Transcarotid Artery Revascularization Vs Carotid Endarterectomy Based on Safety and Efficacy

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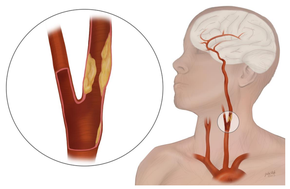
ABSTRACT

For patients with carotid artery disease who are at risk for traditional open surgery, a less-invasive, clinically proven alternative called TCAR is available. This paper assesses whether similar patients undergoing either TCAR or CEA have equivalent rates of postoperative CVA, death, cranial nerve injury, and myocardial infarction (MI). This data is beneficial to surgeons in order to evaluate the most effective therapeutic intervention in patients presenting with carotid artery disease.



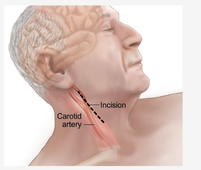
TCAR procedure. Savannah Vascular Institute. https://www.savannahvascular.com/tcar-procedure/. Published June 12, 2019. Accessed April 1, 2022.

BACKGROUND

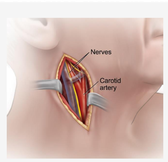
- Stroke (CVA) is the fifth main cause of death and a major risk factor for long-term disability.[1] Ischemic strokes are the most common type of strokes. Approximately thirty percent of ischemic strokes are a result of atherosclerosis of the carotid arteries.[1] This progressive buildup of plaque imposes a blockage in the carotid artery leading to the brain. Risk factors for carotid artery stenosis include dyslipidemia, high blood pressure, diabetes, obesity, cigarette smoking, family history, age, and lack of exercise.[2] Medical management and lifestyle changes may be initiated first. However, when arteriography shows high-grade stenosis, consisting between 70-99% occlusion, operative treatments such as an open surgical carotid endarterectomy (CEA) or endovascular intervention may be recommended to mitigate the risk of an ipsilateral carotid stroke.
- Current treatment options present problems of their own. CEA has been considered the gold standard intervention for the treatment of carotid disease since the 1950's, when it was created by Dr. Michael DeBakey.[4] Despite the fact that CEA is an accepted intervention for patients with asymptomatic and symptomatic carotid artery stenosis, it carries a 1-2% risk of permanent cranial nerve injury, 1-2% risk of postoperative neck hematoma, and 2-6% risk of postoperative myocardial infarction, according to the 2010 CREST study.[3]
- Recently, transcarotid artery revascularization (TCAR) was offered as a clinically proven, less invasive alternative procedure to CEA. This novel carotid intervention may combine the safety of a carotid endarterectomy with the lesser morbidity of a transfemoral carotid stent and is aided by growing evidence of effectiveness in high-risk patients in need of revascularization.[7]

METHODS

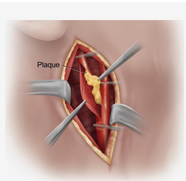
- **Step 1 :** PubMed, EBSCO, and ClinicalKey were searched for studies comparing the outcomes of patients with carotid artery disease who were treated with TCAR or CEA.
- **Step 2:** Meta-analysis was conducted when appropriate.
- **Step 3:** Using the three electronic databases mentioned above, the studies were selected by searching the following key terms: "transcarotid artery revascularization, carotid endarterectomy, safety, efficacy, versus, outcomes."
- **Step 4:** The search terms were then crossed and combined to perform a more advanced search.
- **Step 5:** From there, a detailed reading and critical analysis of each article were performed. Duplicated articles were removed. Each study was classified based on its study design (i.e., systematic reviews, case control, randomized control trials, cohort studies, etc.) and methodological quality.
- The literature searches from all three databases resulted in ten articles.



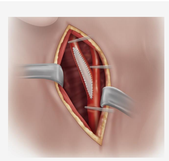
CEA – Step 1
The surgeon exposes your carotid artery through a 4-7 inch long cut in the side of your neck.



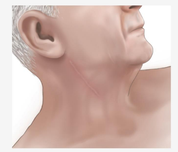
CEA – Step 2
Your surgeon will cut and pull back the skin and muscles in your neck to access your carotid artery.



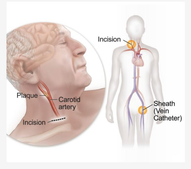
CEA – Step 3
The artery is clamped on both sides of the blockage and opened. The disease-causing buildup is then removed.



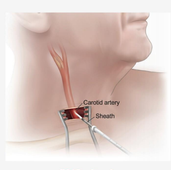
CEA – Step 4
The artery is sewn back together. Sometimes, it is necessary to use a patch or graft when sewing the artery walls together to make the artery wider.



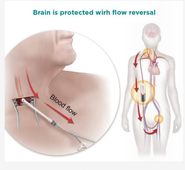
CEA – Step 5
Your surgeon will then close the cut in your neck using stitches. Be sure to ask your doctor about the risks associated with this surgical procedure.



TCAR – Step 1
The surgeon exposes your carotid artery through a small incision in the side of your neck.

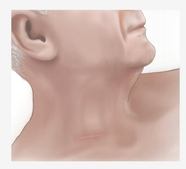


TCAR – Step 2
Your surgeon will cut and pull back the skin and muscles in your neck to access your carotid artery.



TCAR – Step 3
Blood flow is reversed away from the brain, and the blood is filtered and returned through the femoral vein in the thigh.

TCAR – Step 4
While blood flow is reversed, a stent is placed to stabilize plaque and minimize the risk of a future stroke.



TCAR – Step 5
Flow reversal is turned off, blood flow to the brain resumes its normal direction, and the incision is stitched.

Carotid intervention: TCAR procedure benefits & recovery. Silk Road Medical | Global website. https://silkroadmed.com/patient-caregivers/tcar-benefits-recovery/. Published October 29, 2020. Accessed April 1, 2022.

LIMITATIONS AND DISCUSSIONS

- **Limitation 1:** It is difficult to assess the comparison between TCAR and CEA because most of the patients undergoing TCAR have underlying significant comorbidities such as older age, underlying COPD, chronic kidney disease, and heart disease, which deny them the option of CEA due to their poor surgical candidacy. Therefore, unless the patient populations between the two groups are based on a 1:1 propensity matching, the results are not as conclusive.
- **Limitation 2:** Typically, TCAR is performed by vascular surgeons and success rates could vary depending on the type of surgeon performing the operation. Of the studies evaluated, no data was offered on a learning curve for TCAR.
- **Limitation 3:** More data is needed in order to determine whether TCAR is effective on standard-risk or low-risk patients. It is unreasonable to suggest that TCAR can be utilized in all patients with carotid disease without studies representing all risk stratifications.[1]
- **Limitation 4:** The availability of CEA compared to TCAR is unequaled at this time. With growing access to this novel modality, it could be reasonably suggested that the results may change with better access, a better learning curve, and more experienced surgeons performing TCAR.
- **Limitation 5:** Confounding variables between the studies' samples including hospital resources, teaching affiliations, postoperative protocols, and other factors may need to be considered when determining the validity of the various studies. [12]

- **Discussion 1:** Another factor to consider is the cost-effectiveness of TCAR compared to CEA. A recent study conducted by Cui et al.[4] published in the Journal of Vascular Surgery in December 2021 found that, although 5-year costs for TCAR were $11,000 more than CEA, TCAR offered greater quality-adjusted life years (QALYs) and could be more economical in the long-term.[4] These results were gathered from a high-volume institute for carotid revascularization.[4] More economic studies are needed to contrast the cost-effectiveness of CEA and TCAR. Given the novelty of TCAR, it would be reasonable to conclude that the cost of this intervention will decrease with more wide-spread usage.

- **Discussion 1:** A study performed by Wang et al.[15] consisted of 237 TCARs executed at small, respected institutions. Of these cases, 55 stents were placed because of restenosis (47 CEA, 8 transfemoral carotid artery stenting).[15] Within 30 days of the operation, no additional CVAs or myocardial events occurred. In addition, there were zero cases of in-stent restenosis, thrombosis, or re-interventions. The results concluded that TCAR has the potential to treat patients with restenotic carotid disease with sustainable incidences of ipsilateral CVA, myocardial infarct, and death.[15]

OBJECTIVES

- **Objective 1:** This paper challenges the use of carotid endarterectomy (CEA), an invasive vascular surgery, as a primary default to treating carotid stenosis by reviewing studies involving transcarotid artery revascularization (TCAR), CEA, and their post-procedure stroke, myocardial infarction, and cranial nerve injury rates.
- **Objective 2:** This paper addresses the pathophysiology and risk factors of carotid artery disease and the indications for intervention, whether it be TCAR or CEA.
- **Objective 3:** This paper describes the perioperative steps during TCAR and CEA.
- **Objective 4:** This paper compares operative times, perioperative blood loss, and postoperative length of stay associated with CEA and TCAR.
- **Objective 5:** This paper briefly reviews the cost-effectiveness of TCAR and CEA in relation to long-term financial benefit for patients with minimal current data available.

RESULTS

- **Result 1:** Inpatient and post-discharge myocardial infarction and CVA/death rates were comparable between TCAR and CEA.[1,6,7,8,11,12]
- **Result 2:** TCAR resulted in reduced risk of cranial nerve injuries compared to CEA in multiple studies performed within the past decade.[6,7,8,13]
- **Result 3:** TCAR is associated with less operative times and blood loss and shorter postoperative length of stay.[7,11,13]

CONCLUSIONS

Transcarotid artery revascularization (TCAR) could present as a safer alternative to carotid endarterectomy (CEA) for specific patients with high-level carotid artery stenosis. Further comparative studies are warranted to confirm the similarity of TCAR vs CEA, with focus on longer-term follow up and greater sample sizes.

References available upon request.