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Original Research Paper

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APPROACHES TO A-COM ARTERY ANEURYSMS: DIFFERENT PATHS FOR ONE GOAL

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ABSTRACT

BACKGROUND: A-com artery aneurysms are the most common intracranial aneurysms. Clipping and coiling are the two options available for treatment of these aneurysms. Microsurgical clipping, although invasive, is more suitable for the economically challenged sector of our society.

AIM: To evaluate the mortality and morbidity of clipping A-com artery aneurysms by different surgical approaches.

Settings and Design: This is a non-randomized prospective multiple centre study.

MATERIALS AND METHODS: Patients with A-com artery aneurysm fulfilling the inclusion criteria and managed with microsurgical clipping were included in the study. Patients were evaluated preoperatively and postoperatively with CT Scan Brain (Plain), 3D- CT Angiogram of Brain or Digital substraction Angiography of Brain.

STATISTICAL ANALYSIS: Data collection and analysis, was performed using the statistical package for the social sciences version 16 (SPSS, INC, Chicago, IL).

RESULTS: A total of 34 patients of A-com aneurysms (non-giant) were included in the study. Male: Female ratio of 1.62:1 with male preponderance. All the aneurysms were microsurgically clipped by either Pterional transsylvian or modified gyrus rectus or interhemispheric approach. The mortality and morbidity in different surgical approaches were analyzed.

CONCLUSION: Mortality depends on the preoperative grade of subarachnoid hemorrhage. Type of surgical approach has no relation to mortality or morbidity.

KEYWORDS : Anterior communicating artery (A-com artery), Aneurysm, Clipping, Coiling.

INTRODUCTION:

Surgical approaches to A-COM aneurysms dates back to 1918 when George J. Heuerr and Walter E Dandy, first described fronto-temporal craniotomy for lateral sub-frontal approach to the circle of Willis1 . In 1935, W. Tonnis first described anterior interhemispheric approach to clip A-com aneurysm2 . Gosta Norlen and Alec S. Barnum in1953, first described transfrontal approach (partial frontal lobectomy) for clipping of Acom aneurysms3 . In 1956, Valentine Logue did proximal ligation of A1 segment to cure A-com aneurysm4 . In 1961, Lawrence Pool published a large series of bilateral anterior subfrontal interhemispheric approach for clipping A-com aneurysms5,6. Ludwig Kempe in 1968, did sphenoid wing removal for fronto-temporal craniotomy7 . In 1971, Ludwig Kempe and G.D. Vander Ark first advocated gyrus rectus approach to clip A-com aneurysms8 . M.G. Yasargil and John L. Fox in 1975, described "Pterional" or frontosphenotemporal craniotomy for aneurysms9 . Orbitozygomatic osteotomy was later introduced by Zabramski et al to enlarge the fronto-temporal exposure though additional osteotomies10. Among the different microsurgical approaches to A-com aneurysms e.g. pterionaltranssylvian (PTS), sub-frontal modified gyrus rectus resection (MGR), anterior interhemipheric (ITC), bifrontal basal interhemispheric (BBIH) and cranioorbitozygomatic (OBZ), which is more suitable remained the matter of our study. Although different group/surgeon feel comfortable with a particular approach, we in our series performed all the procedures by the same group of surgeons and tried to evaluate our results. We have searched the literature to find other studies comparing the different microsurgical approaches to A-com aneurysms. Endoscopic or endovascular procedures were not included in our study. Mini pterional and supraorbital craniotomy was also not done in our series.

MATERIALS AND METHODS:

This study was a non-randomized, prospective study conducted between January 2010 and January 2015. Thirty eight patients with A-com aneurysms, who were operated by our group were followed up for at least 6 months postoperatively. The study was conducted at three tertiary referral centers. Informed consent was obtained from all the study participants. Inclusion criteria of patients in our series were: i. Hunt and Hess grade I, II, III ii. No comorbidities like hypertension, diabetes mellitus, tuberculosis etc. iii. Single aneurysms in A-com region Intraoperative ICG, intraoperative angiography and endoscopic assistance was not used in our study. Preoperatively, all patients underwent a detailed neurological examination and 3-D CT angiography or digital substraction angiography of brain. Patients with A-com aneurysms were randomly selected for PTS, MGR, ITC approach, Giant A-com aneurysms were selected for BBIH and OBZ approach. We did no bring 'timing of surgery' into our analysis due to some technical reasons. Pterional trans-sylvian approach (PTS) Total 14 patients of A-com aneurysms were selected for PTS Advantages of this approach are: i. As the trajectory is middle cerebral artery → Internal carotid artery → anterior cerebral artery, early proximal control can be achieved. Disadvantages of this approach are: i. Traversing the sylvian fissure ii. Temporal lobe oedema / contusions leading to seizure

Table 1: Series of PTS approach (n=14) SL.NO AGE(Y) SEX(MALE=M,FEMALE=F) PRE OPE GRADE(H&H) MORBIDITY MORTALITY 1 35 M 1 SEIZURE - 2 40 M 2 SEIZURE - 3 45 M 3 FRONTAL LOBE SYMP(TEMPORARY) - 4 60 F 1 SEIZURE - 5 65 M 1 - - 6 70 F 1 - - 7 48 M 1 - - 8 52 M 2 - YES 9 62 F 2 - YES 10 81 M 2 BRAIN OEDEMA - 11 53 M 3 - YES 12 47 M 1 BRAIN OEDEMA - 13 45 F 1 SEIZURE - 14 37 F 1 - - Frontal lobe symptoms signifies development of new frontal lobe symptoms which were not present before operation. Modified Gyrus Rectus Approach (MGR) Total 18 patients of A-com aneurysms were selected for MGR Advantage of this approach is i. As the trajectory is optic nerve → ICA → A1 segment → A-com, there is no need for dissection in sylvian fissure Disadvantages of this approach are: i. Tight brain poses difficulty in frontal lobe retraction ii. Postoperative frontal lobe symptoms may develop which may be temporary or permanent

Table 2: Series of MGR approach (n=18) SL NO AGE SEX PRE OPE GRADE(H&H) MORBIDITY MORTALITY 1 30 M 1 FRONTAL LOBE SYMP(T) - 2 47 M 2 FRONTAL LOBE SYMP(T) - 3 45 M 3 - - 4 37 F 1 - - 5 60 F 1 - - 6 64 M 1 - - 7 72 F 1 - - 8 51 F 1 - - 9

57 M 1 SEIZURE - 10 55 M 1 SEIZURE - 11 44 F 1 FRONTAL LOBE SYMP(P) - 12 43 F 1 FRONTAL LOBE SYMP(T) - 13 61 F 1 FRONTAL LOBE SYMP(T) - 14 67 M 1 BRAIN OEDEMA - 15 73 M 1 BRAIN OEDEMA - 16 77 M 1 - 1 17 79 F 2 - 1 18 69 M 3 - 1 Frontal lobe symptoms signifiesFrontal lobe symptoms signify development of new symptoms. T – Temporary, P – Permanent InterhemisphericTranscristagalli approach (ITC) 2 patients were selected for ITC Advantage of this approach is: i. Midline orientation Disadvantages of this approach are: i. Narrow corridor of interhemispheric fissure ii. Large frontal air sinus sometimes poses difficulty

Table 3: Series of ITC approach (n = 2) SL NO AGE SEX PRE OPE GRADE MORBIDITY MORTALITY 1 35 M 1 FRON LOBE SYMP(T) - 2 42 M 1 FRON LOBE SYMP(T) - T – Temporary, P – Permanent Pterional with orbitozygomatic exposure (OBZ) 2 patients of giant A-com aneurysm were selected for OBZ Advantages of this approach are i. Wide exposure ii. Approach through different corridors like interoptic, carotico optic etc. Disadvantages of this approach are: i. Prolonged time for bone work ii. Unilateral approach iii. Postoperative orbital congestion

Table 4: Series of OBZ approach (n = 2) SL NO AGE SEX PRE OPE GRADE MORBIDITY MORTALITY 1 47 M 1 FRON LOBE SYMP(T) - 2 50 F 2 BRAIN OEDEMA,ORBITAL CONG. - T – Temporary, P – Permanent Bilateral Basal Interhemispheric approach (BBIH) 2 patients of giant A-com aneurysm were selected for BBIH Advantages of this approach are: i. Wide exposure ii. Bilateral approach Disadvantages of this approach are i. Large frontal air sinus leads to contamination ii. Injury to bilateral olfactory tracts iii. Approach to area below tuberculum selle is difficult

Table 5: Series of BBIH approach (n = 2) SL NO AGE SEX PRE OPE GRADE MORBIDITY MORTALITY 1 42 M 1 FRONTAL SINUSITIS, OSTEOMYELITIS - 2 45 F 2 Anosmia –

RESULTS AND ANALYSIS:

We had 4 patients of giant A-com aneurysm and 34 patients of A-com aneurysm. As the number of patients in the giant A-com aneurysms was less we analyzed the non-giant aneurysms in our study. We analyzed the mortality and morbidity in different approaches (PTS, MGR, ITC), in terms of preoperative grades and in different age groups by SPSS version 16. A p value of less than 0.05 was considered to be significant. Of the 34 patients, 21 (61.8%) were male and 13 (38.2%) were female.

MORTALITY AND MORBIDITY:

According to the type of approach, morbidity occurred in 7 (50%) patients of PTS, 9 (50%) patient of MGR and 2 (100%) 2 patients of ITC. There was no significant difference in occurrence of morbidity according to the type of approach (H=1.83, P=0.4). Morbidities were seizure, frontal lobe symptoms (temporary or permanent) and brain oedema. Most common morbidity in PTS was seizure in 4 (28.6%) patients, in MGR was temporary frontal lobe symptoms in 4 (22.2%) patients and in ITC was temporary frontal lobe symptoms in 2 (100%) patient. Type of morbidity did not vary significantly with type of approach (H = 2.27, P = 0.32). Different types of morbidities in different surgical approaches are shown in Table 6.

Table 6: Association between approach and type of morbidity Approach Morbidity type Total No Seizure Frontal lobe sym(p) Frontal lobe sym(T) Brain oedema PTS Count % within approach 7 50.0% 4 28.6% 0 0.0% 1 7.1% 2 14.3% 14 100.0% MGR Count % within approach 9 50.0% 2 11.1% 1 5.6% 4 22.2% 2 11.1% 18 100.0% ITC Count % within approach 0 0.0% 0 0% 0 0.0% 2 100.0% 0 0.0% 2 100.0% Total Count % within approach 16 47.1% 6 17.6% 1 2.9% 7 20.6% 4 11.8% 34 100.0% Comment: Type of morbidity did not vary signifciantly with approach of surgery (H=2.27, p = .32) Mortality in PTS was 3 (21.4%), MGR 3 (16.7%) and ITC was 0. There was no significant difference in occurrence of mortality according to the type of approach (H = 0.561, P = 0.75). MortalityMorbidity in preoperative Hunt and Hess grade 1 was 14 (58.3%), grade 2 was 3 (50%) and grade 3 was 1 (25%). There was no significant difference in occurrence of morbidity according to the preoperative H&H grade of SAH (H = 1.5, P = 0.47). Mortality in preoperative grade 1 was 1 (4.2%), grade 2 was 3 (50%) and grade 3 was 2 (50%). Mortality varied significantly with the grade of SAH (H = 9.9, P = 0.007). Post hoc test showed that mortality was only significantly more in grade 2 than grade 1 (z = 2.28, P = 0.02). The association between preoperative H & H grade and mortality is shown in table 7.

Table 7: Association between preoperative Hunt & Hess grade and mortality. Grades (H&H) Mortality Total No Yes 1 Count % within approach 23 95.8% 1 4.2% 24 100.0% 2 Count % within approach 3 50.0% 3 50.0% 6 100.0% 3 Count % within approach 2 50.0% 2 50.0% 4 100.0% Total Count % within approach 28 82.4% 6 17.6% 34 100.0% Comment: Mortality varied significantly with the grade of SAH (H = 9.90, p = .007). Post-hoc test showed that mortality was only significiantly more in grade 2 than grade 1 (z = 2.28, p = 0.02). Morbidity in different age groups was, in less than 40 years was 3 (60%), 40 to 49 years was 8 (80%), 50 to 59 years was 2 (40%) and in more than 60 years was 5 (35.7%). No significant difference in occurrence of morbidity according to age group was seen (H = 4.89, P = 0.18). Mortality in less than 40 years was 0, 40 to 49 years was 0, 50 to 59 years was 2 (40%) and more than 60 years was 4 (28.6%). There was no significant difference in occurrence of mortality according to age group (H = 5.9, P = 0.12).

LEGENDS OF FIGURE

FIG 1a: Initial CT scan showing frontal ICH
FIG 1b: DSA showing A-com Aneurysm
FIG 2a: Postoperative DSA showing clipping
FIG 2b: Postoperative scar mark

DISCUSSION:

A-com segment aneurysms are most common intracranial aneurysms "Cooperative study intracranial aneurysms and sub-arachnoid hemorrhage" (1958-1965) showed the incidence of A-com aneurysms to be 30.3%. In the Yasargil's series, the direction of fundus of A-com aneurysms are superior (34%), anterior (23%), posterior (14%), inferior (13%) and multiple projection (16%)11. There are various microsurgical trajectories to clip the A-com aneurysms (giant or not). Over a span of 5 years we have operated (clipped) 34 non giant A-com aneurysms by pterional transsylvian approach, modified gyrus rectus approach and interhemispheric transcibriform approach. We analyzed the mortality and morbidity in different approaches, in different preoperative grades and in different age groups, we found in our analysis, that different surgical trajectories and different age groups did not have any impacton mortality and morbidity. Mortality significantly depended on preoperative grade of subarachnoid hemorrhage (H&H). Sano et al in a review of surgical approaches to A-com aneurysms described that there are two main types of approaches for A-com aneurysms, namely pterional and interhemispheric approach12.

There are some variations of interhemispheric approach including bifrontal, unifrontal, basal interhemispheric and transcristagalli interfalcine approach. In pterional approach, the advantages are i) Subarachnoid space is opened and hematoma evacuated in acute stage, ii) Damage to olfactory tract is diminished iii) Bilateral parent arteries of the proximal side can be secured early. The disadvantages of pterional approach are i) Partial resection of gyrus rectus is often

required in cases of high positioned A-com aneurysms. In interhemispheric approach, the advantages are i) Midline approach so that bilateral A1 and A2 can be visualized equally and long enough. The disadvantages are, i) Dissection in the interhemispheric fissure and ii) venous injury Diraz et al. reviewed 102 cases of A-com aneurysms which were operated by two microsurgical approaches (pterional and interhemispheric) 13.

The operative results for pterional and interhemispheric approach were comparable with each other. The final outcome was correlated to the preoperative clinical grading and timing of surgery which corroborates with our results (mortality significantly depended on preoperative grade of SAH). Yum Yun et al, in a retrospective study of 231 patients with A-com aneurysms, operated 96 patients through sylvian fissure dissection and 135 patients without sylvian fissure dissection14.

In this study, eliminating the step of sylvian fissure dissection by gently lateral basal frontal retraction (sub-frontal approach) did not increase morbidity and mortality. Hernesniemi et al in a large series of microsurgical management of A-com artery aneurysms reported that lateral supraorbital approach is used in almost all A-com aneurysms15.

An important exception is downward projecting A-com aneurysms in which pterional approach may provide more lateral access to the aneurysm. If the A-com complex is located high in the interhemispheric fissure, the interhemispheric approach should be considered. The orbitozygomatic approach reduces retraction of frontal lobe. The orbital contents, however, may reduce the space achieved by additional bone removal, a feature not apparent in formalin fixed cadaver studies. In addition, injury to frontal nerves, pulsatile exophthalmos and diplopia may occur. Ki-Chul Cha et al, in a comparison between lateral supraorbital approach and pterional approach in the surgical management of unruptured intracranial aneurysms concluded that lateral supraorbital approach is a good alternative to classic pterional approach for clipping unruptured intracranial aneurysms15 .

Schaller et al commented that the transsylvian approach is minimally invasive but not 'a traumatic'17.

Andaluz et al, in a anatomic and clinical study of orbitopterional approach to A-com aneurysms, opined that the angles of observation were increased 46% in the axial plane and 137.5% in the projection plane in orbitopterional approach as compared to pterional approach18.

The surgical window depth was decreased 13% with the orbitopterional approach. Schwartz et al quantified increased exposure resulting from orbital rim and orbitozygomatic osteotomy via the fronto-temporal transsylvian approach19.

The conclusion was, significant and consistent increases in surgical exposure were obtained by using orbital osteotomy, whereas zygomatic arch removal produced less consistent gains. Fujitsu et al emphasized on orbitofrontotemporobasal craniotomy20.

Retraction of orbital contents decreases the amount of retraction of the brain to such an extent that a brain spatula is not necessary for access to the anterior communicating complex. Fiqueiredo et al in a quantitative anatomic study of three surgical approaches to the anterior communicating artery complex commented that the vertical and horizontal angles of approach to the A-com complex are significantly larger for orbitopterional and orbitozygomatic approaches compared with pterional approach21.

Use of the orbitozygomatic approach may decrease the need for frontal lobe retraction and resection of gyrus rectus. Alaywan et al in a study in 11 fresh human cadavers, with brain in situ found that with orbitozygomatic removal the field view angle was increased by 75% in sub-frontal approach, 46% in pterional approach and 86% in subtemporal approach22 .

Andaluz et al in a long term follow up of 75 consecutive patients of A-com artery aneurysms, concludes that orbitopterional approach has low surgery related morbidity rates and good patient outcomes and functionality23

Vanderark Vanderak et al in a review of 100 A-com aneurysms revealed that preoperative arteriogram is the key to planning the operative approach24.

In aneurysms that project superiorly, a sub-frontal approach is used. Aneurysms which project inferiorly are approached from above by making an incision though the gyrus rectus. Gandhi et al compared the outcomes of A-com aneurysm operation by Basal interhemispheric approach and Pterional approach,and commented that Basal interhemispheric approach can be used to treat A-com aneurysms with good clinical results25 .

Mylong Cheol Kim et al studied on rupture risk of A-com aneurysms and commented that A-com aneurysms may rupture despite their smaller sizes26 .

In addition the morphology parameter of height/width ratio and difference of dominance of A1 may be useful for describing risk of rupture. Xue-Jing Zhang et al studied on the development of A-com aneurysms and commented that presence of A-com aneurysm is significantly associated with patient age, wider angles of the anterior cerebral artery bifurcation and smaller vascular diameter of the anterior communicating complex27 .

A-com aneurysms being the most common aneurysms are encountered by every neurosurgeon. This may be incidental (non-ruptured), ruptured and giant (causing pressure effect). Literature of A-com aneurysm enumerates different modalities of treatment 1) observation, 2) Endovascular procedure, 3) Microsurgical procedures 4) Formatted: Font: (Default) Times New Roman, 13 pt Formatted: Font: (Default) Times New Roman, 13 pt Formatted: No Spacing, Justified, Line spacing: 1.5 lines Formatted: Font: (Default) Times New Roman, 13 pt Formatted: Font: (Default) Times New Roman, 13 pt Minimally invasive procedures through minicraniotomies 5) Endoscopic procedures. Sutability of one procedure over the other depends on several factors like 1) patient factors - (grade of SAH, comorbidities, personal choice etc), 2) Surgeon factors (competence, experience etc.) and 3) Institutional factors (gazets available, funds, volume of patient etc.) In our country all the neurosurgical centres are not equipped with all the gazets required for treating aneurysms. In this scenario we tried to analyze, the procedures of microsurgical clipping for A-com aneurysm by craniotomies which is possible atleast in every neurosurgical centre. Our group performed five microsurgical procedures namely PTS, MGR, ITC, BBIH and OBZ. In a small sample size of 38 patients, we had 4 patients of giant A-com aneurysm for whom we did BBIH and OBZ and therefore did not bring these two procedures into our analysis. In our study the other procedures namely PTS, MGR and ITC did not have any impact on the patient outcome i.e. none of them can be claimed to be superior than the other in terms of patient morbidity and mortality. In our study mortality solely depended on preoperative grade of SAH.

CONCLUSION:

There are different microsurgical approaches to A-com artery aneurysms. Preoperative arteriogram is important key to planning the surgical approach. Pterional craniotomy with orbitozygomatic bone removal gives wide exposure. Transsylvian and sub-frontal approaches are comparable. Interhemispheric approach is suitable in selected cases. Outcome of the surgery depends on the preoperative grade and timing of surgery. ACKNOWLEDGEMENT: We acknowledge Mr. Subhankar Saha for preparing the manuscript.

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