endpoints.[24] The study was terminated early secondary to loss of funding because of low recruitment.[24] However, for those enrolled in the study, the authors reported that those patients who underwent CABG alone had a lower rate of nonfatal stroke (from any cause) and death postoperatively than the group that had combined CABG + CEA at the 30-day follow-up.[24] Patients who had only CABG in this study tended to have overall better outcomes at 30 days, and at the 1-year follow-up on all factors assessed which included any stroke or death from vascular causes, the number of heart attacks, change in cognition function on selected tests, length of time spent on the ventilator after either surgery, and the number of disabling strokes experienced.[24] Long-term follow-up continues for some patients in this study.

TRENDS IN CONCURRENT CAROTID ARTERY REVASCULARIZATION

An analysis of trends in the use of synchronous carotid and coronary artery as well as staged CEA–CABG surgeries that spanned 2004–2012 found an overall decrease in the numbers of synchronous CEA + CABG procedures but a slight increase in the numbers of staged procedures during this time.[15] The numbers of synchronous CEA + CABG procedures decreased from 1,901 in 2004 to 1,370 in 2012, but the numbers of staged procedures went from 542 in 2004 to 680 in 2012.[15] However, these authors found that the synchronous CEA + CABG was used most frequently to treat patients undergoing combined revascularization surgeries.[15] Results from this analysis point to synchronous CEA + CABG as the preferred treatment option among providers, with a slight increase in the frequency in the use of staged procedures.

POSTOPERATIVE CARE FOR PATIENTS UNDERGOING CEA AND CABG

Postoperative care for patients who have undergone carotid revascularization includes maintaining a patent airway, monitoring vital signs, level of sedation, neurological, cranial, cardiac, and wound assessments, pain management, managing comorbidities such as diabetes, monitoring activity level and urine output, as well as assessing for postoperative complications.[25] An uncomplicated postoperative stay for CEA recovery alone is

typically one day. Post-CEA patients will be discharged with an antiplatelet aggregation medication such as aspirin to help reduce the risk of stroke.[25] HMG-CoA reductase inhibitors should be administered daily or other medications that induce cholesterol and low density lipoprotein reduction and increase high density lipoproteins.[25] After discharge, multiple follow-up carotid ultrasound examinations are recommended, which will extend from early in the postoperative period at approximately 1 month, every 6 months, and then yearly.[25]

Care of postoperative CABG patients include maintaining a patent airway usually via ventilator during the beginning stages of recovery and close monitoring for any signs of dyspnea, decreased oxygen saturation, or pulmonary congestion.[26,27] Care also includes routine monitoring of vital signs as well as intake and output and observing for a decline in renal perfusion.[26] These patients will also need neurological, cardiac, and wound assessments, as well as central venous catheter care and pain management.[27] Antiplatelet medications are usually indicated, as well as antilipid and antihypertensive medications. Patients typically remain in the hospital for about 10.1 days before being discharged.[28]

Patients who undergo staged or reverse-staged revascularization will require the same postoperative care required for combined CEA + CABG. The notable difference in the postoperative care between those who have the combined surgery and those with the staged operations is that those with the staged operations have 2 separate operations, so they must recover from the first surgery and be stable enough to undergo a second surgery on either their carotid or coronary arteries.

DISCUSSION

In summary, no clear evidence was found that conclusively supported one surgical approach over another for patients who undergo synchronous or concomitant CEA+CABG procedures. Among staged procedures, CEA is recommended before CABG (as opposed to the reverse-staged CABG prior to CEA) because of the increased stroke risk. Published guidelines on the management of asymptomatic carotid stenosis offer conflicting information regarding best practice for management of both asymptomatic and symptomatic carotid artery stenosis.[29] CEA was the most frequently recommended treatment option, but it was recommended for asymptomatic carotid artery stenosis patients whose surgical risk was average.[29]

CONCLUSION

The severity of the carotid stenosis, coronary artery disease, and risk factors must be weighed and considered before deciding if a patient is to have surgical intervention, including staged or concomitant procedures. A synchronous CEA + CABG approach worked well for Mr. S. Each patient's medical condition, prior surgical history, concomitant disease state, social and family support should be carefully considered before determining a treatment plan.

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