DOI: https://doi.org/10.66984/jsmdc.v12.i01.oa.01.

Original Article

# Comparative Analysis of Procedural Success of Patients Undergoing Carotid Angioplasty in Tertiary Care Center

Muhammad Faizan Younus, Asim Javed, Asma Shabbir, Zunera Hakim, Mujaddid Mudassir, Adeel ur Rehman

**ABSTRACT**

**Objective:** To compare the procedural success between symptomatic and asymptomatic patients who underwent carotid angioplasty in a tertiary care center.

**Methodology:** This cross-sectional analytical study was conducted at the Rawalpindi Institute of Cardiology, Rawalpindi after taking ethical approval. Data was collected from March 2023 to March 2026. Following written informed consent, 170 patients aged ≥18 years with severe carotid artery stenosis who underwent carotid angioplasty were included using non-probability consecutive sampling. The patients were divided into symptomatic and asymptomatic groups. All cases of carotid angioplasty with stenting were performed electively by the team of interventional cardiologists in the catheterization lab using aseptic protocols. Procedural success was defined as residual stenosis of <30% after stent placement with no major adverse cardiac and cerebrovascular events (MACCEs). Patients were followed up at 30 days and 6 months. Data was analyzed using the Statistical Package for the Social Sciences (SPSS) version 26.

**Results:** One hundred and forty one (82.9%) patients had a history of stroke, and were symptomatic, whereas, 29(17.1%) patients were asymptomatic, with either no symptom (6%) or planned for coronary artery bypass grafting (16.5%). The technical success was 100%, with <30% residual stenosis. Out of 170 patients, 2(1.2%) patients died, 3(1.8%) patients developed stroke and 1(0.6%) patient had myocardial infarction at 6 months. The overall procedural success was 96.5%. The procedural success was not significantly different between symptomatic and asymptomatic patients (p-value = 1.00).

**Conclusion:** Carotid angioplasty showed excellent procedural success in symptomatic as well as asymptomatic patients in a tertiary care center.

**Keywords:** *Carotid stenosis. Stents. Stroke.*

## INTRODUCTION

In many developed nations, cerebrovascular accidents (CVAs) are the second or third leading cause of death and the primary cause of disability among adults. Ischemic stroke represents 70-90% of all CVAs. Carotid artery stenosis continues to be a significant factor in ischemic stroke. Atherosclerosis of the internal carotid artery (ICA), causing >50% stenosis, accounts for 9-40% of ischemic strokes.[1,2] First-line treatment for patients with atherosclerosis involves pharmacotherapy. However, literature indicates that pharmacotherapy may not be effective for patients who are at a higher risk of experiencing a CVA.[3] Traditionally, carotid endarterectomy (CEA) has been regarded as the standard treatment. In the last 20 years, carotid artery stenting (CAS) has been introduced as an alternative option, especially for patients at high risk for surgery. Nevertheless, with the increased use of CAS, in-stent restenosis has become a more commonly recognized issue. In-stent thrombosis develops in 20% of patients after undergoing CAS, in contrast to 9% following CEA.[4] With the advancement of endovascular techniques, imaging guidance, embolic protection devices, and procedural success, the complication rates associated with carotid angioplasty have decreased.[2]

The procedural success of carotid artery stenting depends on patient, lesion, and technical factors. Older age, co-morbidities, and complex vascular anatomy can make the procedure more challenging and may increase the risk of complications. Similarly, heavily calcified plaques, long segment disease, and tortuous vessels can lead to technical issues. Outcomes also vary based on the operator's experience, careful selection of stent type and size, and the routine use of embolic protection devices. Adequate antiplatelet therapy and proper intraprocedural management also contribute significantly to procedural safety. [5,6]

Despite widespread adoption, variability exists in reported procedural success rates due to differences in patient selection, operator experience, and procedural techniques. Therefore, evaluating the procedural success of carotid angioplasty in different clinical settings is essential to optimize the outcomes and guide future practice. So, our study was conducted to determine the procedural success of patients who underwent carotid angioplasty in a tertiary care center and compare the outcomes between symptomatic and asymptomatic patients.

*Sharif Medical & Dental College, Sharif Medical City. Sharif Medical City Road, Off Raiwind Road, Jati Umra, Lahore 54000, Pakistan.*

*Correspondence: Dr. Muhammad Faizan Younus*
*Senior Registrar, Department of Cardiology*
*Rawalpindi Institute of Cardiology, Rawalpindi*
*E-mail: faizanstalwart@gmail.com*

---

*Received: April 27, 2026; Accepted: May 25, 2026*

## METHODOLOGY

This cross-sectional analytical study was conducted at the Rawalpindi Institute of Cardiology, Rawalpindi, after taking ethical approval (Letter No. RIC/RERC/05A/25, 26-03-2025). Data was collected from March 2023 to March 2026. Data from March 2023 to March 2025 was obtained retrospectively from medical records, while data from March 2025 to March 2026 was collected prospectively. The sample size of 168 (rounded off to 170) was calculated using 87.5% success rate of carotid angioplasty, 5% margin of error, and 95% confidence interval.[7.] After obtaining informed written consent, patients aged ≥18 years with a diagnosis of severe carotid artery stenosis who underwent carotid angioplasty were included using a non-probability consecutive sampling technique. The indications for carotid angioplasty were a history of stroke, planned for coronary artery bypass grafting (CABG) or asymptomatic carotid artery stenosis. The carotid artery stenosis was diagnosed based on duplex ultrasound and computed tomography (CT)/magnetic resonance (MR) angiography. Severe stenosis was defined as greater than 70% stenosis of the internal carotid artery.[8]

Patients who had previous carotid intervention, total carotid occlusion or did not give consent were excluded. All cases of carotid angioplasty with stenting were performed electively by the team of interventional cardiologists in the catheterization lab using aseptic protocols. All patients received a preoperative aspirin and clopidogrel. The procedure was performed through transfemoral access under local anesthesia. The catheter was advanced to common carotid artery. Intravenous heparin was given during the procedure. An embolic protection device was placed distal to the lesion in the internal carotid artery (ICA) to prevent the risk of stroke. A guide wire was passed carefully across the stenosis into distal ICA and stent was positioned across the lesion. The stent length varied from 20 mm to 40 mm and its diameter ranged from 6 mm to 10 mm. The demographic profile of the patients, co-morbidities such as diabetes mellitus (DM), hypertension (HTN), dyslipidemia, & smoking, and lesion characteristics (type & location of lesion) were recorded on a proforma. Patients were divided into two groups: symptomatic and asymptomatic based on their clinical presentation. The patient follow-up was done at 30 days and 6 months.

Technical success was defined as residual stenosis of <30% after stent placement. Patients with technical success and no major adverse cardiac and cerebrovascular events (MACCEs) were labeled as procedural success. The MACCEs included mortality, stroke, and myocardial infarction (MI).[9]

## STATISTICAL ANALYSIS

Data was analyzed using the Statistical Package for the Social Sciences (SPSS) version 26. Mean and standard deviation were used for quantitative variables such as age. Frequency and percentage were used for qualitative variables such as gender, co-morbidities, indications for carotid angioplasty, lesion characteristics, stent dimensions, and procedural success. The comparison of variables between symptomatic and asymptomatic patients was done using the Chi-square/Fisher's exact test. The p-value of <0.05 was considered statistically significant.

## RESULTS

Patients had a mean age of 64.26±8.76 years, with the minimum and maximum of 40 and 84 years, respectively. There were 136(80%) males and 34(20%) females. One hundred and forty one (82.9%) patients had a history of stroke and were symptomatic. Twenty nine (17.1%) patients were asymptomatic, with either no symptom [1(6%)] or planned for CABG [28(16.5%)]. One hundred and nineteen (70%) patients had hypertension, 74(43.5%) had diabetes mellitus, 60(35.3%) had dyslipidemia, and 42(24.7%) were smokers.

Most of the lesions were non-thrombotic (45.3%). Seventy three lesions were ostial (42.9%), 9(5.3%) were at the bifurcation, and 88(51.8%) were at other sites. The contralateral carotid artery was patent in 93(54.7%) of the patients, subtotally occluded in 54(31.8%), and totally occluded in 23(13.5%) of the patients. There was no significant difference in demographic variables, co-morbidities, and lesion characteristics between two groups (Table 1).

The most commonly used stent lengths were 30 mm (30.6%) and 40 mm (30.6%), followed by 25 mm (26.5%) and 20 mm (11.1%). The stent with a diameter of 8 mm was used in the majority of the patients (50.6%), followed by 7 mm stent (22.9%).

The residual stenosis was <30% in all the patients, showing 100% technical success. Out of 170 patients, 2(1.2%) patients died, 3(1.8%) patients developed stroke and 1(0.6%) patient had MI at 6 months. The overall procedural success was 96.5%. The procedural success was not statistically different between symptomatic and asymptomatic patients (Table 2).

**Table 1: Comparison of Demographic Variables, Co-Morbidities, & Lesion Characteristics between Two Groups**

| Parameters | | | Symptomatic Patients (n=141) | Asymptomatic Patients (n=29) | Total (n=170) | p-value |
|---|---|---|---|---|---|---|
| Gender | | Male | 114(80.8%) | 22(75.8%) | 136(80%) | 0.54 |
| | | Female | 27(19.2%) | 7(24.2%) | 34(20%) | |
| Co-Morbidities | Hypertension | Yes | 100(71%) | 19(65.5%) | 119(70%) | 0.56 |
| | | No | 41(29%) | 10(34.5%) | 51(30%) | |
| | Diabetes Mellitus | Yes | 59(41.8%) | 15(51.7%) | 74(43.5%) | 0.32 |
| | | No | 82(58.2%) | 14(48.3%) | 96(56.5%) | |
| | Dyslipidemia | Yes | 48(34%) | 12(41.4%) | 60(35.3%) | 0.45 |
| | | No | 93(66%) | 17(58.6%) | 110(64.7%) | |
| Smoking | | Yes | 31(22%) | 11(37.9%) | 42(24.7%) | 0.07 |
| | | No | 110(78%) | 18(62.1%) | 128(75.3%) | |
| Lesion Type | | Non-Thrombotic | 67(47.5%) | 10(34.5%) | 77(45.3%) | 0.39 |
| | | Thrombotic | 35(24.8%) | 8(27.5%) | 43(25.3%) | |
| | | Calcific | 39(27.7%) | 11(38%) | 50(29.4%) | |
| Lesion Site | | Ostial | 62(44%) | 11(37.9%) | 73(42.9%) | 0.08 |
| | | Bifurcation | 5(3.5%) | 4(13.8%) | 9(5.3%) | |
| | | Others | 74(52.5%) | 14(48.3%) | 88(51.8%) | |
| Contralateral Carotid Artery | | Patent | 78(55.4%) | 15(51.7%) | 93(54.7%) | 0.33 |
| | | Subtotal Occlusion | 42(29.8%) | 12(41.4%) | 54(31.8%) | |
| | | Total Occlusion | 21(14.8%) | 2(6.9%) | 23(13.5%) | |

**Table 2: Procedural Success in Symptomatic versus Asymptomatic Patients after Carotid Angioplasty**

| Outcomes | | Symptomatic Patients (n=141) | Asymptomatic Patients (n=29) | Total (n=170) | p-value |
|---|---|---|---|---|---|
| Technical Success | Yes | 141(100%) | 29(100%) | 170(100%) | 1.00 |
| | No | 0(0%) | 0(0%) | 0(0%) | |
| Mortality | Yes | 2(1.4%) | 0(0%) | 2(1.2%) | 1.00 |
| | No | 139(98.6%) | 29(100%) | 168(98.8%) | |
| Stroke | Yes | 3(2.1%) | 0(0%) | 3(1.8%) | 1.00 |
| | No | 138(97.9%) | 29(100%) | 167(98.2%) | |
| Myocardial Infarction | Yes | 1(0.7%) | 0(0%) | 1(0.6%) | 1.00 |
| | No | 140(99.3%) | 29(100%) | 169(99.4%) | |
| Overall Procedural Success | Yes | 136(96.5%) | 28(96.5%) | 164(96.5%) | 1.00 |
| | No | 5(3.5%) | 1(3.5%) | 6(3.5%) | |

## DISCUSSION

Carotid angioplasty with stenting has been introduced as a less invasive alternative to surgical endarterectomy. Recent literature has demonstrated that it is a safe and effective alternative to carotid endarterectomy in selected patients. Improvements in techniques and devices, driven by advances in interventional cardiology, have further enhanced the outcomes of carotid angioplasty.[10,11]

The mean age of the patients was 64.26±8.76 years in our study, and 80% were males. Barath et al. revealed that patients had a mean age of 64.8 ± 9.1 years, with 64.1% males.[12] In the current study, 43.5% of patients had diabetes mellitus, 70% were hypertensive, 24.7% were smokers, and 35.3% had dyslipidemia. All patients had DM, HTN, and dyslipidemia in another study.[7] Most of the patients were hypertensive (66.7%), followed by diabetic patients (53.9%) in a study.[12] Ezzeldin et al. observed that 86.08% patients had HTN, and 40.17% had DM, and 26.45% were current smokers.[13]

Our results showed that 82.9% of the patients were symptomatic and 17.1% were asymptomatic. Algahtani et al. and Barath et al. observed that all patients were symptomatic.[7,12] In our study, there was no significant difference in demographic variables, co-morbidities, and lesion characteristics between the two groups. In another study, the two groups only differed in smoking status, with significantly more smokers among symptomatic patients (43% versus 28%).[14]

In our study, the technical success rate was 100%, whereas other studies reported technical success rates of 99.4% and 98.3%.[11,14] Only a few patients (1.8%) in this study developed stroke, and 0.6% experienced myocardial infarction (MI). In a study, stroke occurred in 1.6% of the patients after carotid angioplasty.[14] In another study, 4.15% of the patients developed complications; ischemic stroke in 0.55%, hemorrhagic stroke in 0.28%, and myocardial infarction in 0.07%, and transient ischemic attack in 0.4% of the patients.[13] Another study reported stroke in 2.5%, symptomatic diffusion weighted imaging ischemic lesions (on MRI) in 33%, and repeat stenting in 7.5% of the patients.[15] Malas et al. reported stroke in 2% of the patients after carotid angioplasty.[16] A study conducted in 2025 revealed 2.2% frequency of major adverse events after carotid angioplasty.[17] In contrast, Algahtani et al. reported no episode of MI or stroke in any patient after procedure.[7] Similarly, in another study, none of the patients developed stroke or MI. Other complications were seen in 6.3% of the patients who presented with in-stent thrombosis and symptomatic showering of thrombi.[12] According to our results, the mortality rate was 1.2%. Ezzeldin et al. reported 0.9% mortality.[13] Similar results were reported in another study, where the in-hospital mortality rate was 1.08%, and the 30 day mortality rate was 1.80%[16] In contrast, the mortality rate was higher (7.7% and 18.8%) in other studies.[7,12] The procedural success was achieved in 96.5% of the patients in our study. The success rate was 87.5% and 100% in other studies.[7,12] The procedural success was not different between symptomatic and asymptomatic patients in our study. Similarly, a study conducted in Iraq reported no significant difference in outcomes between the two groups.[14]

Another study reported that carotid angioplasty is linked with a significantly lower risk of mortality or stroke at 30 days as compared to medical therapy or surgical endarterectomy. In patients who underwent angioplasty, these outcomes occurred in 2.8% compared to 6% of the patients on medical treatment and 3.7% in the endarterectomy group.[18] In contrast to our results, a study revealed that surgical endarterectomy was associated with better results than carotid angioplasty. The mortality rate was significantly lower with CEA, with no statistical difference in the rate of postoperative MI and stroke.[19]

## CONCLUSION

Carotid angioplasty showed excellent procedural success in symptomatic as well as asymptomatic patients in a tertiary care center. It is a highly effective & minimally invasive technique and should be adopted in tertiary care centers with experienced interventional operators, appropriate patient selection, careful evaluation of lesion characteristics and meticulous endovascular techniques.

## LIMITATIONS & RECOMMENDATIONS

This study had a cross-sectional design, was conducted at a single institution, and did not evaluate long term outcomes in patients who underwent carotid angioplasty. Therefore, large multicenter randomized controlled trials with long term follow-up are recommended in the future. Carotid angioplasty with stenting is a recommended catheter based procedure for the treatment of carotid artery stenosis in both symptomatic and asymptomatic patients.

**Conflict of interest:** None.
**Source of funding:** None.

**Authors' Contributions:**
Authors approved the draft and are accountable in ensuring that questions related to accuracy or integrity of the work are duly investigated and resolved.
**M.F.Y:** Concept, data collection, analysis, manuscript writing, and final approval.
**A.J:** Study supervision, methodology, critical review, and final approval.
**A.S:** Literature review, drafting, and final approval.
**Z.H:** Data analysis, editing, and final approval.
**M.M:** Data management, patient follow-up, and final approval.
**A.R:** Critical revision, supervision, and final approval.

## REFERENCES

1. Alchaer MW, Gorran H, Alchaer AW, Abbruzzese TA. Carotid endarterectomy with stent explantation for in-stent restenosis in two patients and review of the literature. Cureus. 2026; 18(1):e101321. doi:10.7759/cureus.101321.

2. Taliuridze MT, Shukurov FB, Abugov SA, Bondarevsky SI, Feshchenko DA, Vasiliev DK, et al. Carotid artery stenting: state of the art. Cardiovasc Ther Prev. 2025; 24(12):4582. doi:10.15829/1728-8800-2025-4582.

3. Aprotosoaie AC, Costache AD, Costache II. Therapeutic strategies and chemoprevention of atherosclerosis: what do we know and where do we go? Pharmaceutics. 2022; 14(4):722. doi:10.3390/pharmaceutics14040722.

4. Bracale UM, Peluso A, Di Mauro E, Del Guercio L, Di Taranto MD, Giannotta N, et al. Carotid endarterectomy versus carotid artery stenting with double-layer micromesh carotid stent: contemporary results of a single-center retrospective study. Ann Vasc Surg. 2022; 82:41-6. doi:10.1016/j.avsg.2021.10.07.

5. Zhang X, Zhou J, Yang R, Jin J, Zeng Y, Guo S, et al. Age-related anatomical changes in carotid artery stenosis and its impact on postoperative complications in stenting and endarterectomy. CNS Neurosci Ther. 2025; 31(7):e70527. doi:10.1111/cns.70527.

6. Calo P, Oberhuber A, Gortz H. Patient selection criteria and procedural standardization for carotid artery stenting-a single center experience. J Clin Med. 2023; 12(10):3534. doi:10.3390/jcm12103534.

7. Algahtani H, Shirah B, Alghamdi AS, Subahi A, Alqahtani SA, Alshamy A. Carotid artery angioplasty and stenting for carotid stenosis: a single-center experience from Saudi Arabia. Neurointervention. 2020; 15(3):133-9. doi:10.5469/neuroint.2020.00052.

8. Jeon SY, Lee JM. Protected carotid artery stenting in patients with severe stenosis. Medicine (Baltimore). 2022; 101(33):e30106. doi:10.1097/MD.0000000000030106.

9. Vadala G, Sucato V, Costa F, Castriota F, Nerla R, Roscitano G, et al. Uncommon carotid artery stenting complications: a series by images. J Pers Med. 2024; 14(3):250. doi:10.3390/jpm14030250.

10. Brown MM, Bonati LH. Managing asymptomatic carotid stenosis. N Engl J Med. 2026; 394(3):296-7. doi:10.1056/NEJMe2515725.

11. Kok M, de Heide EJ, Hellegering J, van der Laan MJ, Mazuri A, et al. Optimizing treatment of significant carotid artery stenosis in times of logistic restraints as a result of COVID-19 pandemic. Ann Vasc Surg. 2024; 108:498-507. doi:10.1016/j.avsg.2024.05.020.

12. Barath S, Patel R, Mittal GK, Mohindru R, Sharma JB, Jain D. Procedural and short-term outcomes of carotid artery stenting: a single-center experience. Cureus. 2024; 16(12):e75763. doi:10.7759/cureus.75763.

13. Ezzeldin M, Hassan AE, Kerro A, Martucci M, Hussain MS, Mir O, et al. Carotid artery stenting outcomes by neurointerventional surgeons (CASONI). Stroke Vasc Interv Neurol. 2024; 5(1):e001459. doi:10.1161/SVIN.124.001459.

14. Aljabry KNO, Al-Dulaimi MRR, Abeid ST, Al-Fahham AA. Impact of carotid artery angioplasty in symptomatic vs. asymptomatic carotid artery disease. J Contemp Med Sci. 2025; 11(4):286-90. doi: 10.22317/jcms.v11i4.1974.

15. Tsuchigauchi S, Matsushige T, Hashimoto Y, Hosogai M, Takahashi H, Oku S, et al. Efficacy of carotid artery stenting in patients with symptomatic low-grade carotid artery stenosis. J Neurosurg. 2025; 144(2):400-7. doi:10.3171/2025.7.JNS25577.

16. Malas MB, Hamouda M. An inconvenient truth? Optimization of carotid stenting is dependent on the approach and method of embolic protection. Endovasc Today. 2025; 24(10):25-8. Available from: https://assets.bmctoday.net/evtoday/pdfs/et1025_FT_BSC.pdf.

17. Langhoff R, Vajda Z, Odrowaz-Pieniazek P, Gjoreski A, Beelen R, Deloose K, et al. 30-day outcomes of real-world elective carotid stenosis treatment using a dual-layer micromesh stent (ROADSAVER Study). Cardiovasc Intervent Radiol. 2025; 48(4):427-37. doi:10.1007/s00270-025-04003-z.

18. Brott TG, Howard G, Lal BK, Voeks JH, Turan TN, Roubin GS, et al. Medical management and revascularization for asymptomatic carotid stenosis. N Engl J Med. 2026; 394(3):219-31. doi:10.1056/NEJMoa2508800.

19. Fan Y, Peng N, Jiang L, Zhang S, Xue M, Yao D. Carotid endarterectomy versus stenting in patients with carotid artery stenosis and type 2 diabetes: a nationwide cohort study from the USA. BMJ Surg Interv Health Technol. 2025; 7(1):e000431. doi:10.1136/bmjsit-2025-000431.


***How to cite:*** *Younus MF, Javed A, Shabbir A, Hakim Z, Mudassir M, Rehman A. Comparative analysis of procedural success of patients undergoing carotid angioplasty in tertiary care center. JSMDC. 2026; 12(01):3-7. doi:https://doi.org/10.66984/jsmdc.v12.i01.oa.01.*