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Carotid Artery Stenting in Patients undergoing Emergency Intracranial Endovascular Therapy for Acute Stroke

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ABSTRACT

Objective: To assess the outcomes of concurrent carotid artery stenting in patients undergoing emergency intravascular management for acute stroke.
Study Design: Case Series Study.
Place and Duration of Study: Department of Interventional Radiology, Armed Forces Institute of Radiology and Imaging, Rawalpindi Pakistan, from Mar 2020 to Mar 2021.
Methodology: The study involved recruitment of patients undergoing emergency intracranial vascular intervention for Acute Ischemic Stroke, with concurrent ipsilateral carotid stenosis. Thrombus aspiration from the intracranial vessels was done with help of SOFIA Catheter. Following the confirmation of successful cerebral revascularization, the carotid lesion was stented using an appropriately sized stent. All patients were closely monitored for one year to assess any morbidity and mortality outcomes.
Results: A total of 11 patients were included in this study out of which 8(72.7%) were male and 3(27.3%) were female. Mean age was 63.73+10.56 years. Hypertension was the most common co-morbid disease, 9(81.8%). The stenosis ranged from 58 - 94%. The residual stenosis after stenting was 11 – 40 %. Per-operatively, 2 patients (18.2%) had Cerebral Hyperperfusion and 1 (9.1%) had asymptomatic stent thrombosis. In terms of complications, there were a total of three (27.3%) CVA events in the study population at 1 years follow up. Two patients recovered and there was 1(9.1%) mortality.
Conclusions: The initial experience in management of tandem stenosis of the carotid artery by stenting while performing thrombectomy of ipsilateral ischemic stroke has shown encouraging results.

Keywords: Carotid Stenting, Carotid Stenosis, Carotid Artery Disease.

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INTRODUCTION

Stroke is the second most common cause of death worldwide. It is also the third most frequent reason of disability.[1] Thrombosis of a cerebral vessel leads to cerebral ischemia causing Acute Ischemic Stroke (AIS). It has been estimated that death caused by stroke occurs every 4 minutes in the United States.[2] Previously, tissue-Plasminogen activator (tPA) was the only available recanalization treatment for patients presenting with AIS. Unfortunately, due to a narrow treatment window and considerable contraindications, it is available to very few patients.[3] But now progress in the field of Vascular and Endovascular interventions have enabled us to use modern devices for thrombus retrieval.[4] A recent meta-analysis has revealed a considerable difference in long term quality of life after endovascular thrombectomy.[5]

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Carotid artery stenosis due to atherosclerosis is considered an important risk factor for the development of AIS.[6] The stenosis can be treated surgically by Carotid End Arterectomy (CEA) or Carotid Artery Stenting (CAS). CEA entirely removes the atheromatous plaque, but stenting is less invasive.[7] ACST-2, a recently published international RCT including 33 countries, 130 hospitals and 3625 patients found comparable short and long term complications between the two treatment modalities.[7]

The optimal time of Carotid Artery intervention following stroke has not yet been ascertained, and literature contains inconsistent data. Initially, it was postulated that delaying the procedure would decrease the peri-procedural complication rate.[8] However, latest SVS Treatment Guidelines recommend that intervention be carried out within 2 weeks of onset of stroke if possible.[9] It has been noted in these same guidelines that, there is no available data to evaluate the role of adjuvant carotid artery stenting in patients undergoing emergency intracranial endovascular

intervention.[9] In a study conducted in the Netherlands (Mr CLEAN Study) in 2015, 13% of the patients underwent simultaneous CAS with thrombectomy, but they were unable to determine if this was associated with higher or lower risks.[10] In our landmark study, we aim to report the first series of patients treated simultaneously by a single endovascular procedure for carotid stenosis and acute ischemic stroke in Pakistan.

METHODOLOGY

This case series study was conducted in department of interventional radiology, AFIRI, Rawalpindi Pakistan, from Mar 2020 to Mar 2021, after taking approval from Institutional Ethical Review Board (IERB Number 005 dated 25-04-2022). Non Probability consecutive sampling was used.

Inclusion Criteria: All patients undergoing emergency intracranial vascular intervention for acute ischemic stroke and found to have a concurrent ipsilateral carotid stenosis were included in the study.

Exclusion Criteria: Patients having a carotid stenosis of less than 50%, significant neurological deficit (modified Rankin >4), those having an area of infarct greater than one-third of MCA territory, and unconscious patients were found unsuitable for carotid stenting and were thus excluded from the study.

Thrombus aspiration from the intracranial vessels was done with help of SOFIA Catheter, whose effectiveness and complication rates have been found to be comparable to other devices used in contemporary trials.[11] After confirmation of cerebral revascularization, the carotid lesion was stented using an appropriately sized stent (Figure). The stent design was selected based on vascular anatomy of the carotid region.

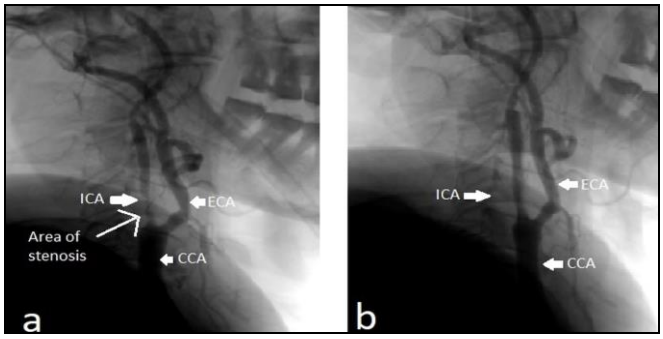

Figure: Angiogram of carotid arteries before (a) and after (b) stenting.

CCA: Common carotid artery, ECA: External carotid artery, ICA: Internal carotid artery

Open cell configuration of self-expanding stents were used, size of which was selected according to the diameters of the common and internal carotid artery. In case of an unstable plaque, or if post stenting angioplasty was anticipated, a closed cell/braided stent was used to avoid Swiss cheese effect of plaque. In cases with significant infarct volume, intravenous antiplatelet therapy was given (Aggrastat/Tirofiban®) followed by stenting of the carotid. These patients were closely observed for ISR (In Stent Rethrombosis) by Ultrasound as well as Hemmorhagic stroke by CT Scan after 6 to 8 hours.[12] Dual antiplatelet therapy was started (low dose Aspirin & Tigacrelor) after 8 hours.

Residual Stenosis if any was noted. All patients were admitted to Hyper Acute Stroke Unit (HASU) for observation after the procedure. 30 day and one year outcomes were recorded in terms of Death, Ipsilateral Stroke, Transient Ischemic Attack (TIA), Stroke, Myocardial Infarction (MI) and Access Site Hematoma Requiring Drainage.

The demographic data was analyzed using Statistical Package for Social Sciences (SPSS) version 22. Mean and standard deviation were calculated for age, percentages, ordinal variables and outcomes.

RESULTS

A total of 11 patients were included in this study out of which 8(72.7%) were male and 3(27.3%) were female. Age of the patients ranged from 49 to 80 years with a mean of 63.73+10.56 years. One patient (9.09%) was less than 50 years of age. Hypertension was the most common comorbid disease 9(81.8%) patients. Most of the patients had multiple co-morbidities (72.7%) as shown in Table. The baseline modified Rankin score ranged from 1 to 3 with a mean of 2.36+0.67. Five patients had a modified Rankin score of 2 and 3 each (45.5%,45.5%). The percentage of carotid artery stenosis was estimated during Digital Subtraction Angiography (DSA) by the standardized NASCET Method.[13] The stenosis ranged from 58 – 94% with a mean of 76.82+11.13%. The residual stenosis after stenting was 11 – 40 % (Mean 19.64+9.08%).

Two patients (18.2%) developed symptoms of Cerebral Hyperperfusion, and both were managed medically and stabilized. Both patients did not have any further complications. One patient (9.1%) had asymptomatic stent thrombosis at 30 days follow up and was managed medically. Patient was asymptomatic with an occluded stent at one year follow up.

One patient (9.1%) had ipsilateral stroke on the 2nd post op day, however patient was managed with tPA infusion. Improvement in symptoms was noted and patient was discharged on 7th post op day. The patient did not have a recurrent stroke on 1 year follow up. One patient (9.1%) had a stroke involving the posterior circulation 2 weeks after discharge. She underwent repeat aspiration thrombectomy of the vertebral artery. Mild improvement in symptoms were noted on follow up. This patient was noted to have particularly tortuous arteries during Carotid Artery Stenting. Technical difficulty was faced while negotiation the wire through these vessels. There was a suspicion of undiagnosed vasculitis, however since the plaque had a soft morphology, decision for stenting was made. The stent did not re-thrombose on followup ultrasound examination, but there was significant residual stenosis (40%).

Table-I: Age, Comorbid Conditions, Percentage of Carotid Artery Stenosis & Post Procedure Residual Stenosis

Age (years)	Co-Morbidities	Modified Rankin Score	Percentage of Carotid Artery Stenosis	Post Procedure Residual Stenosis
55	HTN/IHD	2	71%	11%
80	HTN/DM/IHD	2	91%	32%
58	HTN/DM	3	73%	14%
50	HTN/IHD/CKD	2	67%	17%
63	DM/IHD	3	82%	21%
49	PVD	3	94%	40%
74	HTN/IHD	1	77%	15%
65	HTN/DM	2	58%	11%
78	HTN	3	89%	23%
61	HTN	2	74%	18%
68	HTN/IHD	3	69%	14%

HTN: hypertension, IHD: Ischemic Heart Disease, DM: Diabetes Mellitus, CKD: Chronic Kidney Disease, PVD: Peripheral Vascular Disease

One patient (9.1%) had an ipsilateral stroke on 1 year follow up. Patient was a 68 year of female who underwent an uneventful primary procedure with acceptable post op stenosis (14%). However on telephone follow up, it was found that she had suffered a massive debilitating stroke about 8 months after the procedure. She passed away a few weeks after her second episode.

There were no complications of transient ischemic attack, myocardial infarction or access site hematoma at 30 days and 1 year follow up. Additionally, there were no new episodes of stent thrombosis and stroke of the contra lateral/posterior circulation after 1 year.

DISCUSSION

This was the first ever study conducted in Pakistan to assess safety of simultaneous carotid stenting in patients who had ischemic stroke of ipsilateral site being managed by thrombectomy. There is paucity of data in International literature as well. Carotid disease is one of the major causes of major stroke and transient ischemic attacks, accounting for 10-15% of cases.[13] Simultaneous management of significant carotid stenosis or an unstable plaque by stenting may confer benefit in terms of recurrence of stroke. The present prevalence and incidence of stroke in Pakistan is unidentified[14] and is expected to pose a significant disease burden in the future.[15]

The Society of Vascular Surgery has cautioned regarding treatment of tandem occlusions in the extra and intracranial carotid systems, with the postulated risk of re-bleeding.[9] However, by adhering to our carefully thought out inclusion criteria, we have had a relatively safe initial experience in the management of these patients.

Most of the stroke patients have multiple co-mobidities and in our case hypertension was the most common pre-exisiting disease present in 81.8% patients followed by Ischemic heart disease in 54% and Diabetes in 36.4%. This co-relates well with meta-analysis showing that hypertension can increase the risk of carotid atherosclerosis by 81% and Diabetic patients have higher odds of developing diseased carotids (OR=1.31, 95% CI: 1.13–1.53, I2=0%, p=0.74).[14,16,17]

In a study conducted in Austria in 2022,[18] 85 % of patients had a residual stenosis of less than 50%. In this study, 100% (n=11) had a residual stenosis of less than 50%. Additionally in the reported study, 1.7% of the patients had stent occlusion at 30 days, while no patient suffered any symptoms of stent rethrombosis. In this study, one patient (9.1%) had stent thrombosis at 30 days and 1 year follow up. However, as this patient was asymptomatic, no further intervention was required. In the same study, hemodynamic instability was noted in 4.2% of patients after the procedure. In our study, 2 patients (18.2%) of patients developed hemodynamic instability but had uneventful recovery.

In terms of complications, there were a total of three (27.3%) CVA events in the study population at 1 year follow up. One patient (9.1%) developed ipsilateral stroke on 2nd post procedure, and another

had a stroke of posterior circulation at 2 week's time. Fortunately, both patients did not have a significant neurological deficit. One patient had stroke 8 months after the intervention and ultimately died making mortality of 9.1% in our study.

In the management of tandem occlusions, there is a risk of reperfusion injury and hemorrhagic transformation of stroke. Some patients may have had a tPA infusion previously. Heparin is needed during the procedure and antiplatelet therapy is advised afterwards. Careful selection of patients and accurate medical management is crucial. Prior to CNS thrombectomy, a Dyna CT was employed to determine the viability of brain tissue. This, along with estimation of infarct volume guides the clinician as significant loss of tissue viability can have adverse outcomes.

Patients are given a loading dose of Aspirin 300mg, 30 minutes before the procedure, unless tPA has been used in the last 24 hours. Open cell configuration of self expanding stents were used, whose size was selected according to the diameters of the common and internal carotid artery. In case of an unstable plaque, or if post stenting angioplasty was anticipated, a closed cell/braided stent was used to avoid swiss cheese effect of plaque. In cases with significant infarct volume, intravenous antiplatelet therapy was given (aggrastat/tirofiban®) followed by stenting of the carotid. These patients were closely observed for ISR (In Stent Rethrombosis) by Ultrasound as well as Hemorrhagic stroke by CT scan after 6 - 8 hours. Dual antiplatelet therapy was started (low dose aspirin & tigacrelor) after 8 hours.

This study provides data on a management of tandem occlusions which is so rare that SVS guidelines[9] have quoted a paucity of data to comment on its effectiveness. We hope our experience will be able to guide other clinicians in the management of similar scenarios and contribute towards creation of institutional and national guidelines on management of tandem occlusions.

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LIMITATION OF STUDY

There are some limitations of study. Firstly, the sample size is too small to generalize the findings. Moreover, outcome of stable and unstable plague were not assessed separately. Author recommends a multicentric Cohort study to ascertain effectiveness of simultaneous stenting of significant carotid stenosis while managing ipsilateral ischemic stroke.

CONCLUSION

The initial experience in management of tandem occlusions has been encouraging.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

SN & AS: Conception, study design, drafting the manuscript, approval of the final version to be published.

JL & SA: Data acquisition, data analysis, data interpretation, critical review, approval of the final version to be published.

GA & AURS: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES

1. Johnson O, Nguyen M, Roth A, Nichols E, Alam T, Abate D, et al. Global, regional, and national burden of stroke, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet Neurol 2019; 18(5): 439–458. https://doi.org/10.1016/s1474-4422(19)30034-1
2. Virani S, Alonso A, Benjamin J, Bittencourt S, Callaway W, Carson P, et al. Heart Disease and Stroke Statistics—2020 Update: A Report From the American Heart Association. Circulation 2020; 141(9): 139–596. https://doi.org/10.1161/cir.0000000000000757
3. Jolugbo P, Ariëns S. Thrombus Composition and Efficacy of Thrombolysis and Thrombectomy in Acute Ischemic Stroke. Stroke 2021; 52(3): 1131-1142. https://doi.org/10.1161/strokeaha.120.032810
4. De Meyer F, Andersson T, Baxter B, Bendszus M, Brouwer P, Brinjikji W, et al. Clot Summit Group. Analyses of thrombi in acute ischemic stroke: a consensus statement on current knowledge and future directions. Int J Stroke 2017; 12: 606–614. https://doi.org/10.1177/1747493017709671
5. McCarthy J, Diaz A, Sheinberg L, Snelling B, Luther M, Chen H, et al. Long-term outcomes of mechanical thrombectomy for stroke: a meta-analysis. Sci World J 2019; V-2019: 7403104. https://doi.org/10.1155/2019/7403104
6. Feng Y, Bai X, Zhang X, Wang T, Lu X, Yang K, et al. Risk factors for new ischemic cerebral lesions after carotid artery stenting: A systematic review and meta-analysis. Ann Vasc Surg 2021; 77: 296-305. https://doi.org/10.1016/j.avsg.2021.05.031
7. Halliday A, Bulbulia R, Bonati H, Chester J, Cradduck-Bamford A, Peto R, et al. Second asymptomatic carotid surgery trial (ACST-2): a randomised comparison of carotid artery stenting versus carotid endarterectomy. The Lancet 2021; 398(10305): 1065–1073. https://doi.org/10.1016/S0140-6736(21)01910-3
8. Rockman B, Maldonado S, Jacobowitz R, Cayne S, Gagne J, Riles S. Early carotid endarterectomy in symptomatic patients is associated with poorer perioperative outcomes. J Vasc Surg 2006; 44: 480-487. https://doi.org/10.1016/j.jvs.2006.05.022

9. Naylor R, Ricco B, de Borst J, Debus S, de Haro J, Halliday, et al. Editor's Choice – Management of Atherosclerotic Carotid and Vertebral Artery Disease: 2017 Clinical Practice Guidelines of the European Society for Vascular Surgery (ESVS). Eur J Vasc Endovasc Surg 2018; 55(1): 3–81. https://doi.org/10.1016/j.ejvs.2017.06.021
10. Berkhemer A, Fransen S, Beumer D, van den Berg A, Lingsma F, Yoo J, et al. A randomised trial of intra-arterial treatment for acute ischaemic stroke. N Engl J Med 2015; 372: 11-20. https://doi.org/10.1056/nejmoa1411587
11. Bolognini F, Lebedinsky PA, Musacchio M, Delaitre M, Traoré M, Vuillemet F, et al. SOFIA catheter for direct aspiration of large vessel occlusion stroke: A single-center cohort and meta-analysis. Interv Neuroradiol 2021; 27(6): 850-857. https://doi.org/10.1177/15910199211005328
12. Fan X, Zuo Z, Lin T, Lai Z, You H, Qu J, et al. Arterial transit artifacts on arterial spin labeling MRI can predict cerebral hyperperfusion after carotid endarterectomy: an initial study. Eur Radiol 2022; 32(9): 6145-6157. https://doi.org/10.1007/s00330-022-08755-x
13. Bonati H, Kakkos S, Berkefeld J, de Borst J, Bulbulia R, et al. European Stroke Organisation guideline on endarterectomy and stenting for carotid artery stenosis. Eur Stroke J 2021; 6(2): I–XLVII. https://doi.org/10.1177/23969873211012121
14. Khan I, Khan I, Ahmed I, Ali S. The epidemiology of stroke In a developing country (Pakistan), *Pak J Neurological Sci 2019;* Vol 13-3, 29-44.
15. Khealani B, Hameed B, Mapari U. Stroke in Pakistan. *J Pak Med Assoc* 2008; *58*(7): 400-403.
16. Ji X, Leng Y, Dong Y, Ma H, Xu W, Cao P, et al. Modifiable risk factors for carotid atherosclerosis: a meta-analysis and systematic review. Ann Transl Med 2019; 7(22): 632. https://doi.org/10.21037/atm.2019.10.115
17. Mortimer R, Nachiappan S, Howlett C. Carotid artery stenosis screening: where are we now? Br J Radiol 2018; 91(1090): 20170380. https://doi.org/10.1259/bjr.20170380
18. Nguyen T, Vokó B, Nyárádi B, Munkácsi T, Bérczi Á, Vokó Z, et al. Restenosis rates in patients with ipsilateral carotid endarterectomy and contralateral carotid artery stenting. PLOS ONE 2022; 17(2): e0262735. https://doi.org/10.1371/journal.pone.0262735

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