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Modality-Specific Outcomes of Patients Undergoing Carotid Revascularization in the Setting of Recent Myocardial Infarction

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This study was presented as a poster presentation at the Vascular Annual Meeting of the Society for Vascular Surgery, National Harbor, MD, June 15, 2023.

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This study was presented as a mini presentation at the Western Vascular Society Annual Meeting, Koloa, HI, September 9, 2023.

## ARTICLE HIGHLIGHTS

**Type of Research**: Retrospective review of prospectively collected Vascular Quality Initiative data.

**Key Findings:** In this study of 1,217 CEA, 445 TFCAS, and 584 TCAR patients, we found that recent MI was associated with 169% higher odds of stroke/death and 67% higher odds of stroke/death/MI for TFCAS compared to CEA.

**Take home Message:** Recent myocardial infarction increases the odds of stroke/death and stroke/death/MI for patients undergoing TFCAS compared to CEA, while TCAR had similar outcomes to CEA.

## Table of Contents Summary

In this retrospective review of 1,217 CEA, 445 TFCAS, and 584 TCAR patients, the presence of recent MI was associated with a lower risk of stroke/death and stroke/death/MI in CEA patients compared to TFCAS. TCAR patients had similar outcomes to CEA.

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**Abstract**

**Introduction:**

Recent myocardial infarction (MI) represents a real challenge in patients requiring any vascular procedure. There is currently a lack of data on the effect of preoperative MI on the outcomes of carotid revascularization methodology (carotid enterectomy (CEA), transfemoral carotid artery stenting (TFCAS), or transcarotid artery revascularization (TCAR)). This study looks to identify modality-specific outcomes for patients with recent MI undergoing carotid revascularization.

**Methods:**

Data was collected from VQI (2016-2022) for patients with carotid stenosis in the United States and Canada with recent MI (<6 mo.) undergoing CEA, TFCAS, or TCAR. In-hospital outcomes after TFCAS vs CEA and TCAR vs CEA were compared. TCAR vs TFCAS were compared in a secondary analysis. We used logistic regression models to compare the outcomes of these three procedures in patients with recent MI, adjusting for potential confounders. Primary outcomes included 30-day in-hospital rates of stroke, death, and MI. Secondary outcomes included stroke/death, stroke/death/MI, post-operative hypertension, post-operative hypotension, prolonged length of stay (>2 days), and 30-day mortality.

**Results:**

The final cohort included 1,217 (54.2%) CEA, 445 (19.8%) TFCAS, and 584 (26.0%) TCAR cases. Patients undergoing CEA were more likely to have prior CABG/PCI and to use anticoagulant. Patients undergoing TFCAS were more likely to be symptomatic, have prior CHF, COPD, CKD, and undergo urgent operations. Patients undergoing TCAR were more likely to have higher rates of ASA class IV-V, P2Y12 inhibitor, and protamine use. In the univariate analysis, CEA was associated with a lower rate of ipsilateral stroke (P=0.079), death (P=0.002), and 30-day mortality (P=0.007). After adjusting for confounders, TFCAS was associated with increased risk of stroke/death (aOR= 2.69 [95% CI: 1.36-5.35] P=0.005) and stroke/death/MI (aOR=1.67, [95% CI: 1.07-2.60], P=0.025) compared to CEA. However, TCAR had similar outcomes compared to CEA. Both TFCAS and TCAR were associated with increased risk of post-operative hypotension (aOR= 1.62 [95% CI: 1.18-2.23] P=0.003 and aOR= 1.74 [95% CI: 1.31-2.32] P=<0.001, respectively) and decreased risk of post-operative hypertension (aOR= 0.59 [95% CI: 0.36-0.95] P=0.029 and aOR= 0.50 [95% CI: 0.36-0.71] P=<0.001, respectively) compared to CEA.

**Conclusion:**

Although recent MI has been established as a high-risk criterion for CEA and an approved indication for TFCAS, this study showed that CEA is safer in this population with lower risk of stroke/death and stroke/death/MI compared to TFCAS. TCAR had similar stroke/death/MI outcomes in comparison to CEA in patients with recent MI. Further prospective studies are needed to confirm our findings.

**Keywords:** Carotid Artery Stenting; Carotid Endarterectomy, Myocardial Infarction, MI, Cerebrovascular Disease/Stroke; Quality and Outcomes.

**Conflict of interest:** None

**Funding:** This work was not funded.

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**Introduction**

Carotid revascularization procedures have been proven to be effective in preventing stroke in patients with significant stenosis of the carotid artery. Several studies have been conducted to evaluate the efficacy of the various methods of carotid revascularization including carotid endarterectomy (CEA), carotid artery stenting (CAS), transfemoral carotid artery stenting (TFCAS), and transcarotid artery revascularization (TCAR).[1,2,3,4,5,6] Historically, CEA has been the ideal method of carotid revascularization with better post-operative outcomes such as lower risk of death and stroke.[3,5,7,8,9] Nevertheless, some recent studies have found that in patients with carotid artery stenosis, TCAR was associated with similar or lower risks of death, stroke, and myocardial infarction (MI).[1,4]

Previous studies have indicated that recent MI represents a real challenge in non-vascular procedure outcomes, as patients are at an increased risk of postoperative MI, 30-day mortality, and 1-year mortality.[10] Clinical risk factors including mild angina pectoris, previous MI, prior history of heart failure, diabetes mellitus, and renal insufficiency were all associated with higher risk of adverse outcomes such as death and postoperative MI.[11] Yet, comparing outcomes across the different revascularization methodologies in these patients, particularly ones with history of prior MI, has not been investigated. Given that there is currently a lack of data on the effect of preoperative MI on the outcomes of carotid revascularization methodology, there is a need for more robust evidence regarding revascularization outcomes for these patients.

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The aim of this study is to identify and compare modality-specific outcomes in patients with recent MI undergoing carotid revascularization. This study will provide much-needed evidence to support clinical decision-making and improve the outcomes of patients undergoing carotid revascularization after a recent MI. By evaluating adverse post-operative outcomes including mortality, stroke, and MI across the three carotid revascularization methods in this patient population, we hope to provide clinicians with a better understanding of the best revascularization method for patients with recent MI.

## Methods

Database and study population:

This study analyzed patients with carotid stenosis in the United States and Canada with recent MI (<6 mo.) undergoing CEA, TFCAS, or TCAR from 2016 to 2021, using data from the SVS VQI database. This database includes information from over 1000 medical centers in North America and provides de-identified data on major vascular procedures, such as patient demographics, medical history, and treatment outcomes. To ensure data accuracy, the database is regularly audited. More information about VQI is available at www.vqi.org. Because only de-identified data was used, the study was exempt from requiring individual patient consent or Institutional Board Review, but it was approved by the SVS data safety organization.

The patients were divided into three groups depending on the method of carotid revascularization: CEA, TFCAS, and TCAR. The study excluded patients who did not have a recent pre-operative MI in the 6 months before surgery. Additionally, the study excluded patients with non-atherosclerotic lesions, such as those that were identified as dissection procedures,

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trauma, or fibromuscular dysplasia. Finally, patients with two treated lesions were excluded from the analysis.

The baseline characteristics of the three patient groups were compared, including age, sex, ethnicity, race, medical history, smoking status, preoperative medication use, symptomatic status, American Society of Anesthesiologists class, anesthesia type, procedural urgency, and living status. Obesity was designated as a BMI over 30. Hypertension was defined as having a documented blood pressure of 130/80 or higher on three or more occasions. Coronary artery disease was defined as a history of angina or myocardial infarction. Chronic kidney disease was defined as an estimated glomerular filtration rate of less than 60 ($mL/min/1.73m^2$). Smoking was divided into never, prior, or current categories. Symptomatic status was categorized as asymptomatic or symptomatic in which the patients experienced amaurosis fugax, transient ischemic attack, or stroke within six months of presentation. Anesthesia modality was separated into general anesthesia and local/regional anesthesia. Procedural urgency was categorized as elective or urgent /emergent, and living status was divided into home, nursing home, or without a home.

Outcomes

Primary outcomes included in-hospital rates of stroke, death, and MI. In-hospital stroke was defined as symptoms of motor/sensory loss, speech abnormality or other new neurologic symptoms documented in medical record lasting 24 hours or longer. Postoperative MI was defined as any new MI after the operation: troponin rise above $99^{th}$ percentile, electrocardiography or clinical evidence of acute MI. Secondary outcomes included stroke/death,

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stroke/death/MI, post-operative hypertension, post-operative hypotension, and prolonged length of stay (>2 days). Post-operative hypertension indicates IV meds or continuous infusion (>=15 minutes), or more than one dose required more than one hour after surgery to control hypertension. Similarly, post-operative hypotension indicates IV meds or continuous infusion (>=15 minutes), or more than one dose required more than one hour after surgery to control hypotension.

Statistical Analysis

We used two-way ANOVA test to compare continuous baseline demographic characteristics and the Pearson $\chi 2$ test or Fisher's exact test to compare categorical baseline characteristics. Categorical variables were presented as frequencies and percentages. Continuous variables were presented as median (interquartile range). Categorical variables were compared by chi-square or Fisher's exact probability test, whereas continuous variables were compared by median test between the two cohorts as appropriate. Postoperative outcomes were evaluated using univariable and multivariable logistic regression analysis. Logistic regression model was used to adjust for confounding variables. The confounders for logistic regression models were selected by backward stepwise regression and clinical relevance. Multivariate analysis was conducted to account for the following potential secondary confounders: age, gender, race, ethnicity, obesity, symptomatic status, diabetes, hypertension (HTN), congestive heart failure (CHF), chronic obstructive pulmonary disease (COPD), chronic kidney disease (CKD), American Society of Anesthesiology (ASA) class, prior occlusions, coronary artery bypass grafting / percutaneous coronary intervention (CABG/PCI), procedure urgency, smoking, and use of preoperative medications. Final models were clustered by unique center identification numbers to decrease

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bias from unmeasurable factors per hospital level and to account for intragroup correlation. Appropriate theory-based categorical-categorical interactions were tested for and those that were found significant were presented. All adjusted odds ratios (aOR) were expressed with their corresponding 95% confidence intervals (CI). Hosmer-Lemeshow tests were used to assess the calibration of the models and the Area Under the Receiver Operating Characteristic Curve (AUC-ROC) was used for discrimination. The statistical software used was Stata MP version 17.0, and a p-value less than 0.05 was considered significant.

**Results**

Demographic and baseline characteristics:

The final cohort included 2,246 total patients who presented with recent MI, 1,217 (54.2%) of whom underwent CEA, 445 (19.8%) patients underwent TFCAS, and 584 (26.0%) patients had TCAR. Patients undergoing CEA were more likely to undergo elective operations [959 (78.80%) vs. 287 (64.49%) vs. 443 (75.86%), P<0.01], use general anesthesia [1,117 (91.78%) vs. 66 (14.83%) vs. 459 (78.60%), P<0.01], and use anticoagulants [194 (15.95%) vs. 22 (4.95%) vs. 22 (3.77%), P<0.01]. Patients undergoing TFCAS were more likely to be symptomatic [376 (30.97%) vs. 194 (43.60%) vs. 207 (35.45%), P<0.01], have prior CHF [374 (30.76%) vs. 192 (43.15%) vs. 243 (41.75%), P<0.01], COPD [340 (27.94%) vs. 153 (34.38%) vs. 192 (32.88%), P=0.014], CKD [359 (30.48%) vs. 187 (42.40%) vs. 245 (41.95%), P<0.01], have contralateral occlusion [70 (6.02%) vs. 55 (12.79%) vs. 66 (11.85%), P<0.01], and have prior ipsilateral stenosis [581 (48.06%) vs. 260 (59.09%) vs. 313 (55.11%), P<0.01]. Patients undergoing TCAR were more likely to have higher rates of ASA class IV-V [555 (45.64%) vs. 135 (32.22%) vs. 288 (49.40%), P<0.01], protamine use postop [923 (75.84%) vs. 62 (16.58%) vs. 519 (89.33%),

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P<0.01] and P2Y12 inhibitor use [723 (59.46%) vs. 360 (80.90%) vs. 513 (87.99%), P<0.01]. With regards to other factors, the different patient groups had similar distribution across all other comorbidities, preoperative medications, and risk factors. (Table I)

<u>Postoperative Outcomes</u>

In the univariate analysis, CEA was associated with a lower rate of death (1.15% vs 3.82% vs 2.23%; P=0.002), stroke/death (3.29% vs 6.56% vs 4.79%; P=0.012), stroke/death/MI (4.93% vs 8.14% vs 5.82%; P=0.046), post-operative hypotension (15.37% vs 24.03% vs 24.78%; P<0.001), and 30-day mortality (2.22% vs 5.17% vs 2.91%; P=0.007) compared to TFCAS and TCAR respectively. However, CEA was associated with a higher rate of post-operative hypertensin compared to TFCAS and TCAR (22.84% vs 9.84% vs 12.82%; P<0.001) (Table II). After adjusting for confounders, TFCAS was associated with increased risk of stroke/death (aOR= 2.69 [95% CI: 1.36-5.35] P=0.005) and stroke/death/MI (aOR=1.67, [95% CI: 1.07-2.60], P=0.025) compared to CEA. However, TCAR had similar stroke (add OR CI P) and stroke/death (add OR, CI, P) compared to CEA. Both TFCAS and TCAR were associated with increased risk of post-operative hypotension (aOR= 1.62 [95% CI: 1.18-2.23] P=0.003 and aOR= 1.74 [95% CI: 1.31-2.32] P=<0.001, respectively) and decreased risk of post-operative hypertension (aOR= 0.59 [95% CI: 0.36-0.95] P=0.029 and aOR= 0.50 [95% CI: 0.36-0.71] P=<0.001, respectively) compared to CEA (Table III). Furthermore, while TCAR and TFCAS had higher odds of 30-day death compared to CEA, the results were no longer statistically significant after adjusting for confounders. When comparing TCAR to TFCAS, TCAR was associated with decreased risk of post-operative hypertension (aOR=0.40, [95% CI: 0.19-0.82], P=0.013) but increased risk of post-operative hypotension (aOR=1.88, [95% CI: 1.10-3.22], P=0.020) (Table IV).

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**Discussion**

Although recent MI is a high-risk criterion for carotid revascularization, particularly CEA, our study showed that CEA is safer in this population with lower risk of stroke/death and stroke/death/MI compared to TFCAS. Furthermore, TCAR had similar outcomes compared to CEA in these patients.

Historically, CEA has been denoted as the gold standard therapy for carotid revascularization.[9, 12] More recently, TCAR has emerged as a hybrid procedure with lower risk of stroke and death compared to TFCAS and similar postoperative and midterm outcomes compared to CEA. Therefore, the decision of carotid revascularization methodology is of particular relevance. While no other studies have investigated the effect of pre-operative MI on post-operative outcomes across CEA, TFCAS, and TCAR, previous literature has compared outcomes across different carotid revascularization methodologies, accounting for other pre-operative factors.

Although CAS procedures have previously been thought to be the method of choice for high-risk patients,[7, 13, 14, 15, 16, 17] more recent studies have shown that CEA may have similar if not better outcomes. In a systematic review of randomized trials, Rothwell et al. found that CAS is associated with a higher risk of procedural stroke or death especially in patients with symptomatic stenosis compared to CEA.[18] In a similar study, Mas et al. found that in patients with symptomatic carotid stenosis of 60% or more, the rates of death and stroke at 1 and 6 months were lower with endarterectomy than with stenting.[19] More recently, Veith et al. found

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that CAS demonstrated inferior long-term results in symptomatic patients compared to CEA with higher rates of recurrent stenosis, incidence of stroke, and death.[20]

Age has also been previously indicated as a high-risk factor, and thus CAS has been recommended for treatment considering the potential advantages of its less invasive nature, avoiding general anesthesia, eliminating cranial nerve injury and wound complications, and providing a better accessibility to anatomically challenging lesions.[5] Nevertheless, Malas et al. established that CEA is safer in older patients and more recently TCAR has shown similar outcomes in the elderly.[21, 22] In patients with high-risk anatomic criteria initially established as indications for CAS such as contralateral occlusion, and severe calcification and longer lesion, Malas et al. have also shown that both CEA and TCAR are safer than TFCAS with lower risk of stroke and death.[23, 24, 25, 26] When comparing TFCAS to CEA, our findings are largely supported in the literature with CEA having better outcomes compared to TFCAS.[27, 28]

When comparing TFCAS to TCAR, TFCAS had higher odds of stroke or death although the p value was not statistically significant. This finding is also in line with a previous 2019 study. In this study comparing 10,136 TFCAS patients to 638 TCAR patients, the authors found a trend of increased stroke or death rates in TFCAS compared with TCAR, but no statistical significance (2.5% vs 1.7%; P = .25; odds ratio, 1.75, 95% confidence interval, 0.85-3.62).[29] However, the lack of statistical significance when dealing with TCAR and TFCAS, may be attributed to the smaller sample sizes. In a VQI study comparing TCAR to TFCAS utilizing large population sizes or 3,286 pairs of propensity-matched patients, TCAR was associated with significantly lower risk of perioperative in-hospital stroke or death (reported relative risk, 0.51 [95% CI, 0.37–

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0.72]).[30] While our findings suggest trends similar to current literature, the lack of statistical significance when comparing TCAR with TFCAS patients who have had recent MI may be due to limited data and therefore future analyses are needed to confirm findings.

When comparing CEA to TCAR, current literature also supports our findings that CEA and TCAR perform similarly with regards to stroke, death, and MI outcomes. In the largest multi-institutional study to date comparing TCAR to CEA, Malas et al. found that after matching patients based on propensity score, there were no significant differences observed between the two revascularization methodologies in terms of in-hospital stroke/death.[31] Additionally, in a study looking at the 1-year outcomes between TCAR and CEA, O'Malley et al. reported similar rates of stroke and death particularly among symptomatic patients.[32] Similarly, in propensity score-matched analysis of 1-year outcomes, Malas et al. reported no significant differences in ipsilateral stroke/death-free survival between CEA or TCAR.[33] In a follow-up study using both VQI and Medicare data, Malas et al. found the rate of death at one-year was similar in TCAR and CEA regardless of symptomatic status.[34]

Together, these findings may suggest that recent MI should not be a contraindication for TCAR or CEA. Additionally, given that CEA performed better than TFCAS in terms of in-hospital stroke/death and stroke/death/MI, our results suggest that designating pre-operative MI as a high-risk factor for CEA should be re-evaluated. When investigating the risk of recent MI, Rubinfeld et al. concluded that while recent MI increases risk of perioperative MI and cardiac arrect, frailty and ASA class were better predictors of these adverse outcomes.[35] Virgilio et al. also analyzed the effect of recent MI on surgery risk and found that waiting two months reduced adverse outcomes. Furthermore, they noted that the risk of preoperative MI was lower in vascular procedures compared to nonvascular procedures suggesting that MI may not be a high preoperative risk factor in vascular procedures.[10]

Selecting the ideal method of carotid revascularization is a complicated task for treating surgeons given a myriad of complex patient factors including age, sex, comorbidities, operative risks, life expectancy, functional status, anatomical considerations, disease factors, and patient preferences.[36] Nevertheless, this study stands as the first of its kind, exclusively investigating the impact of pre-operative MI on post-operative outcomes across CEA, TFCAS, and TCAR, thus providing critical insights into the interplay between pre-existing myocardial infarction and different surgical approaches. Previously, CAS has been indicated as a reasonable alternative for patients with high operative risk, [37] and has also been suggested as a potential treatment option for recent MI.[38] However, our findings indicate that these patients may derive greater benefits from CEA and experience superior in-hospital outcomes, particularly when compared to TFCAS.

**Conclusion**

In this larger multi-institutional study, we have found that patients undergoing CEA with pre-operative MI have a lower risk of stroke/death and stroke/death/MI compared to TFCAS but similar outcomes to TCAR. These findings suggest that recent MI should not be considered a criterion favoring the use of TFCAS over CEA, given TFCAS patients had higher rates of stroke, post-operative MI, and death. When deciding between CEA and TCAR, surgeons should consider additional risk factors such anatomic eligibility for TCAR, prior CEA, lesion characteristic and risk of cranial nerve injury.[4, 39] Taken together, our findings may ultimately

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improve the quality and availability of care for this population and fill any gaps in practice for this patient group. However further prospective studies are needed to confirm these findings and address some of the limitations.

**Limitations**

While many variables such as age, living status, and comorbidities were captured and eliminated as cofounders in our multivariate analysis, the presence of unmeasured confounders not captured in this dataset may influence outcomes. Furthermore, given VQI does not include a variable specifying the specific time of pre-operative MI, all patients with recent MI of less than 6 months were lumped together. As a result, we were unable to adjust adequately for time after MI. Another limitation of this study is the lack of randomization which subjects the analysis to other potential confounders. Additionally, since our population was derived from self-reported data, this may result in missing data and human error albeit minimized by auditing and comparison to claim data. The retrospective nature of this study also precludes us from making causal inferences and subjects the study to inclusion bias. Additionally, because the VQI database does provide the exact date of pre-operative MI, another limitation of this study is that any inferences regarding delaying time to surgery are unable to be made. Finally, our outcomes analysis focused on short-term outcomes. As a result, long-term studies assessing mortality and stroke are needed to better understand outcomes over time.

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Table I: Baseline Demographic and Clinical Characteristics Stratified by Carotid Revascularization Methodology.

| | **CEA** | **TFCAS** | **TCAR** | **P-value** |
|---|---|---|---|---|
| **Demographics** | | | | |
| Age, mean | 69.1 +/- 9.2 | 69.9 +/- 9.2 | 71.2 +/- 8.6 | 0.142 |
| **Other** | | | | |
| Obesity (BMI>30) | 422 (34.82%) | 146 (32.81%) | 210 (36.02%) | 0.561 |
| **Sex** | | | | |
| Female | 424 (34.84%) | 143 (32.13%) | 190 (32.53%) | 0.461 |
| **Race** | | | | |
| White | 1,080 (88.74%) | 385 (86.71%) | 512 (87.82%) | 0.328 |
| **Ethnicity** | | | | |
| Hispanic or Latino | 47 (3.87%) | 26 (5.87%) | 28 (4.83%) | 0.202 |
| **Symptomatic status** | | | | |
| Symptomatic stenosis | 376 (30.97%) | 194 (43.60%) | 207 (35.45%) | <0.001 |
| Amaurosis fugax | 37 (3.05%) | 21 (5.16%) | 24 (4.15%) | 0.124 |

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| | | | | |
|---|---|---|---|---|
| Transient ischemic attacks | 91 (7.50%) | 53 (12.90%) | 74 (12.80%) | <0.001 |
| Stroke | 259 (21.33%) | 158 (37.80%) | 156 (26.80%) | <0.001 |
| **Comorbidities** | | | | |
| Diabetes | 575 (47.29%) | 210 (47.30%) | 275 (47.09) | 0.997 |
| HTN | 1,142 (94.15%) | 422 (95.05%) | 560 (95.89%) | 0.286 |
| CHF | 374 (30.76%) | 192 (43.15%) | 243 (41.75%) | <0.001 |
| COPD | 340 (27.94%) | 153 (34.38%) | 192 (32.88%) | 0.014 |
| CKD | 359 (30.48%) | 187 (42.40%) | 245 (41.95%) | <0.001 |
| **ASA class** | | | | |
| IV-V | 555 (45.64%) | 135 (32.22%) | 288 (49.40%) | <0.001 |
| Contralateral occlusion | 70 (6.02%) | 55 (12.79%) | 66 (11.85%) | <0.001 |
| **Prior surgeries** | | | | |
| Prior CABG/PCI | 917 (75.41%) | 317 (71.40%) | 429 (73.71%) | 0.244 |
| Prior contralateral CEA/CAS | 139 (11.42%) | 68 (15.32%) | 74 (12.69%) | 0.104 |
| Ipsilateral stenosis >80% | 581 (48.06%) | 260 (59.09%) | 313 (55.11%) | <0.001 |

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| | | | | |
|---|---|---|---|---|
| **Procedure factors** | | | | |
| Elective | 959 (78.80%) | 287 (64.49%) | 443 (75.86%) | <0.001 |
| Protamine use | 923 (75.84%) | 62 (16.58%) | 519 (89.33%) | <0.001 |
| **Smoking history** | | | | |
| Prior smoker | 619 (50.90%) | 228 (51.47%) | 285 (48.80%) | 0.738 |
| Current smoker | 296 (24.34%) | 112 (25.28%) | 142 (24.32%) | |
| **Anesthesia** | | | | |
| General | 1,117 (91.78%) | 66 (14.83%) | 459 (78.60%) | <0.001 |
| **Pre-operative medication** | | | | |
| P2Y inhibitor | 723 (59.46%) | 360 (80.90%) | 513 (87.99%) | <0.001 |
| Statin | 1,084 (89.14%) | 390 (87.64%) | 532 (91.10%) | 0.193 |
| Aspirin | 1,072 (88.16%) | 398 (89.44%) | 537 (91.95%) | 0.050 |
| Beta-blocker | 990 (81.48%) | 350 (78.65%) | 472 (80.82%) | 0.432 |
| ACE inhibitor | 651 (53.54%) | 232 (52.13%) | 321 (54.97%) | 0.663 |
| Anticoagulant | 194 (15.95%) | 22 (4.95%) | 22 (3.77%) | <0.001 |

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Table II: Postoperative Outcomes of CEA, TFCAS, TCAR in Patients with Recent MI.

| **In-hospital** | **Univariable** | | | |
|---|---|---|---|---|
| | **CEA** | **TFCAS** | **TCAR** | |
| | **N(%)** | **N(%)** | **N(%)** | **P-value** |
| Stroke | 27 (2.22) | 15 (3.40) | 19 (3.26) | 0.277 |
| Ipsilateral stroke | 19 (1.56) | 14 (3.17) | 16 (2.74) | 0.079 |
| Death | 14 (1.15) | 17 (3.82) | 13 (2.23) | 0.002 |
| MI | 28 (2.30) | 8 (1.80) | 8 (1.37) | 0.398 |
| Stroke/death | 40 (3.29) | 29 (6.56) | 28 (4.79) | 0.012 |
| Stroke/death/MI | 60 (4.93) | 36 (8.14) | 34 (5.82) | 0.046 |
| Post-op hypertension | 278 (22.84) | 43 (9.84) | 74 (12.82) | <0.001 |
| Post-op hypotension | 187 (15.37) | 105 (24.03) | 143 (24.78) | <0.001 |
| Prolonged length of stay | 565 (46.43) | 233 (52.36) | 268 (45.89) | 0.068 |
| 30-day mortality | 27 (2.22) | 23 (5.17) | 17 (2.91) | 0.007 |

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Table III: Postoperative Outcomes of TFCAS vs CEA and TCAR vs CEA in Patients with Preoperative MI after Adjusting for Confounding Factors (Reference = CEA).

| **In-hospital** | **Multivariable** | | | |
|---|---|---|---|---|
| | **TFCAS vs CEA** | | **TCAR vs CEA** | |
| | **OR (95% CI)** | **P-value** | **OR (95% CI)** | **P-value** |
| Stroke | 1.30 (0.69-2.47) | 0.413 | 1.42 (0.77-2.62) | 0.260 |
| Ipsilateral stroke | 1.49 (0.69-3.23) | 0.308 | 1.90 (0.87-4.11) | 0.105 |
| Death | 2.42 (1.00-5.89) | 0.051 | 2.21 (0.89-5.46) | 0.086 |
| MI | 0.84 (0.37-1.88) | 0.664 | 0.57 (0.24-1.34) | 0.197 |
| Stroke/death | 2.69 (1.36-5.35) | 0.005 | 1.45 (0.84-2.51) | 0.185 |
| Stroke/death/MI | 1.67 (1.07-2.60) | 0.025 | 1.10 (0.68-1.78) | 0.701 |
| Post-op hypertension | 0.59 (0.36-0.95) | 0.029 | 0.50 (0.36-0.71) | <0.001 |
| Post-op hypotension | 1.62 (1.18-2.23) | 0.003 | 1.74 (1.31-2.32) | <0.001 |
| Prolonged length of stay (>2 days) | 1.12 (0.81-1.55) | 0.481 | 0.96 (0.72-1.27) | 0.761 |
| 30-day mortality | 1.23 (0.60-2.54) | 0.566 | 1.17 (0.57-2.43) | 0.668 |

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Table IV: Postoperative Outcomes of TCAR vs TFCAS in patients with Preoperative MI after Adjusting for Confounding Factors (Reference = TFCAS).

| **In-hospital** | **Multivariable** | |
|---|---|---|
| | **TCAR vs TFCAS** | |
| | **OR (95% CI)** | **P-value** |
| Stroke | 1.77 (0.58-5.44) | 0.316 |
| Ipsilateral stroke | 1.62 (0.54-4.83) | 0.388 |
| Death | 0.54 (0.24-1.21) | 0.136 |
| MI | 1.17 (0.18-7.60) | 0.870 |
| Stroke/death | 0.80 (0.33-1.91) | 0.609 |
| Stroke/death/MI | 0.85 (0.42-1.72) | 0.644 |
| Post-op hypertension | 0.40 (0.19-0.82) | 0.013 |
| Post-op hypotension | 1.88 (1.10-3.22) | 0.020 |
| Prolonged length of stay (>2 days) | 1.21 (0.77-1.92) | 0.411 |
| 30-day mortality | 0.76 (0.28-2.06) | 0.592 |

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