Surgical Treatment and Outcome of Giant Intracranial Aneurysm in KCMH from 2005 - 2010

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Abstract

Background: The natural history of giant intracranial aneurysms is generally morbid. Mortality and morbidity associated with giant aneurysms is also higher than for smaller aneurysms. The reported experiences of surgery for giant intracranial aneurysm is slightly limited in Thailand institutes and South-East Asia.

Objectives: The objective of this investigation was to study the clinical presentation, diagnosis, treatment, and outcome of patients with giant intracranial aneurysm in King Chulalongkorn Memorial Hospital (KCMH).

Materials and Methods: We retrospectively analyzed data collected between 2005 – 2010 about patient's demographic, management, and outcome.

Results: Giant intracranial aneurysm was found in 12 patients during a 6 year period. The 2 males and 10 females range in age from 16 to 74 years (mean: 53.6 years). The ICA and MCA were the most frequently involved arteries. Compression of adjacent intracranial structures was the usual course of symptoms, and only 2 patients experienced subarachnoid hemorrhage. No patient present with ischemic stroke. Proximal parent vessel occlusion or trapping and bypass were dominant among the treatment methods. Excellent and good outcome occurred in 50% and 25% of patient with aneurysm in the anterior circulation, respectively. Fifty percent of patient with posterior circulation aneurysm had poor outcome. Two patients in this series died from bleeding before treatment.

Conclusions: In this series, the anterior circulation, especially ICA, is the most frequently involved artery. Mass effect from the aneurysm is the most common clinical presentation followed by features of SAH. Various neurosurgical techniques were used for proper case. With proper case selection, optimal radiological evaluation and appropriate surgical strategy, it is possible to achieve a favorable outcome in 70% of case.

Keywords: **surgical treatment, giant intracranial aneurysms**

Introduction

Intracranial aneurysms larger than 25 mm in maximum diameter are classified as giant.[1] The natural history of giant intracranial aneurysms is generally morbid as a result of hemorrhage, neural compression, and thromboembolic episodes. Left untreated, the majority of patients suffer from ruptures of these aneurysms. Once ruptured, the cumulative frequency of rebleed at 14 days is 18.4%. It has been shown that mortality is above 60% within 2 years and 80% of patients with untreated symptomatic giant aneurysms are dead or totally incapacitated within 5 years of diagnosis.[2,3]

The goal of aneurysm obliteration with maintenance of adequate cerebral blood flow (CBF) and relief of mass effect therefore remains a definite surgical challenge. The reasons for the higher complication rates are the occlusion of perforators or parent arteries by the aneurysm clipping itself, or temporary occlusion of main arteries.[4] The reported experiences of surgery for giant intracranial aneurysm is slightly limited in Thailand institutes and South-East Asia. Most of the reported experiences of surgery for giant intracranial aneurysms are from the west. This study was carried out to assess the demographic profile, presenting features, complications, and outcome after surgical treatment of giant intracranial aneurysms at a tertiary referral centre in Thailand.

Materials and Methods

Patient population

We retrospectively analyzed data collected between 2005 – 2010 about patient's demographic, management, and outcome.

Between 2005 and 2010, 12 patients (2 males, 10 females) with symptomatic giant aneurysm were treated at the King Chulalongkorn Memorial Hospital (KCMH). The patient range in age from 16 to 74 years (mean 53.6 years). Ten patients underwent surgery but two dead due to bleeding before surgical treatment begin. Postoperative neurological function was evaluated using modified Rankin scale grade (mRS), in which a mRS grade 0 is excellent, 1 is good, 2-5 is poor outcome, and dead.

Aneurysm location

Ten aneurysms were located in the anterior circulation, and two aneurysms were located in the posterior circulation. Among the anterior circulation aneurysms, six involved ICA (one: petrous-cavernous segment, one: cavernous segment, one: ICA terminus, one: C3-4 segment ICA, and two: supraclinoid segment), three involved MCA, and one involved A1-AcoA. Among the posterior circulation aneurysms, two involved the vertebral artery (VA). (Table1 and 2)

Clinical presentation (Table1 and 2)

Seven patients with anterior circulation aneurysm presented with mass effect, including double vision, blur vision, hemiparesis, headache and dysarthria. Three patients presented with subarachnoid hemorrhage (SAH). Preoperative neurological deficits were present in ten patients with anterior circulation aneurysms, including 5 patients with cranial nerve deficit, 2 patients with abnormal motor examinations.

Two patients with posterior circulation aneurysms presented with brainstem compression, including ataxia and weakness of leg. There were no incidental, asymptomatic posterior circulation aneurysms. No pa-

tients presented with SAH or thromboembolic symptoms.

Treatment (Table 1 and 2)

Of the anterior circulation lesion, three aneurysms were treated directly with bypass and trapping (case 1,4,9). Two aneurysms were treated with proximal occlusion of parent vessel (case 6,8). Case 6 was passed the preoperative balloon test occlusion of right ICA before right cervical ICA was ligated. Case 8 (Fig. 3, 4) had good cross-flow from left A1 to right ACA on preoperative DSA (left ICA injection with right carotid artery compression). The remaining three patients underwent clip reconstruction (case 2), bypass with proximal occlusion of parent vessel (case 11), and bypass with partially clip proximal MCA in first stage then clip reconstruction in second stage due to residual aneurysm (case 12).

Of the two posterior circulation aneurysms, all of them were treated surgically. One saccular Rt. VA-PICA aneurysm (case 10, Fig. 6, 7) were treated by proximal occlusion of parent vessel (using Selverstone clamp to V3 segment of vertebral artery for gradually occlusion of right VA). Another aneurysm were Lt. VA aneurysm (case 7), underwent direct clipping procedure. All two aneurysm were exposed via the far-lateral approach.

Two of the intracranial giant aneurysm (case 3,5) were treated by non-operative management due to rupture (case 5) and re-rupture (case 3) caused poor neurological status before surgical intervention.

Results

Surgical outcome and modified Rankin scale grade (Table 3)

There was no surgical mortality in this patient series. Six patients (60%, case 1,2,4,6,7,12) encountered the surgical complication (Table 1). Two patients (case 4, 12) had postoperative bypass graft occlusion (40% of bypass procedure). One case of bypass graft occlusion (case 4) developed right MCA territory infarction that required decompressive craniectomy and frontotemporal lobectomy. Another case of bypass graft occlusion (case 12), had residual aneurysm of left M2 segment of MCA on the first-postoperative angiography after left ECA-M2 bypass with partial clip of left MCA was accomplished. Second operation was performed for clip reconstruction. The second-postoperative angiograpghy was shown complete absence of aneurysm and total occlusion of left MCA bifurcation with leptomeningeal collateral vessels from left ACA and PCA branches to supply left MCA territory. The patient had no neurological deficit at postoperative period and at follow-up period.

Case 6 was stable in neurological assessment during preoperative balloon test occlusion (BTO) of right ICA. Large right MCA territory infarction occurred following right cervical ICA ligation. No surgical treatment was performed for this large infarction. The subsequent deficits include left hemiparesis (upper limb grade 1, lower limb grade 2) and left side neglect. These deficits improved during subsequent 6 months.

Case 2 had postoperative hematoma required surgical evacuation and then developed deep vein thrombosis and pulmonary embolism. Case 1 had postoperative subdural hygroma required subduro-peritoneal shunt. Case 7 had postoperative right true vocal cord paralysis and dysphagia that required tracheostomy.

A postoperative check DSA was performed in 8

Table 1 Clinical characteristics of patients with giant intracranial aneurysms

Case NO.	Age (yr)	Sex	Location	Aneurysm type	Symptoms	Signs	Treatment	Complication	F/U DSA	m RS	F/U (yr)	Outcome at last F/U
1	74	F	Rt. ICA (C3-4 segment)	Unrup. fusiform	diplopia	Rt. CN3 palsy	Rt. ECA-M2 bypass(radial graft) + trapping	Lt. subdural hygroma	No aneurysm, patent graft	1	1	Same
2	69	F	Lt. supraclinoid ICA	Unrup. saccular	Blur vision	VF defect	Clip reconstruction with suction decompression technique	Lt. frontal hematoma, DVT, pulm. embolism	No residual aneurysm	1	1.83	Improve
3	66	F	Rt. ICA-PcoA	Rup. saccular	SAH, drowsy	Stiffneck, E3M6V4	-	Rebleed → dead	-	-	-	-
4	16	M	Rt. M1	Rup. partial. thromb. fusiform	SAH, drowsy	Stiffneck, E3M6V4	Rt. ECA-M2 bypass(radial graft) + trapping	Rt. MCA territory infarction and graft occlusion	-	5	2.25	Worse
5	48	F	Rt. ICA terminus	Unrup. partial. thromb. saccular	Sudden Lt. hemiparesis	gr.4 Lt. hemiparesis	-	Rupture → dead	-	-	-	-
6	70	F	Rt . cavernous ICA	Unrup. partial. thromb. fusiform	diplopia	Rt. ophthalmo-paresis	Rt. cervical ICA ligation (passed pre-op. Rt.ICA BTO)	Rt. MCA territory infarction	No aneurysm, inadequate cross flow to Rt. M4 branches	4	0.5	Worse
7	77	F	Rt. VA	Unrup. partial. thromb. saccular	Ataxia	Rt. CN6 paresis, ataxia	Clipping	Rt. TVC paralysis, dysphagia	MRA: no aneurysm seen	3	1.25	Worse
8	41	F	Rt.A1-AcoA	Unrup. partial. thromb. fusiform	Blur vision	Bitemporal hemianopia	Prox. occlusion Rt.A1 (cross flow from Lt.A1 to Rt.ACA on preop. DSA)	No	No aneurysm, good cross flow	0	0.42	Improve
9	21	M	Rt. petrous-cavernous ICA	Unrup. partial. thromb. fusiform	diplopia	Rt. ophthalmo-paresis	Rt. ECA-M1 bypass (saphenous graft) + trapping	No	No aneurysm, patent graft	0	1.09	Improve
10	63	F	Lt. VA-PICA	Unrup. partial. thromb. saccular	Lt. leg weakness	Lt. leg weak, ataxia	Selverstone clamp Lt. VA	No	No aneurysm, good flow from Rt.VA to BA and both PCA	1	0.83	Improve
11	56	F	Rt. M1	Rup. partial. thromb. fusiform	SAH, drowsy	Stiffneck, E3M6V4	Rt. ECA-M2 bypass (radial graft) + prox. occlusion Rt. M1	No	No aneurysm, patent graft	0	0.58	Improve
12	42	F	Lt. M2	Unrup. partial. thromb. fusiform	Headache, dysarthria	Rt. arm weak, dysarthria	1.Lt. ECA-M2 bypass (radial graft) + partial clip prox. MCA 2. Clip reconstruction	Graft occlusion	First: residual aneurysm, graft occlusion Second:M1 occlusion, good leptomeningeal collaterals, no aneurysm	0	0.25	Improve

Abbreviation: AcoA = Anterior communicating artery, BA = basilar artery, BTO = Balloon test occlusion, DSA = Digital subtraction angiography, DVT = Deep vein thrombosis, ECA = External carotid artery, F/U = follow up, ICA = Internal carotid artery, M1 = M1 segment of MCA, M2 = M2 segment of MCA, MCA = Middle cerebral artery, mRS = modified Rankin scale, partial. = partially, PcoA = Posterior communicating artery, PICA = Posterior inferior cerebellar artery, prox. = proximal, pulm. = pulmonary, Rup. = ruptured, SAH = subarachnoid hemorrhage, throm. = thrombosed, TVC = true vocal cord, Unrup. = Unruptured

patients (case 1,2,6,8,9,10,11,12) and revealed well obliterated aneurysm. A residual aneurysm observed in one patient (case 12) on first-postoperative DSA. In this case, the residual aneurysm was well obliterated with clip reconstruction. One case (case 7) was shown complete obliteration of aneurysm on postoperative MRA.

For the entire series, the mean follow-up period was 1 year. Overall for surgical treatment, four patients had excellent outcome (mRS grade 0, 40%), three had good outcome (mRS grade 1, 30%), and three had poor outcome (mRS grade 2-5, 30%). Patients with anterior circulation aneurysms had better outcomes than patients with posterior circulation aneurysms. In the former group, four patients (50%) received mRS grade 0, two patient (25%) had mRS grade 1, and two patients (25%) had mRS grade 2-5 (poor outcome). The latter group included 1 patient (50%) with mSR grade 1 (good outcome), one patient (50%) with mRS grade 3 (poor outcome).

Two patients (case 3,5) in this series died, one patient (case 3) with ruptured right giant ICA-PcoA aneurysm died from rebleeding before treatment; one (case 5) with unruptured right giant ICA terminus aneurysm died from rupture before cerebral angiography was performed.

At the last follow-up period, three patients (30%, case 4,6,7) were neurologically worse after treatment, one (case 1) had returned to his preoperative condition, and six patients (60%, case 2,8,9,10,11,12) were improved after treatment.

Discussion

The most common clinical presentation of giant aneurysm mentioned in previous reports is local mass effect.[5,6,7] It has been observed that 25-40% of giant aneurysms present initially with SAH.[2,6] In our series, local mass effect was the most common presenting feature, found in 75% of the cases. This is in contrast to the report by Gewirts et al., which described 68% patients presenting with SAH.[8] Unruptured giant aneurysms have a higher probability of subsequent

Table 2 Aneurysm location, presenting symptoms, and surgical procedures

Location of aneurysm	No. of patient (%)	Symptoms of aneurysm		Clip	Clip recon.	Prox. Parent vessel occlusion	Bypass + trapping	Bypass + prox. occlusion	Bypass then clip recon	No surgery
		SAH	Mass							
ICA	6 (50%)	1	5	0	1 (NO.2)	1 (NO.6)	2 (NO.1,9)	0	0	2 (NO.3,5)
MCA	3 (25%)	2	1	0	0	0	1 (NO.4)	1 (NO.11)	1 (NO.12)	0
A1-AcoA	1 (8%)	0	1	0	0	1 (NO.8)	0	0	0	0
VA	2 (17%)	0	2	1 (NO.7)	0	1 (NO.10)	0	0	o	0
Total	**12**	**3**	**9**	**1**	**1**	**3**	**3**	**1**	**1**	**2**

Table 3 Aneurysm location and outcome

Aneurysm	Outcome of surgical treatment at last follow up									
	Modified Rankin scale grade					Compare to pre op. status				
	Excellent (mRS grade 0)	Good (mRS grade 1)	Poor (mRS grade 2–5)	Dead	Total	Improve	Same	Worse	Dead	Total
Anterior circulation	4 (50%)	2 (25%)	2 (25%)	0 (0%)	8	5 (62.5%)	1 (12.5%)	2 (25%)	0 (0%)	8
Posterior circulation	0 (0%)	1 (50%)	1 (50%)	0 (0%)	2	1 (50%)	0 (0%)	1 (50%)	0 (0%)	2
Total	**4 (40%)**	**3 (30%)**	**3 (30%)**	**0 (0%)**	**10**	**6 (60%)**	**1 (10%)**	**3 (30%)**	**0 (0%)**	**10**

rupture and thrombosis, and giant size does not preclude rupture.[2,9]

Intracranial giant aneurysms have a propensity to occur at certain locations. Our observation that 83% of all aneurysms are located in the anterior circulation and the single most common site of giant aneurysm is the ICA is consistent with previous findings.[2,5,10,11]

The treatment strategy is imperative to carefully consider multiple factors before the mode of treatment is decided upon for an individual patient: clinical presentation, age of the patient, comorbid conditions, the location, morphology, and type of aneurysm, hemodynamic factors, and circulation within the normal brain. Preoperative assessment of cross-flow, size, and patency of the opposite vertebral artery, anatomical variation in circle of Willis is important in planning a surgical strategy.

In our series, direct surgical clipping was performed as soon as possible. The direct clipping was possible in two cases (case 2,7). The majority of treatment in our case is proximal parent vessel occlusion (case 6,8,10) and bypass with trapping (case 1,4,9). (Table 2)

Giant aneurysms require adequate deflation of the aneurysm sac prior to clipping (case 2 used suction decompression technique, Fig.1). When there is a risk of mass effect, giant aneurysm may required opening and thrombus evacuation after they have been eliminated completely from circulation (case 12).

For all aneurysms, direct clipping is usually the first choice. Some aneurysm which are not clippable due to incorporation of branches or lack of aneurysm neck can be treated with trapping with bypass procedure, proximal ligation with or without bypass procedure, and wrapping.

In complex aneurysm, bypass procedure may be required for preservation of CBF.12 An indirect procedure to achieve aneurysm occlusion from the circulation is required in 20–40% of case, which was also observed in the present series.13 We treated giant aneurysms of cavernous ICA, MCA, VA, and A1–AcoA with proximal parent vessel occlusion with bypass (case11) (Fig.2) or without bypass (case 6,8,10) (Fig. 3, 4) and trapping with bypass (case 1,4,9)

(Fig. 5).

As seen in our study, ICA and VA occlusion is safe and effective therapeutic method in selected patients with adequate collaterals. Preoperative trial occlusion of the ICA has been used to predict the probability of a patient to tolerate permanent occlusion for treatment an ICA aneurysm. Case 6 had good cross-flow to right M4 segment on angiographic compression study (Lt.ICA injection with Rt.CCA compression) and was stable in neuroclinical assessment during BTO of left ICA. Right cervical ICA ligation was performed after passing the preoperative neuroclinical assessment. However, postoperative infarction of right MCA territory was occurred. This early permanent deficit is possibly due to thromboembolic phenomenon or decreased blood flow. CBF insufficiency after ICA occlusion, despite of passing preoperative BTO, is due to false-negative finding of BTO, which has been reported about 7.5-20%.[14] This false-negative rate can be reduced by using of BTO with specific testing para-

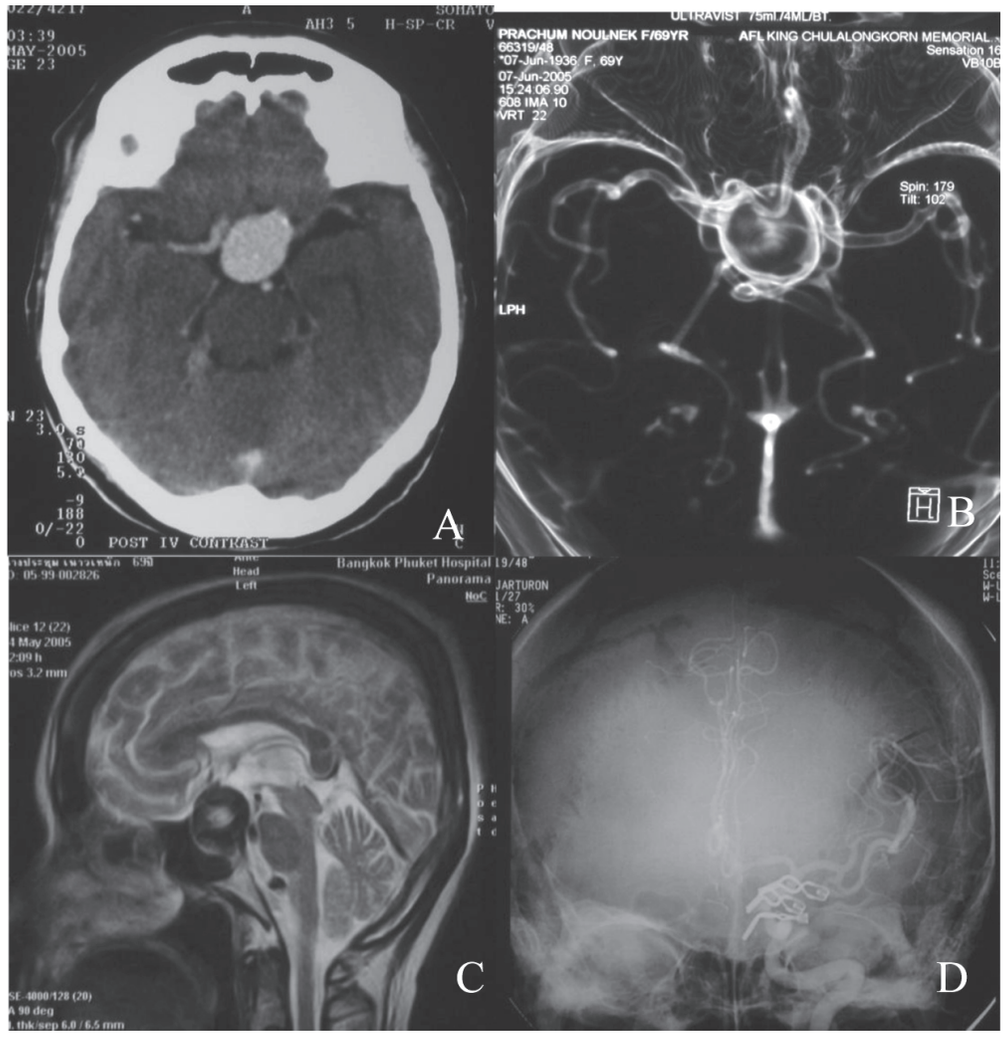

Fig. 1 A 69-year-old female (case NO.2) presented with visual field defect. A contrast CT scan (A) revealed a vivid contrast enhancing mass at suprasellar region. CTA and MRI revealed a giant saccular supraclinoid Lt. ICA aneurysm (B,C). Clip reconstruction was performed with suction decompression technique. Post-operative DSA (D) showed a well obliterated aneurysm and patent Lt ICA. Lt. frontal lobe hematoma was occurred at postoperative period, which required hematoma removal. Vision gradually improved at 1.83 year-follow up.

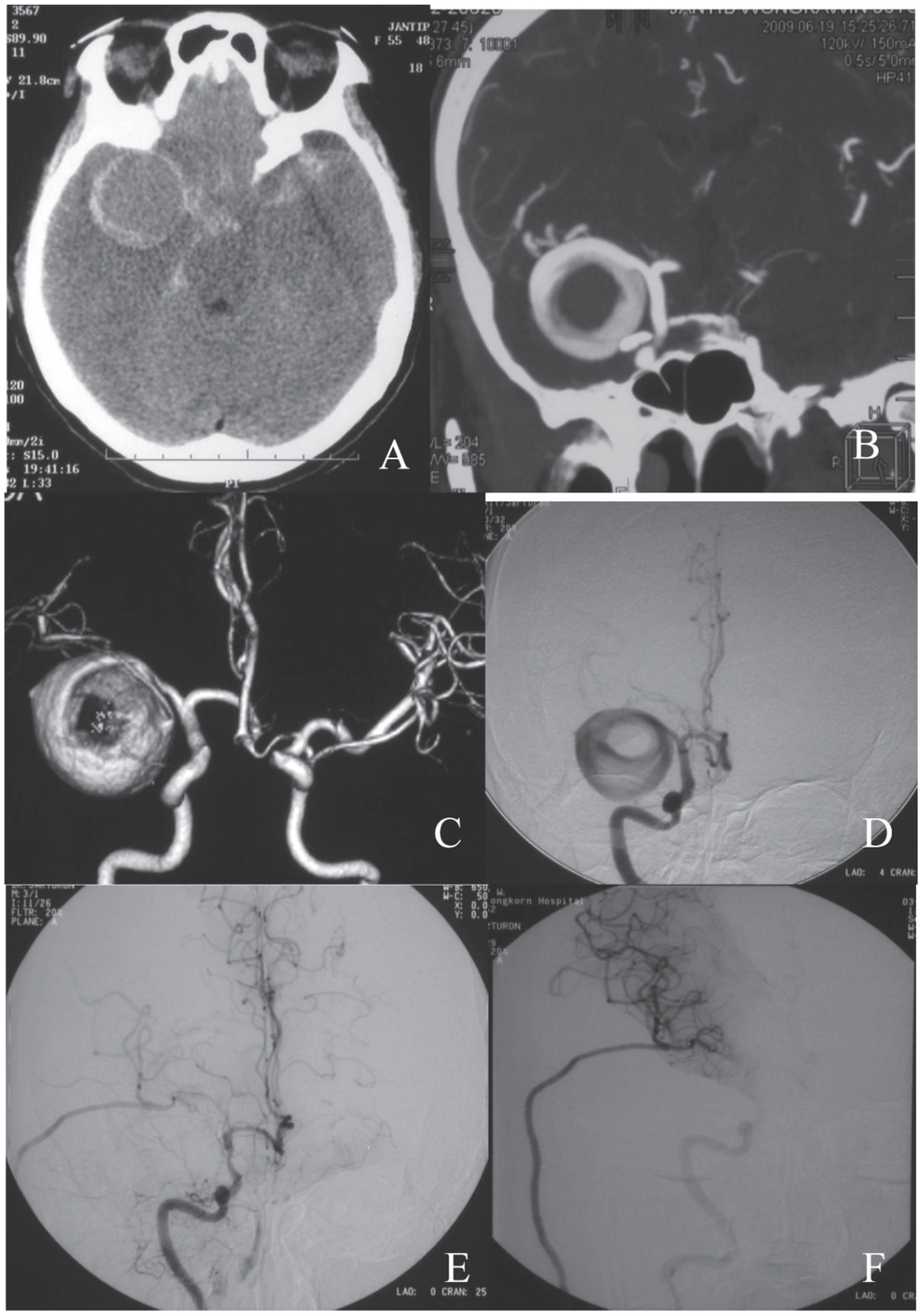

Fig. 2 A 56-year-old female (case NO.11) presented with severe headache and loss of consciousness. A non-contrast CT scan (A) revealed a subarachnoid hemorrhage and partially thrombosed mass at right temporal region. CT angiography, 3D reconstruction angiography and digital subtraction angiography (DSA) revealed a giant right M1 aneurysm with turbulent flow (B,C,D). Right ECA-M2 bypass (radial artery) with proximal occlusion of right M1 was performed. Post-operative DSA (E,F) showed a well obliterated aneurysm and patent bypass graft. The patient had no focal deficit at immediate postoperative period and at 7-month follow-up.

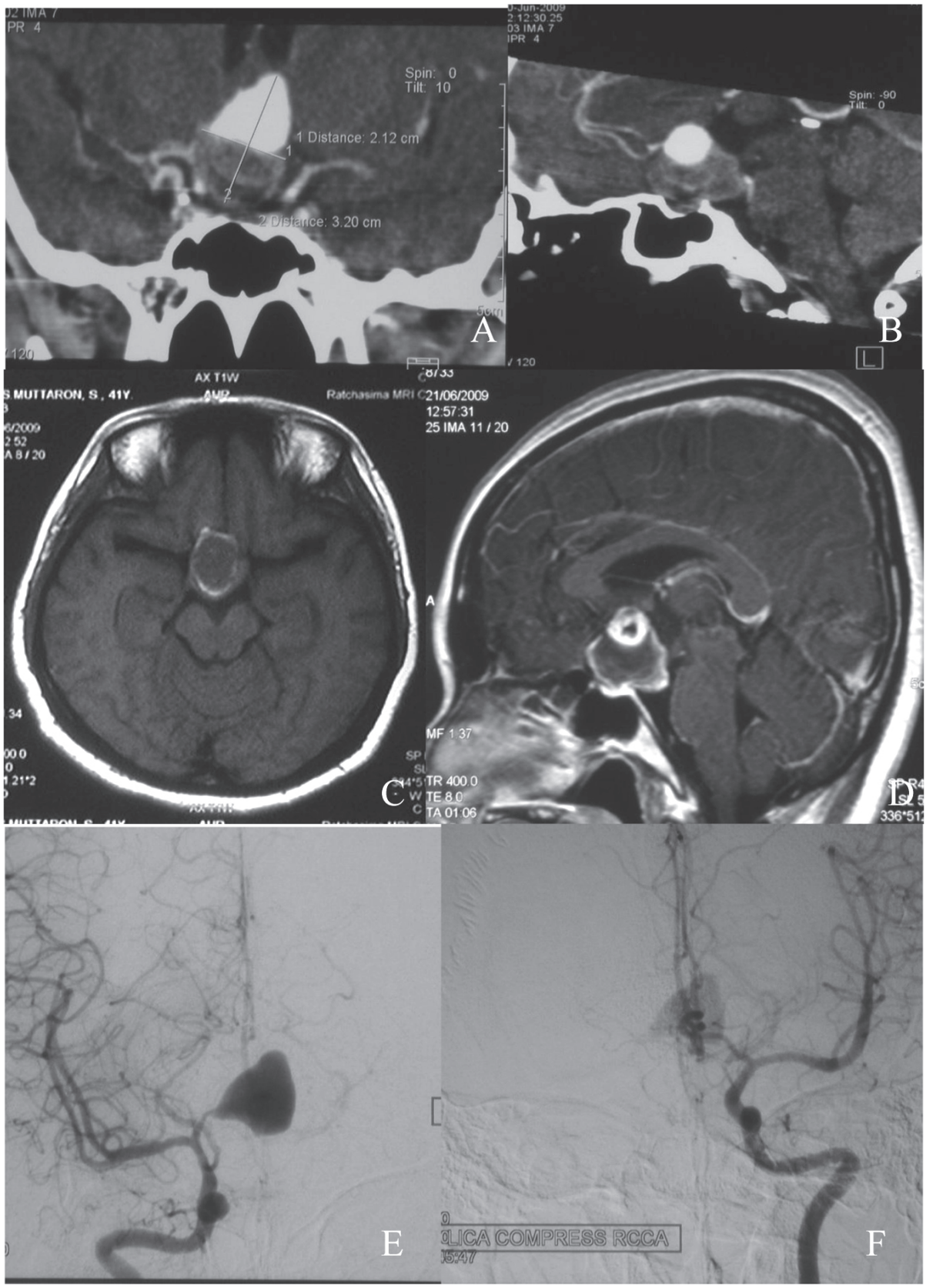

Fig. 3 A 41–year–old female (case NO.8) presented with headache and visual field defect. A CT angiography (A,B) and MRI (C,D) revealed a partially thrombosed giant A1–AcoA aneurysm. DSA revealed a giant A1–AcoA aneurysm fed from Rt.A1(E). Good cross–flow from Lt.A1 to Rt.ACA with patent AcoA was demonstrated on Lt.ICA injection with compress Rt. carotid artery (F).

digm, that compose of 4 modalities (1.neuroclinical assessment, 2.hemodynamic evaluation, 3.neurophysiological EEG, and 4.provacative test).[15] This testing method was highly correlated with tolerance to vessel sacrifice in 95% of patient in one study.16 Preoperative DSA of case 10 (Fig. 6, 7) revealed partially thrombosed giant aneurym at PICA segment of left vertebral artery, smaller right VA, dominant left VA, and no cross-flow between both VA. Proximal parent vessel occlusion was planned. BTO of VA was not performed due to high risk. Therefore, cross-flow and CBF after occlusion of left VA was not assessed. Gradual occlusion of left VA at V3 segment using a Selverstone clamp was performed. Complete occlusion of V3 segment of left VA and aneurysm with good collateral flow from right VA were shown in postoperative DSA. No postoperative neurological deficit was detected. Case 8 (Fig. 3, 4) was found to have a giant fusiform A1-AcoA aneurysm. Preoperative DSA showed the aneurysm involving and have major feeder from right A1. Cross-flow assessment revealed patent AcoA and good cross-flow from left A1 to right ACA. Proximal trapping of right

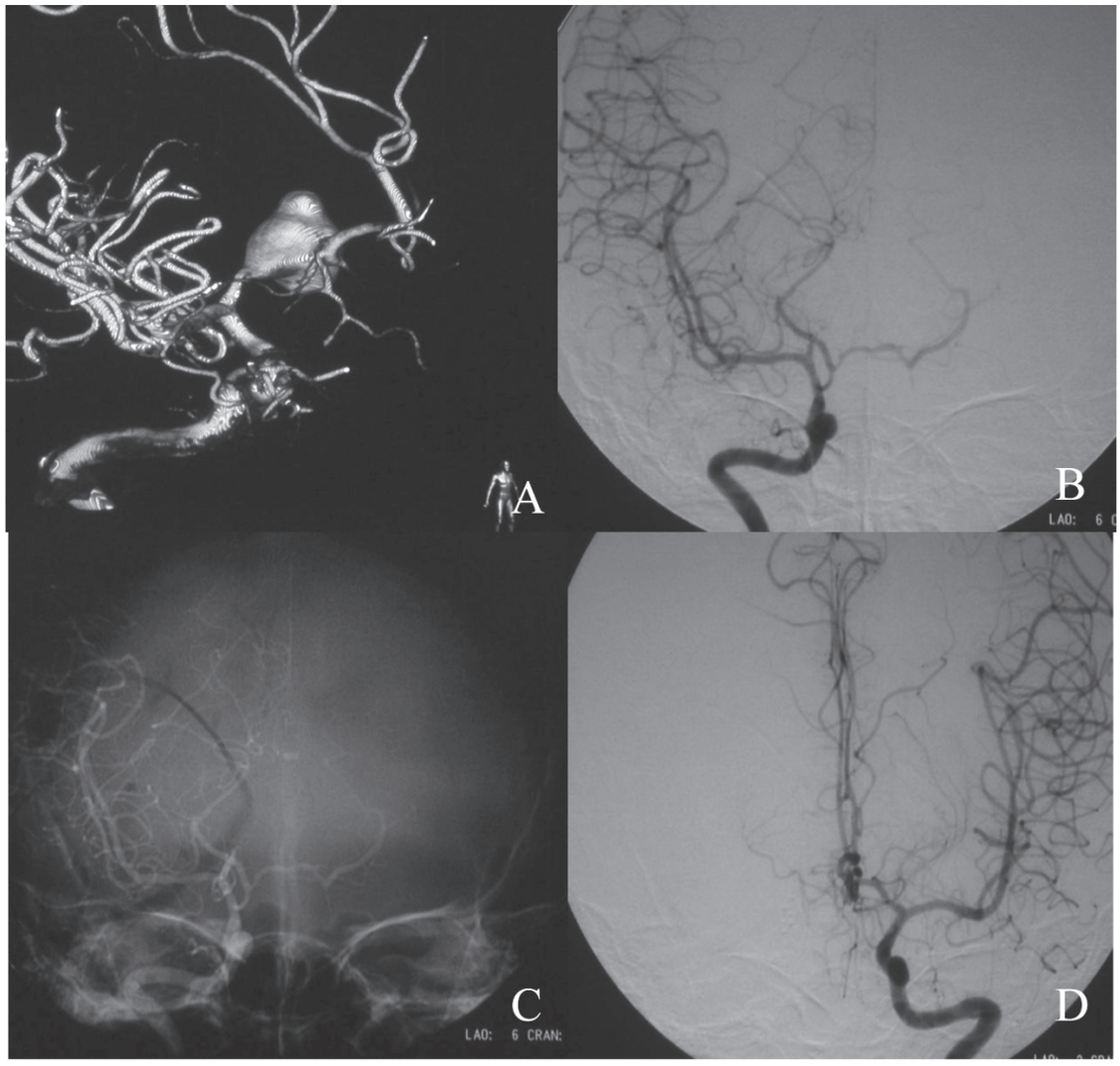

Fig. 4 (case NO.8) Three-dimension reconstruction DSA showed a giant fusiform A1-AcoA aneurysm (A). Proximal occlusion of Rt. A1 was performed. Postoperative DSA revealed a well obliterated aneurysm (B,C) and good cross-flow from Lt.A1 to both ACA (D).

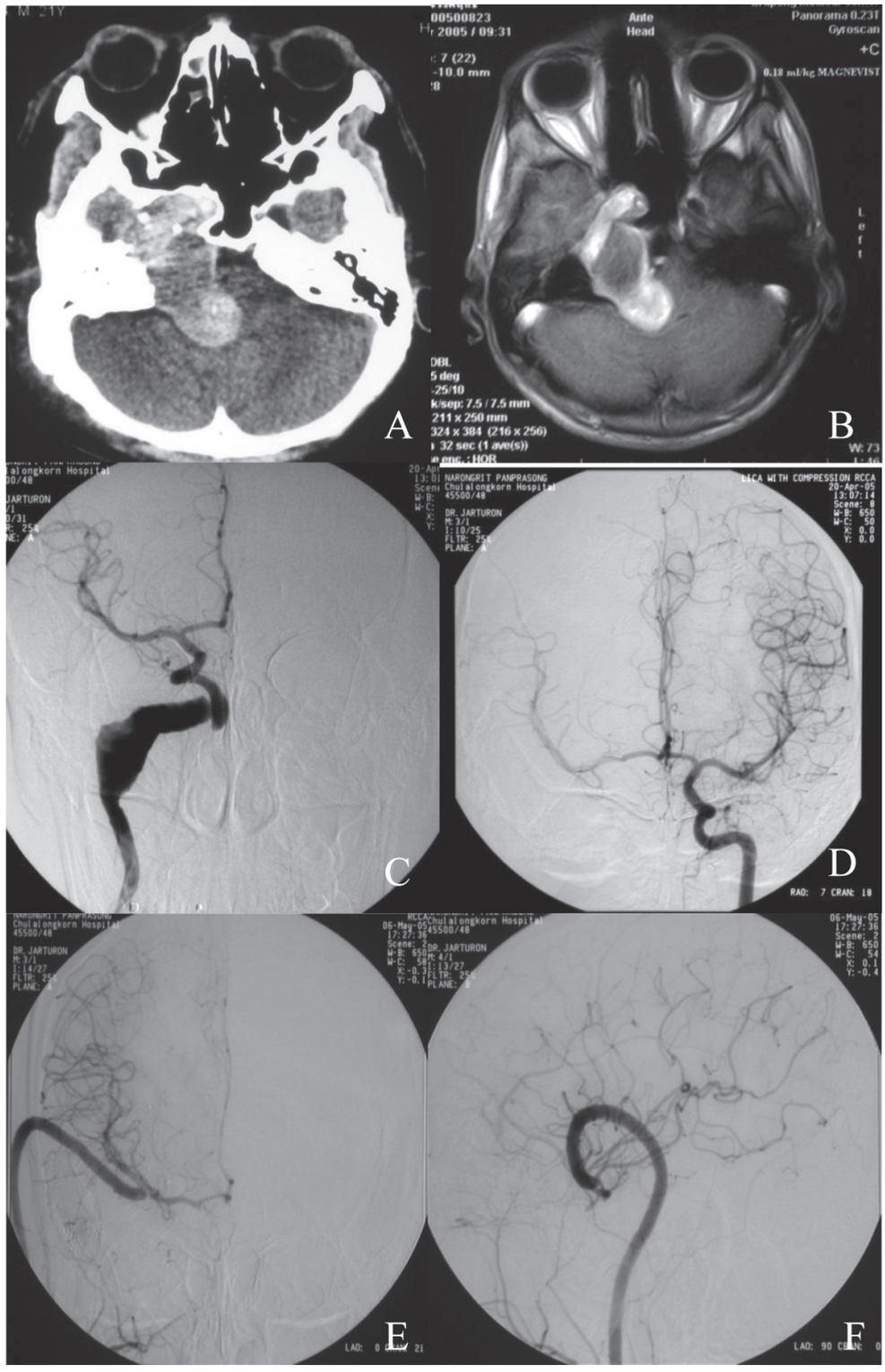

Fig. 5 A 21–year–old male (case NO.9) presented with diplopia due to Rt. ophthalmoparesis. A contrast CT scan (A) and post–gadolinium T1WI MRI (B) revealed a inhomogeneous contrast enhancing mass involved Rt. Petrous, temporal fossa and CP angle region. DSA showed a fusiform giant right ICA aneurysm (C) and poor cross–flow from Lt.ICA through AcoA and minimal retrograde flow from posterior circulation through Rt.PcoA (D). Rt. ECA–M1 bypass and trapping was performed. Post–operative DSA (E,F) showed a well obliterated aneurysm and patent bypass graft. The ophthalmoparesis was improved at immediate postoperative period and completely recovered at 2–month follow–up.

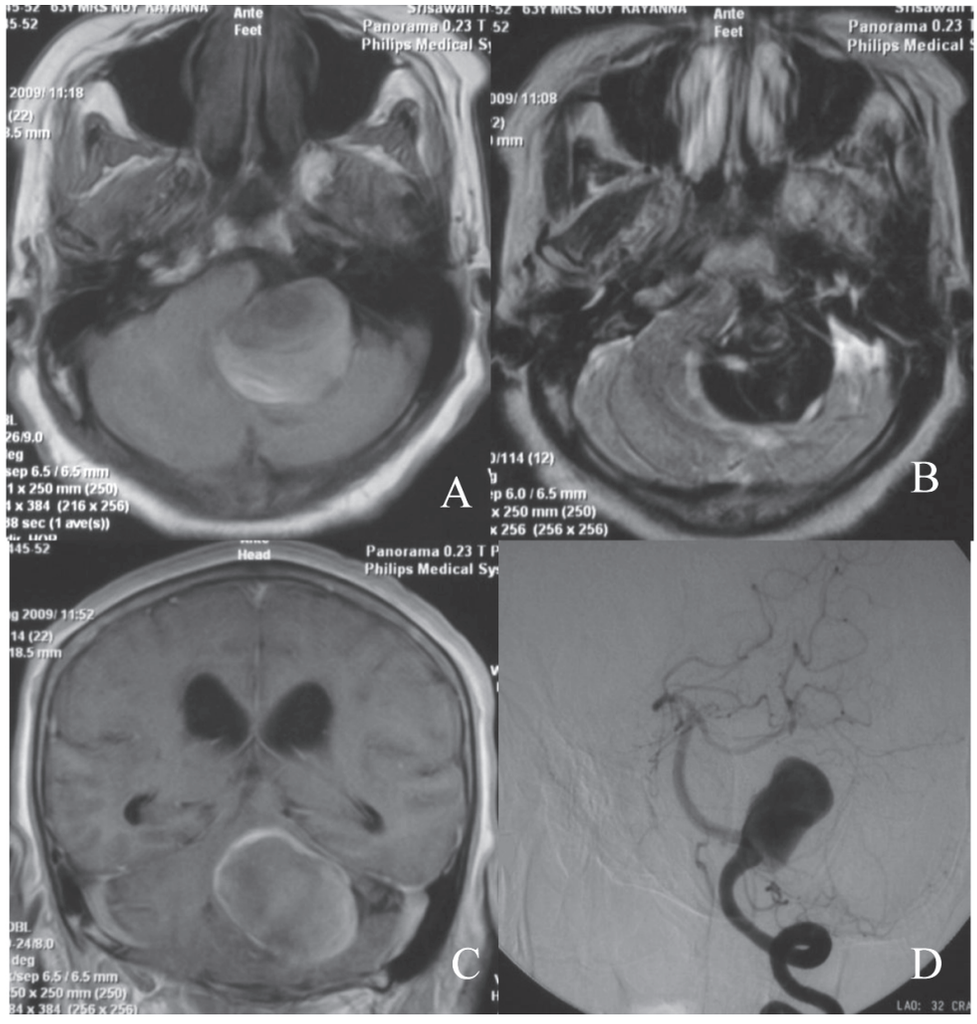

Fig. 6 A 63-year-old female (case NO.10) presented with Lt. leg weakness. MRI (A,B,C) revealed a partially thrombosed giant aneurysm at Lt. CP angle region. DSA showed a saccular giant aneurysm at PICA segment of Lt. VA (D).

A1 segment was achieved for flow reversal. Postoperative DSA demonstrated complete absence of aneurysm and bilateral distal ACA supplied from left A1.

Trapping allows decompression of the thrombus responsible for symptoms in giant aneurysm with focal mass effect.15 Two patients in this series (case 1,9) underwent trapping of aneurysm with good result. Another case (case 4) with trapping with bypass procedure had poor outcome due to graft occlusion.

Surgical mortality rate vary from 4-21% (average 10%) in previous reports.15 No surgical mortality was observed in this series. The most common complication was ischemia. Excellent/good results in surgically treated patients have been reported in 63-85% of case.[15] The favorable outcome in 70% of patients observed in this series.

Conclusions

In this series, the anterior circulation, especially ICA, is the most frequently involved artery. Mass effect from the aneurysm is the most common clinical presentation followed by features of SAH. Various neurosurgical techniques were used for proper case. With proper case selection, optimal radiological evaluation

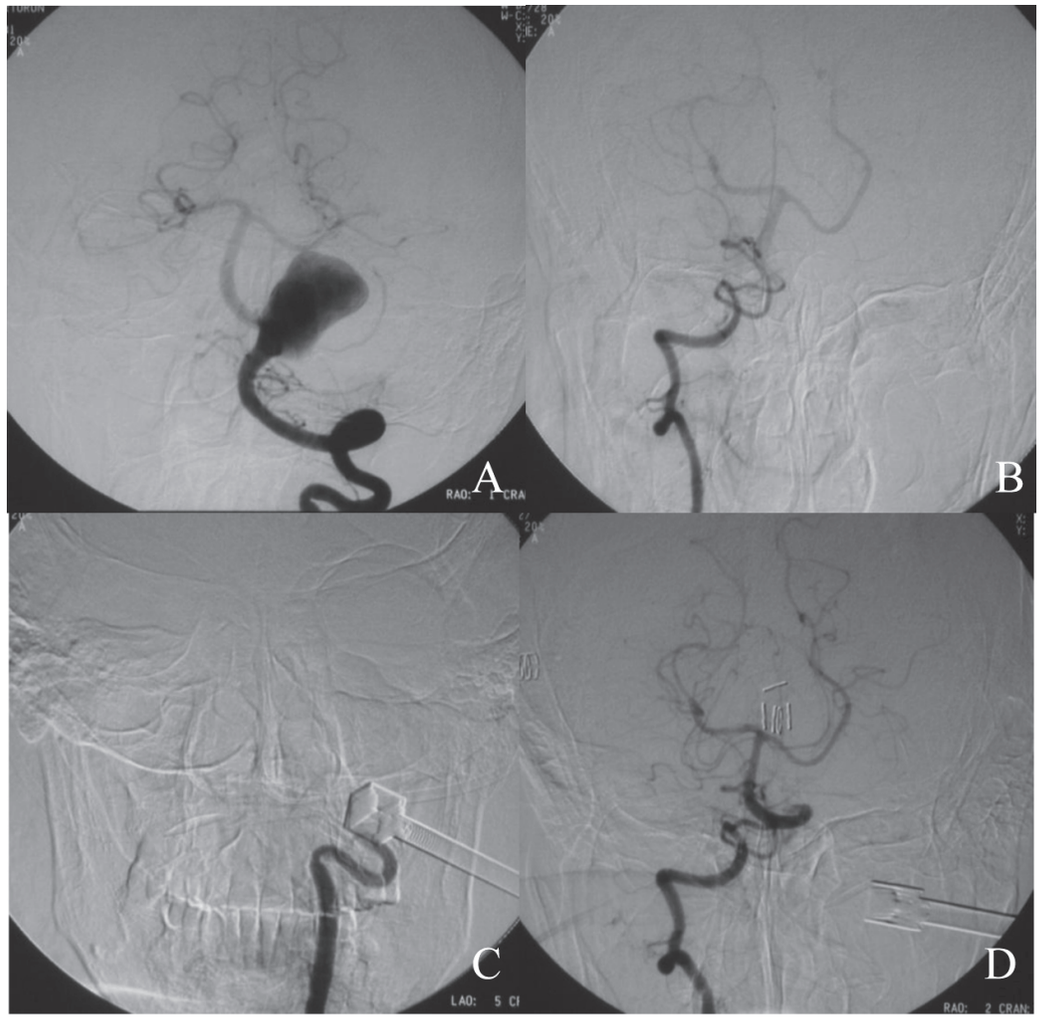

Fig. 7 Post-operative DSA (C,D) revealed a well obliterated aneurysm and good supplement flow from Rt. VA to basilar artery and both PCA. The weakness was improved at immediate postoperative period and at 1-month follow-up.

and appropriate surgical strategy, it is possible to achieve a favorable outcome in 70% of case.

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