

Lateral Supraorbital Subfrontal Keyhole versus Pterional Craniotomy for the Surgical Management of A-Com Aneurysm

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Abstract

Pterion approach is widely accepted as a standard method for clipping of A-com artery aneurysm. With progresses of microscopic instruments and surgical techniques, keyhole approach for clipping of anterior circulation aneurysm is becoming popular. *Objectives:* To evaluate & compare clinical outcome of surgery after lateral supraorbital subfrontal keyhole and Pterional craniotomy for anterior communicating artery aneurysm. *Materials & Method:* This study is a retrospective review between supraorbital subfrontal keyhole versus pterional craniotomy for the surgical management of anterior communicating artery aneurysm in 26 patients operated between jan 2014 and jan 2018 in our institute. *Results:* A total of 26 were operated for A-com aneurysm, 13 patients by lateral supraorbital keyhole 6 (46.15%) male and 7 (53.84%) female and 13 patient by pterional approach 5 (38.46%) male and 8 (61.53%) females. Compared with the pterional approach, keyhole approach showed better outcomes regarding the incidence of craniotomy-related pain, cosmetic look, and patient satisfaction. *Conclusion:* In our study there was significantly less amount of blood loss, post operative pain, duration of stay and complications in key hole approach. Eyebrow-lateral supraorbital keyhole approach for microsurgical clipping of A-com artery aneurysm gives satisfactory therapeutic outcomes.

Keywords: keyhole surgery; A-com aneurysm; supraorbital keyhole.

Introduction

Anterior communicating artery aneurysm is one of the most common intracranial aneurysms accounting for 30%~35% of all intracranial aneurysms [1]. Among the intracranial aneurysm surgical clipping approaches that have been developed, the most accepted is the pterional approach described by Yasargil and Fox. [21].

With improvement in optics, and re-introduction of neuroendoscopy, neurosurgeons have ventured into reducing the size of craniotomy [10,14]. The most popular approach has been frontotemporal

or pterional approach as described by Yasargil [21]. This approach is used to operate many lesions in the sellar, suprasellar, planum sphenoidale, and Sylvian area. However, this traditional approach requires relatively extensive skin, bone, and brain exposure, possibly causing an increase in iatrogenic complications such as temporal muscle atrophy, frontal sinus invasion, and excessive skin exposure and unacceptable scar [22]. This has led to constant endeavour to overcome these complications.

To overcome these problems, lateral supraorbital subfrontal keyhole approach was developed by Perneczky [23]. From then on, keyhole techniques have been gradually known and applied worldwide. Increasing evidence has proved that keyhole techniques, if applied properly, are feasible for the obliteration of intracranial aneurysms. This approach claimed to be minimally invasive for access to anterior cranial fossa neurovascular structures. However, supraorbital keyhole approaches have drawbacks, including limitation of the surgical view and space, and the risk of damage to the supraorbital nerve and frontalis branch of the facial nerve [6,11].

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Received on 24.08.2018, Accepted on 17.09.2018

Materials and Methods:

This study is a retrospective review between supraorbital subfrontal keyhole versus pterional craniotomy for the surgical management of A-com artery aneurysm in 26 patients operated between jan 2014 and jan 2018 in our institute. Twenty six patients were divided in two groups, 13 in each group. Same grade patients were alternatively subjected to keyhole and pterional group. Study population included patients with anterior communicating artery aneurysms of all age, sex, presenting with subarachnoid hemorrhage, sudden onset headache, vomiting and loss of consciousness. There were 15 females and 11 males, with age ranging from 35 to 65 years.

Inclusion Criteria

All patients with Hunt and Hess of grade 1-3

A-Com (anterior communicating) artery aneurysm

Exclusion Criteria

All patients of grade 4 & 5 aneurysm

Posterior circulation aneurysm

Multiple aneurysms

Large Intraparenchymal hematoma

Patients were graded under subarachnoid hemorrhage Hunt and Hess grade 1-5, World Federation of Neurological Surgeons Scale (WFNS) grade 1-5 and C.T Fisher grade 1-4. Nineteen patients were admitted within 7 days of ictus and 11 patients were admitted within 7-14 days of ictus. All patients underwent CT brain with C.T angiography for diagnosis of aneurysmal subarachnoid hemorrhage. Patients in two groups were compared on various parameters. Outcome was compared according to modified Rankin scale at the time of discharge and after 3 months. Post operative pain was compared by VAS at the time of discharge and after 3 months.

Results and Discussion:

Patient Population

The demographic and clinical characteristics of the patients who underwent the supraorbital keyhole and pterional approaches are summarized in [figure 1]. In the supraorbital group 6 (46.15%) patients were male and 7 (53.84%) patients were

female, the patient ages ranged from 36 to 60 years i.e. mean age of 47.73 years. In pterional group 5 (38.46%) patients were male and 8 (61.53%) were females with age, ranging from 19 to 70 years i.e. 44.26 years.

In pterional group eight (61.53%) patients underwent surgery in the acute phase (within 7 days after spontaneous SAH), five (38.46%) patients within 7-14 days after SAH.

In key hole group 4 (30.76%) patients underwent surgery in the acute phase while 9 (69.23%) patients were operated within 7-14 days after SAH.

Signs and Symptoms

In keyhole group all 13 (100%) patients had characteristic headache of SAH, 11 (84.61%) patients had complaints of vomiting, 3 (23.07%) patients had history of loss of consciousness at the time of ictus ranging from 30 minutes to 2 hours. 3 (23.07%) patients had complaints of transient loss of vision, while 1 (7.69%) patient had GTCS and 1 (7.69%) patient developed hemiparesis, summarised in [Table 1].

In pterional group also all 13 (100%) patients had characteristic headache of SAH, 12 (92.30%) patients had complaints of vomiting, 8 (61.53%) patients had history of loss of consciousness at the time of ictus ranging from 30 minutes to 4 hours. 3(23.07%)

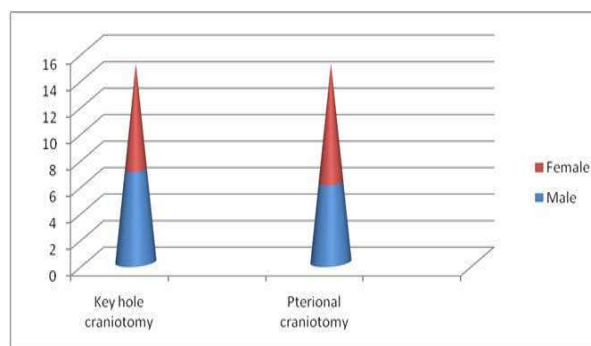


Fig. 1: Distribution of sex

Table 1: Signs and symptoms

	Key hole craniotomy	Pterional Craniotomy
Altered sensorium	3	8
Headache	13	13
Vomiting	11	12
Hemiparesis	1	3
Seizures	1	3
III cranial nerve palsy	2	2
VI cranial nerve palsy	1	0

patients had GTCS and 3 (23.07%) patients developed hemiparesis. 2 (15.38%) patients in each group had 3rd nerve palsy and 1 (7.69%) patient in keyhole had 6th nerve palsy.

Grading

According to Hunt and Hess grading, [Table 2], In keyhole group 6 (46.15%) patients were in grade 1, 3 (23.07%) patients in grade 2 while 4 (30.76%) patients were in grade 4. While in pterional group 6 (46.15%) patients were in grade 1, 3 (23.07%) patients were in grade 2 and 4 (30.76%) patients were in grade 3.

According to Fisher grading, in keyhole group 1 (7.69%) patient was in grade 1, 5 (38.46%) patient were in grade 2, 6 (46.15%) patients were in grade 3 and 1 (7.69%) patient was in grade 4. While in pterional group 1 (7.69%) patient was in grade 2, 10 (76.92%) patients were in grade 3 and 2 (15.38%) patients were in grade 4.

Table 2: Hunt and Hess grading

	Keyhole Craniotomy	Pterional Craniotomy
Grade I	6	6
Grade II	3	3
Grade III	4	4
Grade IV	0	0
Grade V	0	0

In keyhole group 8 (61.53%) patients underwent surgery from right side and 5 (38.46%) patients underwent surgery from left side while in pterional group 6 (46.15%) patients underwent surgery from right side and 9 (69.23%) patients underwent surgery from left side.

Dura was tense in 4 (30.76%) patients in keyhole group and in 6 (46.15%) patients in pterional group. In keyhole group neck of aneurysm was narrow in 12 (92.30%) patients and was broad in remaining 1 (7.69%) patients, while in pterional group neck was narrow in 11 (84.61%) patients and was broad in 2 (15.38%) patients. In both pterional craniotomy and keyhole craniotomy access was adequate in all the patients, and approach did not have to be revised in any patient. Proximal vessel could be prepared for temporary clipping in all patients. Before approaching anterior communicating artery aneurysms, bilateral A1 and A2 could be dissected and visualized and the contralateral A1 could be prepared if required without any difficulty. Wide lysis of arachnoid and release of CSF was the key to exposure of the parent vessel, vital structures and dissection of aneurysm. Aneurysm was exposed as the last step after the parent vessel had been secured and brain was relaxed. All these aneurysms could be clipped without any difficulty, and the direction of the fundus was of no consequence.

Complete aneurysm was dissected in all 15 (100%) patients, Aneurysm size was between 4 and 15 mm. In both the groups two (15.38%) patients has intraoperative rupture at the time of neck dissection and was tackled without any problem.

In keyhole craniotomy temporary clip was applied in 10 (76.92%) cases, while in pterional group temporary clip was applied in 6 (46.15%) cases.

The association between both groups and no of times clip applied is not significant (p value- 0.1432). Average timing of clipping in both the groups was 286.6 seconds and 120 seconds respectively which was not statistically significant (p value- 0.4813)

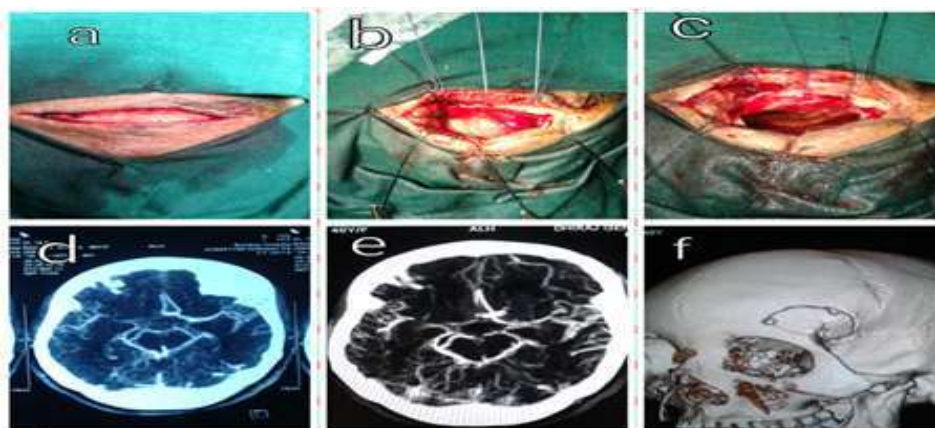


Image 1: lateral supraorbital subfrontal keyhole approach

(a) Eyebrow incision, (b) after durotomy (c) after cysternotomy and csf drainage (d) c.t angiography showing A-com aneurysm, (e) post-op c.t. angiography showing clip, (f) post-op 3D c.t. skull bone showing craniotomy defect of keyhole approach.

In keyhole group intraoperative rupture of aneurysm occurred in 1 (6.67%) patient after the application of permanent clip and in another patient during dissection. In pterional group intraoperative rupture occurred in 2 (13.34%) patients during dissection.

Duration of surgery in keyhole group ranged from 120 minutes to 300 minutes (mean - 173 minutes), while in pterional group duration ranged from 105 minutes to 240 minutes (mean - 167.66 minutes) which is not statistically significant. (p value- 0.8468).

Amount of blood loss in keyhole group was ranged from 80-160 ml (mean 112.3 ml) and in pterional group it ranged from 100-200 ml (mean 134.3 ml) which was not statistically significant (p value - 0.5478). In Post operative period all patients had undergone c.t scan and c.t angiography. Complete obliteration of aneurysm with preservation of perforators was seen in all patients. There was no evidence of residual neck or vasospasm in any of the patients.

The outcome of key hole craniotomy and pterional group did not have any statistical difference (p value = 1) as Glasgow outcome score of 4 and 5 was observed in all patients. 2 patients of both groups were seen in grade 4 score in immediate post op period which later improved to score 5 in 3 months. however this was also not statistically significant (p value = 0.6349)

Complications

In keyhole group 4 (30.76%) patients developed complications in the form of wound infection in 2 (15.38%) patients and infarct and diabetes insipidus in 1 (7.69%) patient each. In pterional group 1 (7.69%) patient required elective ventilation in immediate post operative period and another developed pneumonia. Further, hemiparesis, infarct, seizures and Diabetes insipidus occurred

in 1 (7.69%) patient each. The association of rate of complication was not significant in both groups (p value- 0.4386) [Table 3].

Functional Outcome was measured in terms of Modified Rankin Scale.

In keyhole group 10 (76.92%) patients had mRS scale 0, 2 (15.38%) patients had mRS scale 1 and 1 (7.69%) patient had mRS scale 2. After 3 months only 1 (7.69%) patients remained in mRS scale 1.

In pterional group 6 (46.15%) patients were in scale 0, 5(38.46%) patients were in scale 1 and 2 (15.38%) patients were in scale 2 after 3 months.

Post operative pain was assessed using a 10 point VAS scale in all 26 patients at the time of discharge and after 3 months of surgery. Average score in keyhole group was 2 which reduced to 1 in 3 months. In pterional group average VAS score was 4 which marginally reduced to 3 at 3 months interval. Score between two groups at the time of discharge was not statistically significant (p value-0.0671), however after 3 months association between two groups was statistically significant (p value-0.001)

In keyhole group 2 (15.38%) patients developed transient frontal numbness which improved over a period of 8 months to 14 months. In pterional group 3 patients (23.07%) reported hypoesthesia behind their scalp incision related to their pterional procedure, 9 (69.23%) patients in pterional group developed temporal muscle atrophy during post operative follow up and 1 (7.69%) patient developed limitation in mouth opening on follow up.

In the pterional group, 10 (76.9%) patients reported unpleasant palpable irregularities around the cranial bone flap due to the burr holes and bone gaps, whereas they were no such complaint for the keyhole procedures, (p = 0.001). For cosmetic results, 9 (69.23%) patients reported cosmetic complaints related to their pterional incision. These complaints included loss of hair along the surgical scar, a disfiguring scar, and anterior

Table 3: Complications

	Keyhole craniotomy	Pterional craniotomy	p value
Complications	4	6	0.4386
uneventful	9	7	
Hemiparesis	1	1	
Seizures	0	1	
Infarct	1	0	
Wound infection	2	1	
Diabetes Insipidus	1	1	
Pneumonia	0	1	
Post op ventilation	0	1	

temporal hollowing. In contrast, only 3 patients (23.07%) reported cosmetic complaints related to their keyhole incision. Therefore, the incidence of cosmetic complaints showed a significant between-procedure difference ($p < 0.001$).

In keyhole group duration of stay ranged from 4 to 17 days (average 9.33 days), while in pterional group duration of stay ranged from 8 to 15 days (average 11.2 days)

Discussion

The pterional approach for aneurysm clipping, which was first described by Yasargil and Fox [21]. It has primary advantage of better view of surgical field, clear exposure of microsurgical anatomy of most of the arteries of anterior circulation. However, the pterional approach also has certain long term some disadvantages, such as possible muscle atrophy, temporal hollowing or pain after the dissection of the temporal region, and cosmetic dissatisfaction due to surgical scarring [7,15]. Hence, the need for a surgical approach that provides the same clear anatomical exposure inspired many neurosurgeons to design various successful and minimally-invasive surgical approaches. In 1971, Wilson and colleagues were able to operate on intracranial lesions through a minimal invasive craniotomies [19]. Studies revealed that these less invasive surgical methods resulted in less tissue damage and decreased cerebral edema compared with existing surgical methods.

In 1978, Brock did anterior circulation aneurysm clipping by minimally invasive frontotemporal craniotomy of 3-5 cm diameter and demonstrated better surgical outcome [3]. In 1982, Jane described the supraorbital craniotomy, which opened the anterior orbital roof, thus required less retraction of brain and good exposure of the cranial structures [10]. A new chapter of minimally invasive cranial surgery was opened by Paladino and colleagues by introducing the concept of the keyhole approach in neurosurgery. However, these authors faced the difficulties with the of limitation of surgical view available at that time [13]. In 1998, van Lindert and colleagues introduced the supraorbital keyhole approach [18]. The transciliary keyhole approach was designed by Paladino [13]. Many other studies described surgical approaches with more advantages than those with the pterional approach, including less invasiveness, shorter operative time, and need for less brain retraction. However, these minimally-invasive surgical methods could not be applied to all patients. First, the supraorbital

keyhole approach itself does not actually decrease the danger and high risk associated with aneurysm clipping surgery, which demands ability to operate through a narrow space [20].

In our study also the average keyhole craniotomy was 3.5 x 2 cm and unintentional exposure of frontal air sinus was noted in 2 (15.38%) out of 13 patients. Unintentional opening of the frontal air sinus during surgery through a supraorbital keyhole craniotomy can increase chances of post operative meningitis [18]. Van Lindert and colleagues performed a supraorbital craniotomy for aneurysm clipping in 139 patients. In their study the average craniotomy size was 2-3.5 cm in width and 1.5-2 cm in height. Some studies emphasized the importance of measurement of the frontal air sinus by imaging prior to the operation [18].

In our study, In keyhole group 2 (15.38%) patients developed transient frontal numbness which improved over a period of 8 months to 14 months. In 2010, Trivedi and colleagues carried out a study of the cranial supraorbital notch and supraorbital foramen in 249 patients. Their results showed that the supraorbital notch was on average 24.30 mm from the center of the cranium [17]. 9 (69.23%) patients in pterional group developed temporal muscle atrophy during post operative follow up. Similar results were reported in other such study by Jaechan Park et al. [22]. The supraorbital keyhole approach provided an straight view of anterior communicating artery aneurysm as compared to the conventional pterional approach. The sylvian fissure presents in the lateral side of surgical window in the supraorbital keyhole approach [23]. In our study, during keyhole approach total 2 (13.34%) patients had intraoperative rupture of aneurysm, 1 patient there was aneurysm rupture after the application of permanent clip and in another 1 patient during dissection. In pterional group intraoperative rupture occurred in 2 (13.34%) patients during dissection. During intra operative rupture 2 suction cannulas were used simultaneously to clear blood from the field. In keyhole approach, use of two suction tubes is challenging in surgery on a intra-op ruptured aneurysm due to the narrow view, and proximal control can be difficult [1,8,11,16].

In our study there was more patient satisfaction in keyhole craniotomy group, in terms of post operative pain and cosmetic look, whereas in pterional group patient reported unpleasant palpable irregularities around the cranial bone flap due to the burr holes and bone gaps, loss of hair along the surgical scar, a disfiguring scar, and anterior temporal hollowing. These differences

were statistically significant. Similar results were reported by Jaechan Park et al. [22].

The limitation of our study is small sample size, not being the randomized study, and the selection bias. In the case of severe brain swelling and huge ICH associated aneurysms, we preferred to select the pterional approach rather than the supra orbital.

Conclusion

In our study there was significantly less amount of blood loss, post operative pain, duration of stay and complications in key hole approach. However the comparative parameters were not statistically significant. The disadvantage of the keyhole approach is the limited working angle.

In conclusion, the supraorbital keyhole approach has advantages of less brain retraction, good visualization of surgical field for A-com aneurysm surgery, short operation time, small skin incision, minimizing temporal muscle manipulation and good cosmetic outcome. Except for cases associated with a large amount of intracerebral hemorrhage and those associated with severe brain swelling, we suggest that the supra orbital key hole approach can be a favorable surgical option.

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