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Balloon Angioplasty for Intracranial Atherosclerotic Disease: a Multicenter Study

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Abstract

Aim—To evaluate the role and efficacy of the balloon angioplasty in intracranial atherosclerotic disease (ICAD) in patients who presented with acute stroke due to vessel occlusion and in patients with symptomatic disease despite optimum medical management.

Methods—From 2013 to 2016, a total of 39 patients (24 males and 15 females with a mean age of 64.5 years) underwent balloon angioplasty over a period of 2 years and 8 months in three different institutions in India. Maverick balloon catheter (Boston scientific) is used in all the patients. MRI brain with MR angiogram was done in all the patients prior to intervention. Twenty-three patients who had underlying severe ICAD presented with acute stroke due to vessel occlusion. Sixteen patients presented with symptomatic ICAD with recurrent ischemic attack due to the progressing underlying disease despite optimum medical management. Technical success, peri-procedural events, and clinical outcomes were documented for all the patients.

Results—Technical success (residual stenosis < 50%) was achieved in 37 cases. Extra cranial carotid stenting was required in 2 patients. In patients with acute stroke presentation (NIHSS score median of 16.5), adjuvant intravenous and intra-arterial tissue plasminogen activator were given in 8 and 3 patients, respectively, and mechanical thrombectomy (MT) with solitaire was used in 15 patients. Patients who underwent MT in acute stroke without ICAD were not included in the study. Reocclusion occurred in one patient who developed disabling stroke and one patient died of intra-cerebral hemorrhage. Thus, the mortality of this study is 2%. Clinical outcome was assessed based on mRS. One-month, three-month, and six-month follow-up was available in >90% of the patients. MR angiogram on follow-up of nine months was done in 26 patients, and none of them had restenosis.

Conclusion—Balloon angioplasty is a safe option and can be effectively used in patients of ICAD with acceptable risks and promising outcomes.

Keywords

Introduction

Intracranial atherosclerotic disease (ICAD) carries greater annual risk of ischemic stroke (>20%), with greater risk in patients with high-grade stenosis [1,2] (70%–99%). The disease accounts for 30%–50% of all the strokes in Asian population, with a higher impact than other ethnicities [3]. The results of the Stenting and Aggressive Medical Management for Preventing Recurrent Stroke in Intracranial Stenosis (SAMMPRIS) trail showed increased risk rate in stenting arm as compared with the medical arm [4]. The SAMMPRIS trial was halted after a 14% one-month stroke, and death rate was observed in the stent-treated group. Despite the aggressive medical management, patients present with recurrent ischemic events especially in Asian subgroup. The

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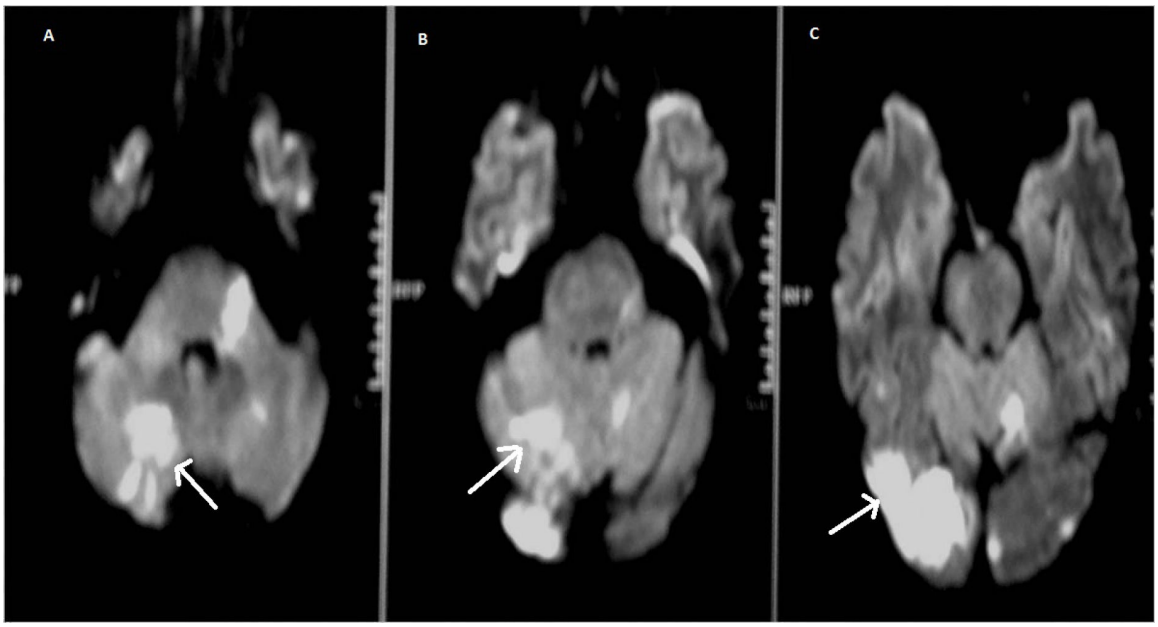

Figure 1. Fifty-five-year-old male presented with recurrent posterior circulation transient ischemic attacks. MR DWI revealed acute infarcts in the bilateral vertebrobasilar territory as shown by arrows in (a), (B), and (C).

stenting arm of SAMMPRIS used wingspan stent with a higher incidence of technical failure owing to the complexity of the device, thus resulting in higher event rates. The role of balloon-mounted stents with favorable outcomes had been earlier reported [5] using coronary stents in selected patients. In this study, we analyzed the safety and effective role of balloon angioplasty in ICAD. The limitation of use of balloon angioplasty is mainly because of the poor trackability and lower compliance. Furthermore, reports of dissection, rupture, and so on were observed in earlier series [6]. In the present series, we used maverick balloon catheter from Boston scientific, which is a low profile system with very good trackability.

Patients and Methods

This study is a retrospective analysis from a prospectively collected institutional review board approved database from all the present three high referral-based centers in India. The study period of case identification is same at each site. The goal of this study is to report the role of balloon angioplasty using maverick balloon catheter. Demographic variables, clinical presentation, location of the lesion antiplatelet treatment, procedural details, and peri-procedural events with clinical outcomes were documented in all the patients.

From August 2013 to April 2016, a total of 39 (24 males and 15 females) patients in the age group of 36–78 years (mean age of 58 years) underwent balloon angioplasty for ICAD. MRI brain and MR angiogram were done in all the patients. Among these patients, 23 patients presented with acute stroke with an average NIHSS score of 16.5, and 16 other patients had recurrent ischemic events despite optimum medical management. In the present series of patients, 31 patients were on prior dual antiplatelet regimen (ecospirin 150 mg and clopidogrel 75 mg) and 8 patients with no prior medical treatment presented with stenotic occlusion due to ICAD. Solitaire stent for mechanical thrombectomy (MT) was used in 15 patients who presented with acute stroke. MT was routinely used for acute stroke in all the three centers; but here, we included the patients with underlying ICAD in whom we used MT as adjuvant therapy. Severe underlying stenosis (>90%) was then seen on digital subtraction angiogram (DSA) in these patients, which was subsequently treated with maverick balloon to dilate the underlying lesion. Adjuvant pharmacolytic treatment with tissue plasminogen activator (intravenous in eight patients and intra-arterial in three patients) was given in 11 patients. Balloon angioplasty without MT was successfully used in achieving good recanalization in eight patients. A balloon of <80%-vessel diameter was used with low pressure in all the patients.

Sixteen other patients, who presented with recurrent ischemic events due to increasing severity of the underlying ICAD (>70% on DSA) despite optimum medical

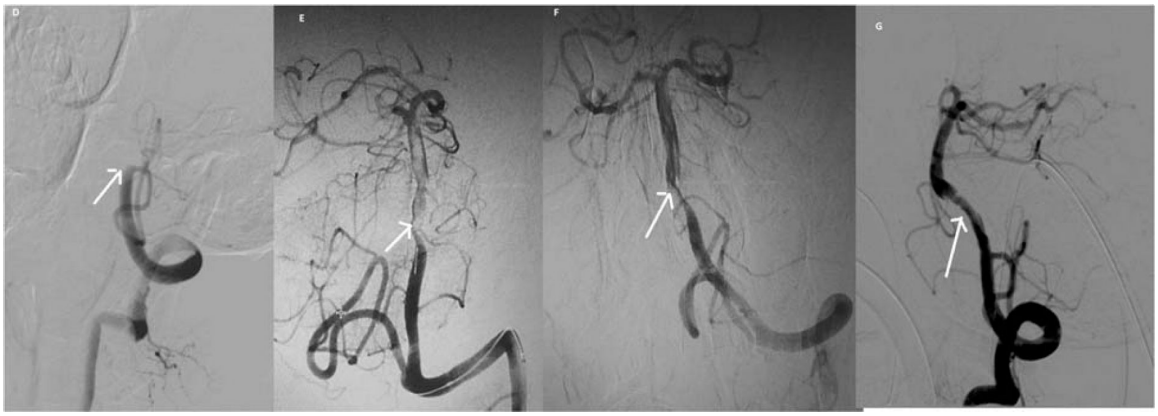

Figure 2. (A) Dsa of patient in Figure 1 showing occlusion of basilar. (B) Residual thrombus with underlying severe stenosis after first pass. (C) Tight lesion in the basilar is seen after mechanical thrombectomy. (D) Post angioplasty angiogram showing good recanalization with patent vessel.

Location of the lesion	Number (n)
M1	11
Basilar	5
M2	2
Ophthalmic ICA	1
Posterior cerebral artery (PCA)	1
Intracranial vertebral (V4)	3

management (aspirin 150 mg/d and clopidogrel 75 mg with atorvastatin 40 mg/d for at least one week), underwent balloon angioplasty successfully with good restoration of ante grade cerebral flow. Angioplasty without stent was preferred in smaller vessels (≤ 2-mm diameter), longer lesions (>12 mm), tortuous vascular anatomy, and vessels at branch points. Patients who underwent stenting for ICAD in our institution were excluded from this study. We presented our experience of role of intracranial stenting in ICAD in an earlier study from one of our present centers [5]. None of the patients who underwent primary angioplasty required rescue stent placement in our series.

Procedure

All the procedures were done under general anesthesia. In the internal carotid or vertebral artery, 6 f guiding catheter is placed. Intravenous heparin was given to maintain ACT > 250.

In order to access the lesion in eight patients, 1.5-mm maverick balloon was used over the 0.014 transcend wire. A combination of microcatheter and microwire was used to cross the lesion in all the other patients. Maverick balloon <80% of the target vessel diameter was used to dilate the lesion with low atmosphere pressure (<6 mm) with slow inflation for a time of 15–30 s under roadmap guidance. In post-procedure, all the patients were closely monitored in the neurointensive unit for a minimum of 24-h time period. All the patients were kept on dual antiplatelets and followed up clinically at one-month, three-month, and six-month intervals. All the patients were continued on double antiplatelet drugs.

Results

Technical success with residual stenoses <50% and TICI grade 2/3 were achieved in 38 patients. Extra cranial carotid stenting was done in two patients, and the distal lesion was accessed and treated. One patient (71-year-old male with NIHSS of 17) with acute MCA territory stroke presentation received IV thrombolysis underwent MT and underlying tight M1 lesion seen after first pass was treated with balloon angioplasty. Symptomatic intracranial hemorrhage developed in this patient, and he eventually succumbed because of mass effect and hydrocephalus (death = 1). Another patient (76-year-old male) who presented with posterior circulation stroke due to basilar occlusion treated with balloon angioplasty for severe underlying calcific plaque had recoil and patient developed pontine infarct and PCA infarct and he subsequently developed disabling stroke. In 19 patients, who underwent balloon angioplasty for recurrent transient ischemic events, no adverse events occurred during the peri- and post-operative period. All the patients underwent CT scan at 6-h and 24-h intervals. Asymptomatic ICH defined as the presence of blood product seen on imaging in the form of small parenchyma hematoma is seen in three patients. The 30-day stroke or death rate in

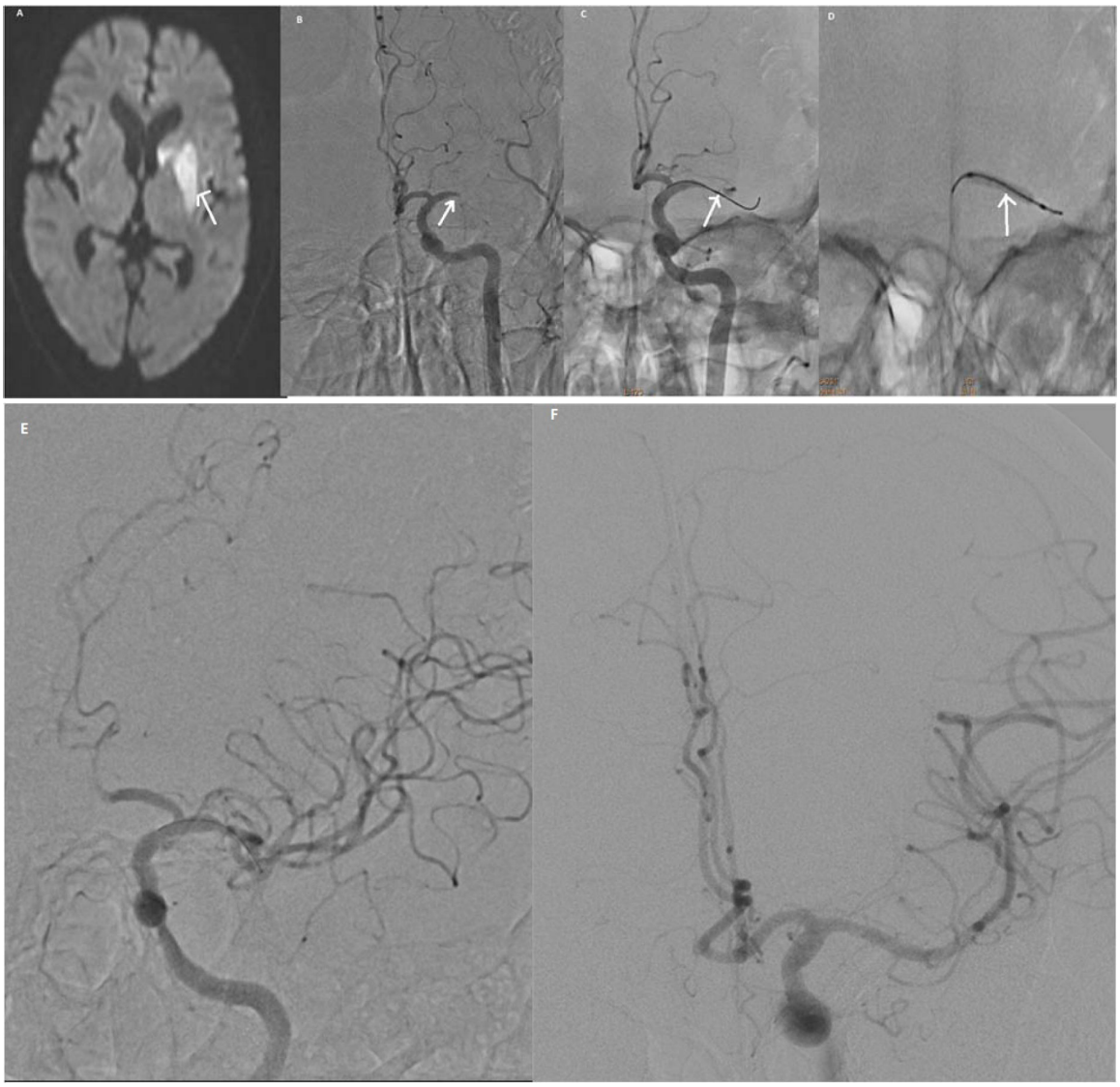

Figure 3. (A) Sixty-three-year-old male with acute stroke and MRI showing restricted diffusion (a) in left capsuloganglionic region. DSA done after IV thrombolysis showed total occlusion of left M1 (arrow in B) and lesion accessed with 1.5-mm maverick balloon (C) and subsequent angioplasty done with 2.5-mm maverick system (D). (B) Post-procedural angiogram showing good recanalization (E). Delayed angiogram showed good intracranial circulation (F).

the present series was 5% (2 of 39). Clinical outcome was assessed with modified Rankin score. One patient died of intra-cerebral hemorrhage. A favorable outcome of mRS score of <2 (functional independence) was seen in 37 patients (95%) at six-month follow-up. One patient had mRS score of 3 at six-month follow-up. MR angiogram was done on follow-up in 26 patients. None of the patients had new ischemic events in the follow-up, and all the patients were kept on dual antiplatelet regimen. The lesions remained stable with no progression in ICAD on follow-up.

Discussion

ICAD accounts for 30%–50% of stroke in Asian population with an annual risk of up to 23% in spite of optimum medical management [7]. In the present series, we evaluated the role and need of intracranial balloon angioplasty with dedicated maverick system in symptomatic disease (>70%) in setting of acute stroke and recurrent refractory ischemic events. Intracranial vessels significantly lack an outer elastic lamina with fragile nature and, hence, undersized balloons are typically used for angioplasty in cerebral vessels. There is >97% of

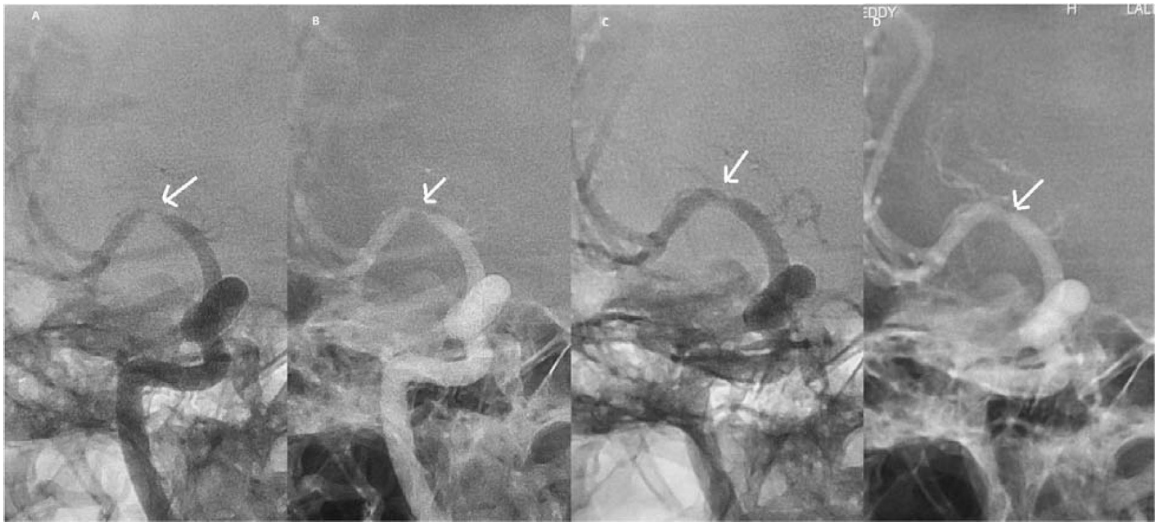

Figure 4. Fifty-five-year-old male presented with recurrent transient right Mca territory ischemic symptoms with angiogram showing critical stenosis (arrow in a and B) of right M1. Post balloon angioplasty balloon showing good antegrade circulation with residual stenosis (<50%) as seen in (C) and (D).

recanalization rate with 5% of mortality and 5% of morbidity reported in our present series.

Stent retriever technology for MT revolutionalized the acute stroke therapy in recent years [8–10]. In the presence of severe underlying ICAD, as in our series, use of MT or other pharmacolytic can cause temporary restoration of cerebral circulation with reocclusion and recurrence being high due to the underlying atheromatous lesion and severe stenosis. Existing underlying plaque causing occlusion results in the acute event and endothelial damage by mechanical device disrupts the underlying vessel wall further causing more reocclusion [10]. Few reports described the effect of stent retrievers in normal vessels in short and long terms [11,12]. In the presence of severe ICAD as in our cases, the lesion became visible after the thrombectomy and such severe underlying stenosis leaves vessel more prone for occlusion. We always waited for 10–15 min to rule out vasospasm. Balloon angioplasty improved the outcomes in these patients. Rescue stenting was not required in any of our patients. In one patient in whom there is severe recoil (basilar) in spite of balloon angioplasty stenting was not opted (patient already received intravenous thrombolysis) due to fear of devastating bleed. This patient infact had suffered disabling stroke. Very few studies reported the importance of acute angioplasty in the recent years [14]. As the retriever is withdrawn with stent expanded, friction by struts occurs and the presence of underlying severe ICAD causes total occlusion [13,15]. Imaging findings of wall thickening and enhancement are reported after use of stent retrievers in vessels [16]. In their experience, Kim *et al*. [17] showed that IAD-related arterial occlusion was associated with complicated endovascular procedure and poor clinical outcomes. Our outcome in these cases improved due to balloon angioplasty. In spite of residual stenosis, there is improved distal perfusion achieved by primary angioplasty, which is more important in these cases. The presence of ICAD needs to be evaluated as a prognostic factor in acute stroke intervention.

Most of the angioplasty balloons are designed for use in coronary vessels, and, hence, complication rates like vessel rupture, dissection, and intimal tear are more when used in cerebral circulation [18,19]. In our series, we had one symptomatic intracranial hemorrhage, accounting for mortality, and this can be considered an acceptable risk. Several studies proved the high efficacy of PTA with good recanalization rates [20,21]. Abou cheb *et al*. [22] used adjunctive like GP IIb IIIa inhibitors to overcome the reocclusion with good outcome. We used adjunctive pharmacolytic and mechanical devices in majority of patients with acute stroke presentation.

Stent-assisted angioplasty in extra-cranial circulation is safe to balloon angioplasty alone [23], but the same is not case in intracranial circulation. In our patients who underwent balloon angioplasty for recurrent TIAs, inclusion criteria included long lesions (>12 mm), difficult tortuous access, distal lesions, and lesions at important

branch points. The hemodynamic compromise due to stenosis is a major cause for the ischemic symptoms in patients with ICAD. Though there is residual stenosis in many of the patients, the lesion improved the perfusion to ischemic territory decreasing the hemodynamic compromise. A small increase in diameter causes a major increase in perfusion. Alurkar *et al.* [5], in their experience of intracranial stenting with balloon expandable stents in ICAD, showed perforator strokes as a major cause of minor strokes with predominance (10.25%) in basilar lesions. The occurrence of perforator stroke is due to compromise of perforating arteries with stent as a result of snow plow effect. Balloon angioplasty alone, as in our study, reduces the incidence of perforator stroke, and we did not have any incidence of perforator strokes in our patients group who presented with recurrent TIAs. The other important problem and major complication are in stent thrombosis due to stent placement can also be avoided with use of balloon angioplasty and avoiding metallic implant in cerebral vessel.

Quereshi *et al* [24] compared primary angioplasty versus stenting with similar results in both groups. Siddiq *et al*. [25] compared the results of 95 angioplasty procedures versus 98 stent placement cases with no significant difference in both groups. Our results were comparable with the above studies in patients whom we used balloon angioplasty alone with presentation of recurrent ischemic events and avoided stent placement.

The major limitation of this study is it is a retrospective analysis and not a randomized study. Our study is limited to the use of only maverick balloons in the patients. The results of the analysis are needed to further test by randomized trial in order to get validate results and understand effective treatment for patients with ICAD.

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