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Evaluation of Intraoperative and Post-Operative Benefits of Supraorbital Keyhole Approach for Anterior Circulation Aneurysm Surgery

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ABSTRACT

Objective: To evaluate the intraoperative and post-operative benefits of the supraorbital keyhole approach for anterior circulation aneurysm surgery.

Study Design: Cross-sectional analytical study

Place and Duration of Study: Neurosurgery Department, Combined Military Hospital (CMH), Rawalpindi Pakistan, from Mar 2021 to Apr 2022.

Methodology: Forty patients came for anterior circulation aneurysm surgery during the above said period in the hospital who met the inclusion and exclusion criteria of the study. Ambulation time against all patients was 24 hours. Patients were treated with clipping. After surgery, patients were followed till the resolution of complications.

Results: Of 40 cases, 21(52.5%) were males, and 19(47.5%) were females. The average age of the patients was 51.97±9.73 years. The aneurysm location of patients was not associated with the gender of the patient, with a *p*-value of 0.115. Similarly, the average age of the patient was not significantly different for the patients' aneurysms location with a p-value of 0.106. Satisfaction appearance was claimed in all 40(100%) cases after surgery. The research study showed no complications in 18(45%) patients out of 40 after treatment, with a *p*-value of 0.041.

Conclusion: Supraorbital keyhole approach for anterior circulation aneurysm surgery is better regarding intraoperative tissue trauma and post-operative cosmetic outcome. The patient and all post-operative complications will be cured within six months after surgery.

Keywords: Anterior circulation aneurysm surgery, Clipping, Supraorbital keyhole approach.

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INTRODUCTION

Various types of clipping techniques have been developed by researchers for the treatment of aneurysm.[1] The earliest history of treating cerebral aneurysms stems from 1855 when Victor Horseley used the legation of the common carotid artery for treating ipsilateral cerebral aneurysms.[2] The keyhole strategy was designed to minimise the trauma caused to the structures present in the surrounding of the brain, such as muscles, bones, dura, skin, etc.[3,4] The deep-seated lesions found in the brain could be treated with the help of a small craniotomy using this keyhole technique. This technique is also recommended because it enables the formation of the reverse funnel-shaped surgical corridor and a sufficient amount of operative field for the surgeon.[5,6]

In addition, implementing this technique lowers the complication rate associated with the surgery and provides a satisfactory level of treatment against an aneurysm.[7] Studies have demonstrated that implementing the keyhole approach requires little wound for operating, a short duration for surgery, little loss of blood, minimal deterioration caused to temporalis muscle, and less pain caused by the wound, ensuring early recovery and early return to the patient to a productive life.[8,9]

The implementation of the keyhole approach for the treatment of anterior circulation aneurysms has successfully demonstrated a variety of benefits over other techniques and treatment methodologies. One of these advantages is the minimal invasiveness caused by implementing keyhole. The incision needed during the keyhole technique is also small and cosmetically pleasant. The problem of a healing wound is also very small because, in the supraorbital region, the supply of blood is good.[8,10]

The supraorbital keyhole approach is the new approach for treating anterior circulation aneurysm surgery, and intraoperative and post-operative benefits of this newly adopted treatment were required to discuss in our local setup.

METHODOLOGY

The cross-sectional study was conducted at the Neurosurgery Department, Combined Military

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Hospital (CMH) Rawalpindi after approval was taken from the Ethical Review Board (No. 35-02- 20) from July 2021 to March 2022. The sample size for this study was calculated with the help of the WHO calculator keeping the proportion of post-operative frontal muscle weakness was 0.11, the proportion of post-operative frontal muscle weakness at 0.1.[11]

Inclusion Criteria: Patients of either gender, aged 20 to 80 years, who came for anterior circulation aneurysm surgery were included in this study.

Exclusion Criteria: Patients with a history of Intracranial lesions, incomplete information in record with no further contact, and not cooperating to complete the questionnaire were excluded from the study.

The diagnosed patients with subarachnoid haemorrhage caused by a ruptured intracranial aneurysms came to the Department to treat anterior circulation aneurysms. A neurosurgical team performed all surgeries, including consultants and trained neurosurgery registrars. The related information was framed through a self-designed questionnaire from the medical record of the department, and the required missing information was completed through the personal interview by telephone and email.

All patients were treated with Supraorbital Keyhole Approach (SKA). The skin incision was started medial to the supraorbital notch and beyond the tail of the eyebrow. A small keyhole was made at the frontozygomatic suture, and an approximate 2 × 2 cm craniotomy was performed. The retractor is placed sub frontally in an anterior direction via a supraorbital mini-craniotomy, and the anterior part of the olfactory tract is retracted.

The base characteristics of the patients, i.e. gender, age, aneurysm location, Glasgow comma scale at admission, Hunt and Hess Grade and Fisher Grade, were used to ascertain the severity of the surgical risk. To assess the intraoperative effects of SKA, we used operative time, estimated blood loss, the need for transfusion and temporary clipping. The complication was observed to assess the post-operative effects of SKA, i.e. symptomatic vasospasm, cerebral artery infraction, frontal muscle weakness, numbness, orbital swelling, acute respiratory distress syndrome and post-operative pneumonia. Patients were followed up to 6 months to assess for resolution of complications.

Data were analysed using Statistical Package for the Social Sciences (SPSS) version 23.00 and MS Excel 2016 software. Mean and SD were calculated for continuous variables. Frequency and percentage were calculated for categorical variables. The chi-square test was used for comparison. The *p*-value of ≤0.05 was considered significant.

RESULTS

In this study, 40 cases were selected. Of 40 cases, 21(52.5%) were male patients, and the remaining 19 (47.5%) were female. 28 (70%) patients were from an anterior communicating artery. In contrast, only 2(5%) patients were arising proximal to the anterior communicating artery and 10(25%) were in distal circulation. The aneurysm location of the patient was not statistically associated with the gender of the patient, with a *p*-value of 0.115. The descriptive analysis of admission of GCS, Hunter and Hess Grade and Fisher Grade is mentioned in Table-I.

Table-I: Descriptive analysis of Patients Characteristics at Admission (n=40)

Variables	Categories	n(%)
GCS at Admission	Minor deficit (13-15)	18(45%)
	Moderate deficit (9-12)	22(55%)
Hunter and Hess Score	Grade-I	18(45%)
	Grade-II	17(42.5%)
	Grade-III	4(10%)
	Grade-IV	1(2.5%)
Fisher Scale	Grade-I	7(17.5%)
	Grade-II	22(55%)
	Grade-III	11(27.5%)

Complete clipping was performed in all 40(100%) cases and in 9(22.5%) cases, temporary clipping had to be done prior to permanent clip application due to gain proximal control of bleeding. All patients at the time of discharge had good GCS, out of which 21(52.5%) were completely cured of having GCS "15 out of 15", 13(32.5%) have GCS "14 out of 15" and the remaining 6(15%) have GCS "13 out of 15". Similarly, the Glasgow outcome scale (GOS) was Grade-I of 22(55%) patients, Grade-II of 14(35%) patients and the remaining 4(10%) patients had Grade-III. The minimum blood loss was reported to be 159 ml, and the maximum blood loss was reported to be 223 ml. The mean estimated blood loss was 187.35(± 20.04 S.D) ml. Out of 40, only 6(15%) patients required blood transfusion. The minimum and maximum ambulation time was reported as seven days and 12 days, respectively. The mean ambulation time was 9.62 (±1.43 S.D) days.

A satisfactory appearance was claimed in all 40(100%) cases after surgery. Unpleasant surgical scars were not claimed by any patient after surgery.

Moreover, no death occurred after treatment. The detailed post-operative complication analysis is mentioned in Table-II. The result showed that at least 45% of patients had no complications after treatment, with a *p*-value of 0.041. The selected cross-table analysis of the complications for gender and location is mentioned in Table-III.

Table II: Frequency Distribution of Post-Operative Complication (n=40)

Complication	Categories	n(%)
Orbital Swelling	Yes	12(30%)
	No	28(70%)
Transfusion Required	Yes	6(15%)
	No	34(85%)
Symptomatic Vasospasm	Yes	4(10%)
	No	36(90%)
Frontal Muscle Weakness	Yes	4(10%)
	No	36(90%)
Cerebral Artery Infarction	Yes	3(7.5%)
	No	37(92.5%)
Frontal Muscle Numbness	Yes	3(7.5%)
	No	37(92.5%)
Acute Respiratory Distress Syndrome	Yes	2(5%)
	No	38(95%)
Pneumonia	Yes	1(2.5%)
	No	39(97.5%)

Table III: Association of Gender Location and Pre-Admission Glasgow Coma Scale (GCS) with Postoperative Complications (n=40)

Characteristics	Categories	Complications		*p*-value
		No	Yes	
Frontal Muscle Weakness				
Gender	Male	17(42%)	4(10%)	0.018
	Female	19(47.5%)	0(0%)	
Location	Anterior Communicating artery	27 (67.5%)	1 (2.5%)	0.076
	Proximal to Anterior communicating artery	2 (5%)	0 (0%)	
	Others	7 (17.5%)	3 (7.5%)	
Orbital Swelling				
Location	Anterior Communicating artery	16 (40%)	12 (30%)	0.005
	Proximal to Anterior communicating artery	2 (5%)	0 (0%)	
	Others	10(25%)	0(0%)	

DISCUSSION

In a retrospective study from China, the researchers included 543 patients from 2010-18. Intraoperative complications were reported in 9(10.5%). The researcher concluded that the supraorbital eyebrow keyhole approach for treating ruptured aneurysms was safe10. In our study, intraoperative complications, i.e., the need for blood transfusion, were reported in 6(15%), which is also not high.

According to the outcomes of the study carried out by Mori *et al*, more than 88.9 percent of the patients were satisfied cosmetically through lateral supraorbital mini craniotomy in anterior communicating artery aneurysm. Moreover, out of a sample space of 63 patients, only three reported weakness in the frontalis.[11] The study conducted by Yamahata *et al*. included 103 patients and reported an aneurysmal occlusion rate of 100% percent in their study.[12]

Operative time is directly related to the expertise of the surgeon, the patient's GCS at admission, intraoperative complications and many other factors.[13] Park *et al*. carried out a research study on 102 patients. The mean operative time was 120±30 minutes for the patients treated with the help of the supraorbital keyhole technique. The treated patients did not require any transfusion of blood during the procedure.[14]

Similarly, in another study, the operation time was 198±37 minutes in 63 cases suffering from anterior artery aneurysms, treated through the superolateral orbital keyhole method.[11] The mean operative time in our study was 185.92±18.48 min.

However, blood loss was also found to be very small compared to other treatment methodologies. For example, according to the study conducted by Tang *et al*., the average blood loss was identified to be 204 (± 100 S.D) ml during the operation of the patients treated through a keyhole approach.[15] In our study, only six patients required blood transfusion, and the mean blood loss was 187.35(± 20.40 S.D) ml.

The supraorbital approach is better than the other traditional old alternative treatment procedure. Chen *et al*. compared the lateral supraorbital approach with the pterional approach for treating middle cerebral artery aneurysms. The researchers included 181 patients in their study. They concluded that the lateral supraorbital approach was better for operative time, skin incision, post-operative HH scale, post-operative GCS and proportion of postoperative complications.[16]

In a recent study conducted in 2021, 235 patients were treated with the supraorbital or pterional keyhole approach. Of 31(13.2%) patients had intraoperative aneurysm rupture, mainly cerebral vascular spasm and intraoperative brain oedema. In addition, 18(7.7%) patients had post-operative complications, mainly infection, cerebral infarction, hematoma, and cognitive impairment.[17] In our study, 16(40%) have intra-operative and post-operative complications.

Hence, the pterional keyhole approach results may not be different from the supraorbital keyhole approach.[18] In a study conducted in Japan, 160 patients of the middle cerebral artery were treated with a pterional keyhole approach. They showed complete clipping results of 157(98.1%) cases. 85.6% of cases were satisfied with this procedure.[19] Our study showed 100% successful complete clipping, and all patients were satisfied with this procedure.

LIMITATIONS OF STUDY

As the frequency of the patients for surgery is rare in the department, it is suggested that a grand study is planned in which other hospitals may also include increasing the patients in the analysis. It is further observed that this study is a short follow-up time, whereas, in many reference studies, follow-up time was more than five years on average.

CONCLUSION

Based on our sample result, we conclude that the supraorbital keyhole approach for anterior circulation aneurysm surgery has a better cosmetic outcome and less tissue trauma prop, and it is also safe. However, a few post-operative complications may appear, mainly orbital swelling; Symptomatic Vasospasm and Frontal Muscle Weakness are the most common complications and disappear completely in around six months.

Conflict of Interest: None.

Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

HAS: Conception, interpretation of data, drafting the manuscript, approval of the final version to be published.

HAC: Study design, data analysis, drafting the manuscript, critical review, approval of the final version to be published.

AA: Critical review, approval of the final version to be published.

SB: Data acquisition, interpretation of data, approval of the final version to be published.

AS: Study design, Drafting the manuscript, interpretation of data, approval of the final version to be published.

NA: Critical review, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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