Carotid artery stenting case series

Limaye et al. analyzed a retrospective database of Carotid artery stenting (CAS) patients from the University of Iowa Hospitals and Clinics. They included patients with symptomatic isolated ipsilateral extracranial carotid artery stenosis and acute tandem occlusions who underwent CAS. Hyperacute CAS (HCAS) and acute CAS (ACAS) groups were defined as CAS within 48 hours and >48 hours to 14 days from symptoms onset, respectively. The primary outcome was a composite of any stroke, myocardial infarction, or death at 3 months of follow-up. Secondary outcomes were periprocedural complications and restenosis or occlusion rates.

They included 97 patients, 39 with HCAS and 58 with ACAS. There was no significant difference between groups for the primary outcome (HCAS 3.3% vs. ACAS 6.1%; p = 1). There were no differences in the rate of perioperative complications between groups although a trend was observed (HCAS 15.3% vs. ACAS 3.4%; p = .057). The rate of restenosis or occlusion between groups (HCAS 8.1% vs. ACAS 9,1%; log-rank test p = .8) was similar with a median time of follow-up of 13.7 months.

Based on this study, CAS may be feasible in the hyperacute period. However, there are potential higher rates of perioperative complications in the hyperacute group, primarily occurring in mechanical thrombectomy (MT) patients with acute tandem occlusion. A larger multicenter study may be needed to further corroborate this findings [1)].

Patients treated with Carotid artery stenting for symptomatic or asymptomatic carotid arterial stenosis were consecutively enrolled. Residual stenosis was estimated from post-procedure angiography findings. The effects of residual stenosis on 30-day periprocedural outcome and times to restenosis and clinical outcome were analyzed using logistic regression models and Wei-Lin-Weissfeld models, respectively.

A total of 412 patients (age, 64.7 ± 17.0 years; male, 82.0%) were enrolled. The median baseline stenosis was 80% (interquartile range [IQR], 70-90%), which improved to 10% (0-30%) for residual stenosis. Residual stenosis was significantly associated with periprocedural outcome (adjusted odds ratio, 0.983; 95% confidence interval [CI], 0.965-0.999, P = 0.01) after adjustment for baseline stenosis, age, hypertension, symptomaticity, and statin use. Over the 5-year observation period, residual stenosis did not increase the global hazard for restenosis and clinical outcome (adjusted hazard ratio, 1.011; 95% CI, 0.997-1.025. In the event-specific model, residual stenosis increased the hazard for restenosis (adjusted hazard ratio, 1.041; 1.012-1.072) but not for clinical outcome (adjusted hazard ratio, 1.011; 0.997-1.025).

Residual stenosis after carotid artery stenting may be useful to predict periprocedural outcome and restenosis [2)].

Sixty-seven consecutive procedures were performed for internal carotid artery stenosis with CAS at the hospital between November 2015 and February 2018. Procedures for emergency CAS for stroke in evolution or crescendo transient ischemic attack were excluded (n = 12). The embolic debris from remaining procedures (n = 55) was stained with hematoxylin-eosin and the red blood cells, white blood cells, and fibrin were quantified by color-based segmentation. Cholesterol crystals and calcification were examined histopathologically. Diffusion-weighted imaging (DWI) was performed 1-3

days after CAS, and the images were used to classify procedures according to the presence of new lesions.

Of the 55 CAS procedures, new DWI lesions were identified after 32. One patient had symptomatic cerebral embolism. Higher proportions of patients with cholesterol crystals in embolic debris (17 vs. 78%, $p < 0.001$) and higher proportion of white blood cells (mean 2.3 [0-9.9] vs. 4.2% [0-29.9%], $p < 0.01$) were observed in the embolic debris of procedures with and without new DWI lesions.

Cholesterol crystals were common in the embolic debris from patients with postoperative ischemic lesions after CAS. These results suggest that inflammatory destabilization of the intraplaque lipid component is related to postprocedural DWI lesions [3].

A clinical study included 43 patients with carotid artery stenting. Cervical computed tomography (CT) images obtained on a 320-slice scanner were reconstructed with AIDR 3D and FIRST. Five blinded observers visually graded the likelihood of neointimal formations on AIDR 3D and AIDR 3D plus FIRST images. Carotid ultrasound images were the reference standard.

Yokomachi et al., analysed results of visual grading by using a Jack-knife type receiver observer characteristics analysis software.

In the phantom study, the difference between the measured and the true diameter of the neointimal formations was smaller on FIRST than FBP or AIDR 3D images. In the clinical study, the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of AIDR 3D were 58%, 88%, 83%, 67% and 73%, respectively. For AIDR 3D plus FIRST images they were 84%, 78%, 80%, 82% and 81%, respectively. The mean area under the curve was significantly higher on AIDR 3D plus FIRST than AIDR 3D images (0.82 vs 0.72; $p < 0.01$).

The model-based IR algorithm helped to improve diagnostic performance for the detection of neointimal formations after carotid artery stenting [4].

A study from Shchanitsyn et al., was aimed at comparative analysis of the transradial versus transfemoral approach used in carotid stenting. They retrospectively analysed the results of transradial and transfemoral stenting of carotid artery in a total of 168 patients. The operations had been performed in two centres over the period from 2012 to 2017. They evaluated the clinical and angiographic data, technical aspects of the operations, as well as the outcomes and complications. In particular, they compared such complications as stroke, transient ischemic attack, myocardial infarction and local complications of the approach. They carried out a univariate analysis of the risk for the development of complications depending on the method of the approach. Stenting of carotid arteries had been performed in 75 patients through the radial artery approach and in 93 patients via the femoral one. Comparing the two groups, the main clinical and angiographic data appeared to have no statistically significant differences. Various techniques of catheterization had been used depending upon anatomical peculiarities. The success of the procedure was achieved in 100% of cases, with the frequency of conversion amounting to 4% for the radial approach and to 1% for the femoral one ($p=0.087$). Amongst complications encountered, disabling stroke was revealed in two (1.2%) patients and minor stroke in four (2.4%). The groups did not differ by the incidence of neurological complications. Within 30 postoperative days neither lethal outcomes nor myocardial infarction were registered. Neither were there haemorrhagic events or other approach-related

complications, however in the transradial-approach group, seven (9.3%) patients were found to have developed asymptomatic occlusions of the radial artery. The duration of the operation, the radiation load, and the length of hospital stay had no statistically significant differences depending on the approach used. Hence, the transradial approach is an effective and safe method in stenting of carotid arteries. In patients with high risk of haemorrhagic complications from the side of the vascular approach and with difficult anatomy of the aortic arch and its branches, hampering catheterization of the carotid artery via the femoral approach, the radial artery may be considered as an advantageous site of access [5].

2016

Transfemoral stenting of common carotid artery stenosis origin is technically difficult because of poor stability of the guiding catheter.

Four patients (5 stenotic lesions) with stenosis of the common carotid artery (CCA) origin underwent transfemoral stenting with a balloon protection device (PercuSurge GuardWire; Medtronic, Santa Rosa, California). These 5 stenotic lesions of the CCA origin included 1 on the right side and 4 on the left side. Two of the stenoses were symptomatic, and 3 were asymptomatic. A balloon-expandable stent (Express LD stent; Boston Scientific, Natick, Massachusetts) was used in all patients.

All stenoses were successfully dilated. With the balloon protection device as an anchor in all patients, the guiding catheter was highly stable during the procedure. There were no intraprocedural or periprocedural ischemic complications in any patients. None of the patients developed a stroke during a mean follow-up period of 8.4 months.

The anchoring technique using a balloon protection device is useful for transfemoral stenting of stenoses at the CCA origin [6].

2002

For a period of 28 months, 31 patients with carotid artery stenosis , most of whom were considered at high risk for carotid endarterectomy (CEA) (87%), underwent treatment with CAS in conjunction with either the PercuSurge GuardWire (n = 19; Medtronic, Minneapolis, Minn), the Cordis Angioguard filter (n = 7; Cordis, Warren, NJ), or the ArteriA Parodi Anti-embolization catheter (n = 4; ArteriA, San Francisco, Calif) with US Food and Drug Administration-approved investigational device exemptions. Factors that made CEA high risk included restenosis after CEA (n = 6), hostile neck (n = 6), high or low lesions (n = 4), and severe comorbid medical conditions (n = 11). Preoperative neurologic symptoms were present in 58%, and the mean stenosis was 85% +/- 12%. Data were prospectively recorded and analyzed on an intent-to-treat basis. Neurologic evaluation was performed before and after carotid artery stenting CAS by a protocol neurologist.

CAS was performed with local anesthesia with the Wallstent (n = 23; Boston Scientific Corp, Natick, Mass) or the PRECISE carotid stent (n = 7; Cordis) in conjunction with one of the protection devices in an operating room with a mobile C-arm. Each patient received dual antiplatelet therapy before surgery. The overall technical success rate was 97% (30/31). In one patient, the lesion could not be crossed with a guidewire because of a severely stenosed and tortuous lesion. This patient was not a candidate for CEA and was treated conservatively. In the remaining 30 cases, CAS had a good angiographic result (residual stenosis, <10%). All patients tolerated the protection device well, and no intraprocedural neurologic complications occurred. Macroscopic embolic particles were recovered

from each case. One patient (3%) with a severely tortuous vessel had a major stroke immediately after CAS, and no deaths occurred. The combined 30 day stroke/death rate was 3%. During a mean follow-up period of 17 months, one subacute occlusion of the stent occurred but did not result in a stroke. Three other patients had duplex scan-proven in-stent restenosis, and two underwent treatment with repeat percutaneous transluminal angioplasty with a good result. No patient had a stroke during the follow-up period.

CAS with cerebral protection devices can be performed safely with a high technical success rate. Although many patients who underwent treatment with CAS were at high risk, the neurologic complication rate was low and CAS appears to be an acceptable treatment option for select patients at high risk for CEA. Tight lesions and tortuous anatomy may make the use of distal protection devices difficult. Further study is warranted [7].

Case series

Of 685 patients, 623 (mean [SD] age, 67 [12.2] years; 406 [65.2%] male) were included in the analysis, of whom 363 (58.4%) were in the CAS group and 260 (41.6%) were in the nonstenting group. The carotid artery stenting (CAS) group had a lower proportion of patients with atrial fibrillation (38 [10.6%] vs 49 [19.2%], P = .002), a higher proportion of preprocedural degree of cervical stenosis on digital subtraction angiography (90%-99%: 107 [32.2%] vs 42 [20.5%], P < .001) and atherosclerotic disease (296 [82.0%] vs 194 [74.6%], P = .003), a lower median (IQR) National Institutes of Health Stroke Scale score (15 [10-19] vs 17 [13-21], P < .001), and similar rates of intravenous thrombolysis and stroke time metrics when compared with the nonstenting group. After adjustment for confounders, the odds of favorable functional outcome (adjusted odds ratio [aOR], 1.67; 95% CI, 1.20-2.40; P = .007), favorable shift in mRS scores (aOR, 1.46; 95% CI, 1.02-2.10; P = .04), and successful reperfusion (aOR, 1.70; 95% CI, 1.02-3.60; P = .002) were significantly higher for the CAS group compared with the nonstenting group. Both groups had similar odds of sICH (aOR, 0.90; 95% CI, 0.46-2.40; P = .87) and 90-day mortality (aOR, 0.78; 95% CI, 0.50-1.20; P = .27). No heterogeneity was noted for 90-day functional outcome and sICH in prespecified subgroups.

In this multicenter, international cross-sectional study, CAS of the cervical lesion during Mechanical thrombectomy (MT) was associated with improvement in functional outcomes and reperfusion rates without an increased risk of sICH and mortality in patients with TLs [8].

There is no consensus regarding optimal antiplatelet regimen for emergent carotid stenting during stroke thrombectomy. We aimed to assess the safety and efficacy of an aggressive periprocedural antiplatelet strategy focused on preserving stent patency, in comparison with a conservative antiplatelet strategy consisting of aspirin monotherapy.

Materials and methods: Retrospective review of a prospectively collected database in a comprehensive stroke center, including all cases of emergent carotid stenting for tandem lesions stroke between 01.03.2012-01.06.2021. Aggressive antiplatelet strategy consisted of dual antiplatelet therapy (DAPT) with aspirin and clopidogrel loading doses, with added intravenous (IV) tirofiban if in-stent thrombosis was observed during thrombectomy. Clinical and radiological outcomes were compared between conservative and aggressive antiplatelet treatment groups using inverse probability of treatment weighting (IPTW) analysis based on propensity scores.

Results: We included 132 cases (76.5% atheroma, 22.7% dissection, 0.7% carotid web). Forty-five patients (34%) cases received conservative antiplatelet therapy. The remaining 87 (65.9%) received aggressive antiplatelet therapy: 66 (75.8%) treated with DAPT, 21 (24.1%) with DAPT and tirofiban. Periprocedural heparin was avoided in all cases. In adjusted analysis of the weighted samples, aggressive antiplatelet strategy was associated with improved carotid stent patency (aOR 0.23, 95% CI 0.07-0.80, p = 0.021), higher proportion of moderate clinical outcome (mRS ≤ 3, aOR 2.72, 95% CI 1.01-7.30, p = 0.04), with no significant differences in mortality and hemorrhagic transformation (HT) rates.

Conclusions: In this retrospective study, aggressive periprocedural antiplatelet strategy led to improved stent patency and clinical outcomes, without increased HT. Further prospective randomized research is warranted to identify the optimal combination of antiplatelet agents for emergent carotid stenting in the setting of acute stroke [9].

2017

A retrospective data set of patients (n=76) who underwent CAS from 2007 to 2014 was used as input (training cohort) to a back-propagation ANN using TensorFlow platform. PHD was defined when systolic blood pressure was less than 90mmHg or heart rate was less 50 beats/min that lasted for more than one hour. The resulting ANN was prospectively tested in 33 patients (test cohort) and compared with MLR or SVM models according to accuracy and receiver operating characteristics (ROC) curve analysis.

No significant difference in baseline characteristics between the training cohort and the test cohort was observed. PHD was observed in 21 (27.6%) patients in the training cohort and 10 (30.3%) patients in the test cohort. In the training cohort, the accuracy of ANN for the prediction of PHD was 98.7% and the area under the ROC curve (AUROC) was 0.961. In the test cohort, the number of correctly classified instances was 32 (97.0%) using the ANN model. In contrast, the accuracy rate of MLR or SVM model was both 75.8%. ANN (AUROC: 0.950; 95% CI [confidence interval]: 0.813-0.996) showed superior predictive performance compared to MLR model (AUROC: 0.796; 95% CI: 0.620-0.915, p<0.001) or SVM model (AUROC: 0.885; 95% CI: 0.725-0.969, p<0.001).

The ANN model seems to have more powerful prediction capabilities than MLR or SVM model for persistent hemodynamic depression after CAS. External validation with a large cohort is needed to confirm our results [10].

2015

One hundred eighty-one patients were treated over an 11-year period. Preprocedural CT angiography (CTA) was performed in 102 of these. A morphological scale (the Predicting Long-term outcome with Angioplasty of the Carotid artery [PLAC] Scale), with grades from 0 to 4 and A or B, was used to evaluate the circumferential degree of plaque calcification, and the presence or absence of soft plaque. All patients were followed using duplex carotid ultrasound and plain radiographs. Satisfactory morphological outcome was defined as a peak systolic velocity < 120 cm/s and internal carotid artery/common carotid artery ratio < 1.4.

The average follow-up duration was 29.7 months (median 24.5 months, range 0.3-87 months). Univariate logistic regression demonstrated that a low calcification grade (p < 0.001), less thick calcification (p < 0.001), and moderate amounts of soft plaque (p < 0.001) are factors that are highly

associated with good long-term outcome. Multivariate analyses confirmed that these factors are independent of each other in predicting outcome.

The long-term morphological outcome of primary carotid stenting was predicted with considerable accuracy by using a straightforward CTA carotid plaque grading scale [11].

2014

319 patients (220 asymptomatic and 99 symptomatic) who underwent carotid angioplasty from 2002 until 2012 for carotid restenosis (CR) that occurred after eversion endarterectomy. During this period, 7993 eversion endarterectomies were done for significant carotid artery stenosis. Significant CR was detected by ultrasound examination and confirmed by digital subtraction angiography or multidetector computed tomography angiography. After angioplasty (with or without stenting), color duplex ultrasound imaging was done after 1 month, 6 months, 1 year, and annually thereafter. End points encompassed myocardial infarction, stroke, and cardiovascular death (fatal myocardial infarction, fatal cardiac failure, fatal stroke), and also puncture site hematoma and recurrent restenosis. Primary end points were analyzed as early results (≤30 days after the procedure), and secondary end points were long-term results (>30 days). Variables and risk factors influencing the early-term and long-term results were also analyzed. Median follow-up was 49.8 ± 22.8 months (range, 17-121 months).

All but one procedure ended with a technical success (99.7%). In the early postoperative period, transient ischemic attack occurred in 2.8% of the patients and stroke in 1.6%, followed by one lethal outcome (0.3%). Stent thrombosis occurred in one patient (0.3%) several hours after the angioplasty, followed by urgent surgery and graft interposition. In the long-term follow-up, there were no transient ischemic attacks or strokes, non-neurologic mortality was 3.13%, and the recurrent restenosis rate was 4.4%. The rate of non-neurologic outcomes during the follow-up was significantly higher in asymptomatic patients than in symptomatic patients (4.54% vs 0%; P = .034). The statically highest rate of transient ischemic attack was verified in patients in whom Precise (Cordis Corporation, New Brunswick, NJ) stents was used (12.2%) and a Spider Fx (Covidien, Dublin, Ireland) cerebral protection device (12.5%) was used. Female gender, coronary artery disease, plaque calcifications, and smoking history were associated with an adverse outcome after angioplasty.

Carotid artery stenting is safe and reliable procedure for CR after eversion endarterectomy treatment, with low rate of postprocedural complications. Type of stent and cerebral embolic protection device may influence the rate of postprocedural neurologic ischemic events [12].

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