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Percutaneous Treatment of Recurrent In-Stent Restenosis of Carotid Artery Stenting: A Case Report and State-of-the-Art Review

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Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
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Conflict of interest: None declared

Patient: Male, 76
Final Diagnosis: Carotid in-stent restenosis
Symptoms: None
Medication: —
Clinical Procedure: Carotid Doppler ultrasound • carotid percutaneous angioplasty
Specialty: Cardiology

Objective: Unusual clinical course

Background: Restenosis after carotid artery stenting (CAS) is a poorly described phenomenon. Studies have reported a variable incidence ranging from 4% to 19.7% at 1 year of follow-up. Doppler Ultrasound (DUS) is now routinely used in the follow-up after CAS and endarterectomy with optimal accuracy in detecting significant restenosis, compared to digital subtraction angiography (DSA).

Case Report: We reported the case of a 76-year-old patient with evidence of recurrent severe in-stent restenosis (ISR) of the left internal carotid artery (ICA). In April 2007, due to evidence at DUS of severe left ICA disease, the patient underwent CAS. In January 2009, due to DUS evidence of severe ISR, the patient underwent balloon angioplasty. In September 2011, DUS showed a severe ISR with a peak systolic velocity (PSV) of 436 cm/s; in June 2012 angiography showed a sub-expanded stent in the middle medial side with severe ISR (70%). Multiple inflations were performed and a slight residual sub-expansion of the lateral side of the stent was observed. Post-procedural DUS showed a reduction of PSV to 283 cm/s and 266 cm/s at 1-month follow-up. An increasing value (322 cm/s) was noticed at 3-month follow-up DUS, while at 6-month follow-up DUS showed an important increase to 483 cm/s. Strict follow-up was adopted because of the patient's refusal of further treatment.

Conclusions: Criteria for diagnosis of restenosis are not well established. The optimal treatment is still debated and no indications have been established, due to the lack of sufficient data. Approaches to ISR include percutaneous transluminal angioplasty, cutting-balloon angioplasty (CB-PTA), stenting, and drug-eluting balloon (DEB) angioplasty. Several studies indicate that endovascular treatment, including balloon angioplasty and (CB-PTA) alone or in conjunction with stenting, is the preferred strategy.

MeSH Keywords: Carotid Artery Diseases • Carotid Stenosis • Ultrasonography, Doppler, Color

Full-text PDF: http://www.amjcaserep.com/abstract/index/idArt/894198

Background

Restenosis after carotid stenting is a poorly described phenomenon. To the best of our knowledge, scant data on the incidence, risk factors, diagnosis, and prognosis are available. Studies have reported a variable incidence ranging from 4% [1] to 19.7% [2] of patients at 1-year follow-up. The percentage should be differentiated depending on the grade of restenosis. Lal et al. observed an incidence of 42.7% of restenosis ≥40% and 16.4% of restenosis ≥60% at 5-year follow-up [3].

Case Report

An asymptomatic 76-year-old patient with hypertension and dyslipidemia arrived to our outpatient clinic after computed tomography angiography (CTA) evidence of severe carotid in-stent restenosis (ISR) of left internal carotid artery (ICA). The patient's cardiovascular history included transient ischemic attack (TIA) in May 1999, for which he underwent right carotid endarterectomy. In April 2007, based on Doppler ultrasound (DUS) showing severe left ICA disease, the patient underwent carotid artery stenting (CAS) with Wallstent 9×30 mm. In January 2009, due to DUS evidence of severe ISR of the left ICA, the patient underwent balloon angioplasty. During this period he remained asymptomatic. In September 2011 the patient arrived at our ultrasound laboratory for a follow-up evaluation; DUS showed a severe ISR with a peak systolic velocity (PSV) of 436 cm/s (Figure 1) of left ICA, with non-significant contralateral carotid disease. Angiography showed a sub-expanded stent in the middle medial side, with severe ISR (70%) at the level of left ICA and occlusion of the external carotid artery (Figure 2). Thus, in June 2012, a revascularization procedure was planned. In the cath lab, multiple inflations with an Aviator Plus 5.5×30 mm balloon, firstly, and then with an Aviator Plus 6.0×30 mm balloon, subsequently, were performed at the maximum pressure of 13 atmospheres, with optimal angiographic result (Figure 3). A slight residual sub-expansion of the lateral side of the stent was observed. Post-procedural DUS showed a reduction of PSV to 283 cm/s (Figure 4) and at 1-month follow-up a further reduction of PSV to 266 cm/s was observed. A trend to slight increase of PSV (322 cm/s) was noticed at 3-month follow-up DUS, while at 6-month follow-up echo color Doppler analysis showed an important increase in PSV (483 cm/s) (Figure 5). The patient refused to undergo further revascularization. An observational approach was then adopted, supported by the good clinical status, absence of symptoms, and evidence of restenosis recurrence. He was subsequently was clinically evaluated in January 2015 and during this period he remained asymptomatic for cerebrovascular events.

Discussion

DUS is frequently used for routine follow-up after CAS because it is an easily used and non-invasive diagnostic tool for evaluation of ICA restenosis. Accuracy of DUS compared with digital subtraction angiography (DSA) was studied in several studies. Keberle [4] compared DUS and DSA in the assessment of ICA stenosis in patients with severe atherosclerosis; the correlation between the 2 techniques was 97% (r=0.97; P<0.001). The sensitivity and specificity in the detection of high-degree stenosis were 100% and 93.3%, respectively [4]. When compared with CT angiography, DUS had a specificity of 97.7%, sensitivity of 100%, a positive predictive value of 98.4%, and a negative predictive value of 100% for the detection of ICA restenosis [5]. However, criteria for diagnosis of restenosis are not well established. Many studies reported different methods and cut-off values for ISR definition. Degree of lumen reduction, peak systolic velocity (PSV), and the ratio of peak internal carotid artery to common carotid artery velocity (ICA/CCA ratio)

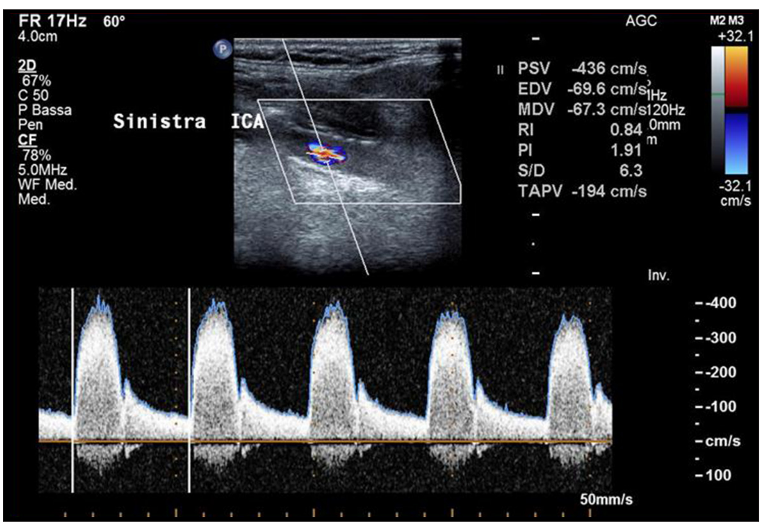

Figure 1. Doppler ultrasound pre-percutaneous transcatheter angioplasty showed a peak systolic velocity of 436 cm/s.

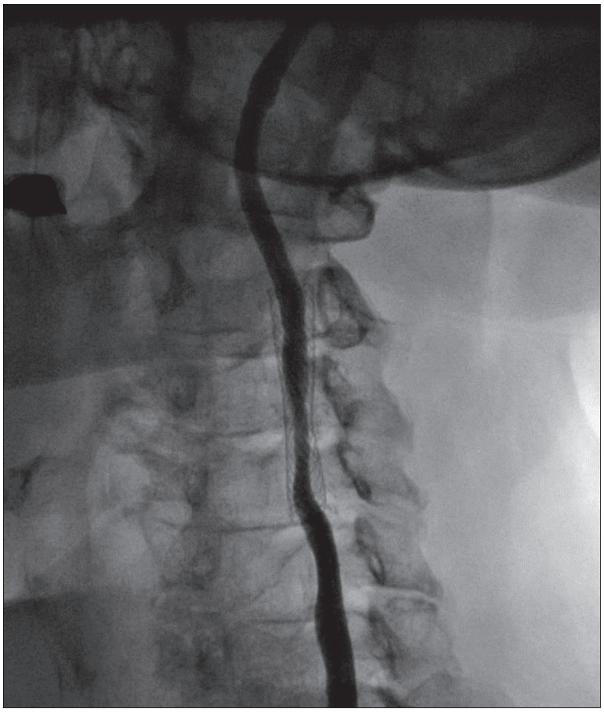

Figure 2. Angiography of left internal carotid artery showing in-stent restenosis.

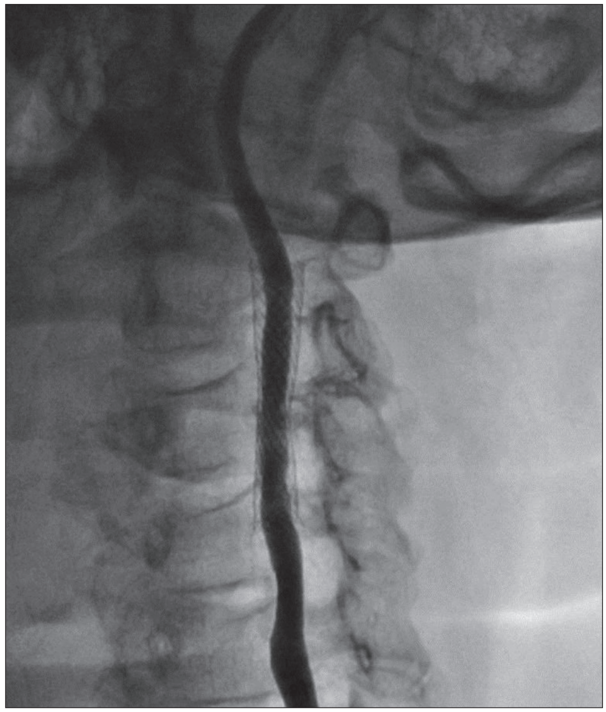

Figure 3. Angiography of left internal carotid artery after balloon angioplasty, showing good angiographic result with a slight residual sub-expansion of the lateral side of the stent.

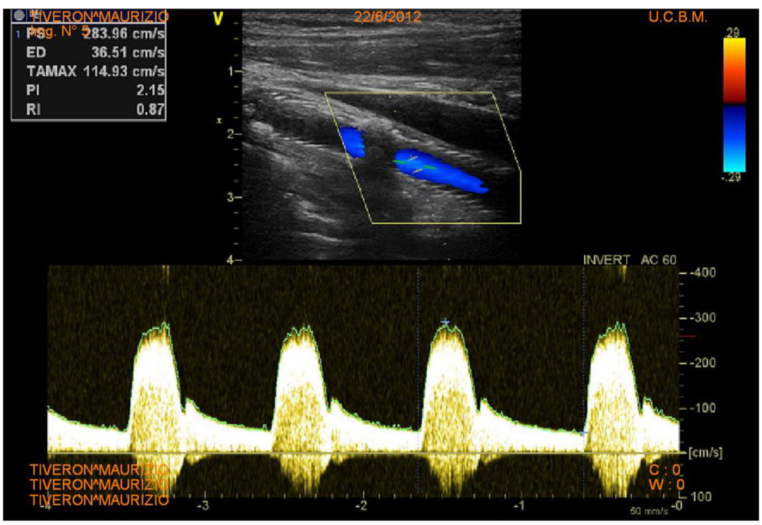

Figure 4. Early Doppler ultrasound post-percutaneous transcatheter angioplasty showing a peak systolic velocity of 283 cm/s.

are the most common parameters, but none of them showed acceptable accuracy. Moreover, a stented artery has different biomechanical properties that make it comparable to a rigid tube – the enhanced stiffness results in increased velocity. Lal et al. showed that as the elastic modulus increases after stenting, the compliance of the vessels decreases [6]. According to this evidence, they proposed adjusted criteria for the definition of stenosis in stented artery, validated by angiography (Table 1) [7]. Of note, it is strongly suggested to record the Doppler parameters of the treated vessel early after CAS. In this way, the "new baseline" can help the subsequent follow-up that should be as most regular as possible since we poorly little about the course. Lal et al. [3] also suggested a classification model for ISR based on morphologic description (Figure 6). The pattern of ISR together with the elevation in PSV and ICA/CCA ratios are indicative of developing ISR. According to this classification, type III and IV lesions more frequently need target lesion revascularization (TLR) for a ≥80% lumen restriction.

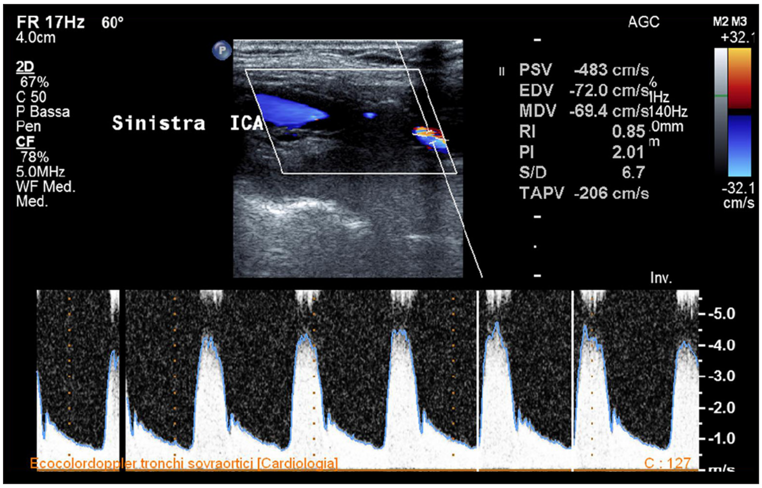

Figure 5. Six-month follow-up Doppler ultrasound post-percutaneous transcatheter angioplasty showing a significative increase of peak systolic velocity (483 cm/s).

Table 1. Suggested velocity criteria defining stenosis in the stented carotid artery compared to criteria for the native carotid artery (*from Lal BK et al.: Patterns of in-stent restenosis after carotid artery stenting: classification and implications for long-term outcome. J Vasc Surg, 2007; 46(5): 833–40*).

Stented carotid artery		Native carotid artery	
0–19%	PSV <150 cm/s and ICA/CCA ratio <2.15	0–19%	PSV <130 cm/s
20–49%	PSV 150–219 cm/s	20–49%	PSV 130–189 cm/s
50–79%	PSV 220–339 cm/s and ICA/CCA ratio ≥2.7	50–79%	PSV 190–249 cm/s and EDV <120 cm/s
80–99%	PSV ≥340 cm/s and ICA/CCA ratio ≥4.5	80–99%	PSV ≥250 cm/s and EDV ≥120 cm/s, or ICA/CCA ratio ≥3.2

PSV – peak systolic velocity; EDV – end-diastolic velocity; ICA – internal carotid artery; CCA – common carotid artery; PSV and EDV measurements for stented carotid arteries are performed within the stented segments.

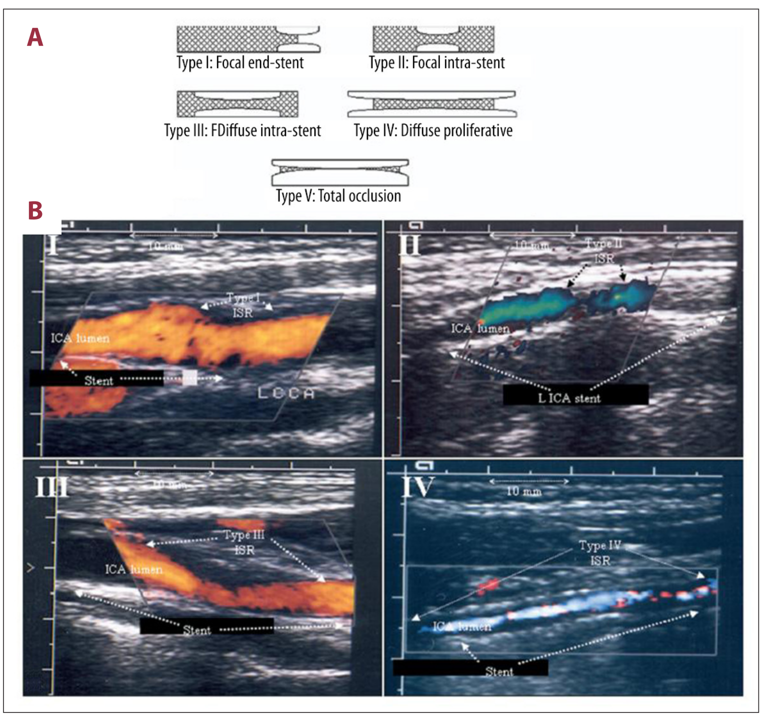

Figure 6. (**A**) Schematic images show the 5 patterns of carotid in-stent restenosis based in the introduced classification. The shaded area represents the stent. (**B**) Representative B-mode ultrasound images of in-stent restenosis correspond to the patterns I through IV (*adapted from Lal BK et al.: Patterns of in-stent restenosis after carotid artery stenting: classification and implications for long-term outcome. J Vasc Surg, 2007; 46(5): 833–40*).

Such cases, after DUS, must then undergo angiographic evaluation when appropriate. A significantly high proportion of patients with ISR had post-carotid endarterectomy (CEA) stenosis and most of them were asymptomatic for cerebrovascular events [8]. Results from the published studies are contradictory. The CAVATAS [9] study showed that long-term risk of developing severe (≥70%) carotid restenosis or occlusion was about 3 times higher after endovascular treatment than after endarterectomy, whereas Gröschel et al. [10] showed that early restenosis rates after CAS compare well with those reported for CEA in previous studies, even if it might be higher, since available data at follow-up are poor. The CAVATAS study also demonstrated that stenting might be superior to angioplasty alone for the prevention of restenosis. The treatment choice is still largely debated and no indications have been elaborated, due to the lack of sufficient data. Approaches to ISR include balloon angioplasty alone (percutaneous transluminal angioplasty [PTA]), cutting-balloon angioplasty (CB-PTA), stenting, and more recently, drug-eluting balloon (DEB) angioplasty. Several studies indicate that endovascular treatment, including balloon angioplasty and cutting balloon alone or in conjunction with additional stenting, is the preferred strategy [11]. We know little about the outcome of PTA compared to stenting in restenotic lesions. Surgeons currently base their choice on the angiographic appearance of the lesions and the hospital staff's experience. Recently, Tekieli et al. [12] used the balloon-expandable zotarolimus-eluting stent to treat significant ISR after CAS in 7 patients; 1 patient developed symptomatic stent occlusion q month after the procedure, and another patient had a recurrent ISR at 12-month follow-up. Evidence is accumulating to support the effectiveness of drug-eluting balloons (DEBs) as a new endovascular strategy for ISR treatment [13]. Montorsi et al. treated 7 patients with carotid ISR with DEB and had no ISR recurrence by DUS at a mean follow-up of 13.7 months [14]. Vajda et al. recently reported DEB treatment of intracranial stent restenosis in 51 patients. Compared to conventional balloons, the ISR recurrence rate was significantly lower with DEB (9% *vs.* 50%) at 8-month follow-up [15]. Limited data exist on the use of DEB to treat ISR in extracranial CAS. Surgery with stent explantation and repeat CEA is reserved for heavily calcified lesions with suboptimal primary stenting results, preocclusive lesions no longer approachable by PTA, stent technical failure, and primary stent thrombosis. Few cases have been treated with brachytherapy [16].

Conclusions

Restenosis after CAS is a phenomenon under investigation, and the treatment choice is still largely debated; no indications have been elaborated, due to the lack of sufficient data. We report a case of recurrent ISR after CAS. The evidence of poor expansion of the stent strongly explains the cause of the multiple restenosis. At angiography, the lesion was suitable for endovascular treatment. Because of lateral side sub-expansion and calcification of the prior implanted stent, we chose an approach with balloon angioplasty alone. Unfortunately, a new early ISR was observed at 6-month follow-up. Given the stability of the clinical status and patient's refusal of treatment, strict follow-up was then performed.

Conflict of interest

All authors have read and approved submission of the manuscript, and have no conflict of interest.

References:

1. Theron JG, Payelle GG, Coskun O et al: Carotid artery stenosis: treatment with protected balloon angioplasty and stent placement. Radiology, 1996; 201(3): 627–36
2. Stolker JM, Mahoney EM, Safley DM et al, SAPPHIRE Investigators: Health-related quality of life following carotid stenting versus endarterectomy: results from the SAPPHIRE (Stenting and Angioplasty with Protection in Patients at HIgh Risk for Endarterectomy) trial. JACC Cardiovasc Interv, 2010; 3(5): 515–23
3. Lal BK, Kaperonis EA, Cuadra S et al: Patterns of in-stent restenosis after carotid artery stenting: classification and implications for long-term outcome. J Vasc Surg, 2007; 46(5): 833–40
4. Keberle M, Jenett M, Wittenberg G et al: [Comparison of 3D power Doppler ultrasound, color Doppler ultrasound and digital subtraction angiography in carotid stenosis.] Rofo 2001; 173: 133–138 [in German]
5. Aleksic N, Tanaskovic S, Radak S et al: Color duplex sonography in the detection of internal carotid artery restenosis after carotid endarterectomy: comparison with computed tomographic angiography. J Ultrasound Med, 2011; 30(12): 1677–82
6. Lal BK, Hobson RW II, Goldstein J et al: Carotid artery stenting: is there a need to revise ultrasound velocity criteria? J Vasc Surg, 2004; 39(1): 58–66
7. Lal BK, Hobson RW II, Tofighi B et al: Duplex ultrasound velocity criteria for the stented carotid artery. J Vasc Surg, 2008; 47(1): 63–73
8. Zhou W, Lin PH, Bush RL et al: Management of in-stent restenosis after carotid artery stenting in high-risk patients. J Vasc Surg, 2006; 43(2): 305–12
9. Bonati LH, Ederle J, McCabe DJ et al, CAVATAS Investigators: Long-term risk of carotid restenosis in patients randomly assigned to endovascular treatment or endarterectomy in the Carotid and Vertebral Artery Transluminal Angioplasty Study (CAVATAS): long-term follow-up of a randomised trial. Lancet Neurol, 2009; 8(10): 908–17
10. Gröschel K, Riecker A, Schulz JB et al: Systematic review of early recurrent stenosis after carotid angioplasty and stenting. Stroke, 2005; 36(2): 367–73
11. Van Haaften AC, Bots ML, Moll FL, de Borst GJ: Therapeutic options for carotid in-stent restenosis: review of the literature. J Vasc Interv Radiol, 2010; 21(10): 1471–77
12. Tekieli L, Pieniazek P, Musialek P et al: Zotarolimus-eluting stent for the treatment of recurrent, severe carotid artery in-stent stenosis in the TARGET-CAS population. J Endovasc Ther, 2012; 19(3): 316–24
13. Gray WA, Granada JF: Drug-coated balloons for the prevention of vascular restenosis. Circulation, 2010; 121(24): 2672–80
14. Montorsi P, Galli S, Ravagnani PM et al: Drug-eluting balloon for treatment of in-stent restenosis after carotid artery stenting: preliminary report. J Endovasc Ther, 2012; 19(6): 734–42
15. Vajda Z, Güthe T, Perez MA et al: Neurovascular in-stent stenoses: treatment with conventional and drug-eluting balloons. Am J Neuroradiol, 2011; 32(10): 1942–47
16. Chan AW, Roffi M, Mukherjee D et al: Carotid brachytherapy for in-stent restenosis. Catheter Cardiovasc Interv, 2003; 58(1): 86–92