MINIPTERIONAL INTERFASCIAL APPROACH FOR MICROQUIRURGICAL TREATMENT OF RUPTURED AND UNRUPTURED ANTERIOR CIRCULATION ANEURYSMS. INITIAL EXPERIENCE IN THE DOS DE MAYO NATIONAL HOSPITAL IN LIMA - PERU

Abordaje interfascial minipterional para tratamiento microquirúrgico de los aneurismas de la circulación anterior rotos y no rotos. Experiencia inicial en el Hospital Nacional Dos de Mayo de Lima – Perú

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ABSTRAC

Objective: To provide information on the experience in the management of ruptured and non-ruptured aneurysms of the anterior circulation through the minipterional interfascial approach, to describe the technique, clinical, surgical results, complications and advantages.
Methods: A retrospective observational study was conducted, from January to December 2018. Of 59 patients with ruptured and non-ruptured aneurysms, 33 were using a minipterional craniotomy. Clinical variables, location, complications and surgical results were analyzed.
Results: In total, there were 33 patients operated by a minipterional craniotomy, 35 aneurysms were clipped: 14 MCA (40%), 13 PComA (37%), 6 AComA (17%), 1 bifurcation of ICA (2%), 1 Choroid artery (2%). Of the total, 11 were men (33%), 22 women (66%). The Hunt and Hess of admission: I in 16 cases (48%), II in 11 cases (33%) and III in 6 cases (18%). There were 3 intraoperative ruptures and 8 radiological clinical vasospasms. Rankin's scale at discharge was: Rankin 0 in 2 patients (6%), Ranking 1 in 11 patients (33%), Rankin 2 in 10 patients (30%), Rankin 3 in 2 patients (6%), Rankin 4 in 1 patient (3%), Rankin 5 in 1 patient (3%) and Rankin 6 in 1 patient (3%).
Conclusions: The Minipterional craniotomy is reliable, less invasive, it maintains the advantages of the pterional approach but avoids greater exposure of the parenchyma and tissue manipulation. Aneurysms of the anterior circulation, ruptured and unruptured, can be treated safely and effectively with limited bone extraction, good cosmetic results and good temporomandibular function.

Keywords: *Intracraneal Aneurysm, Craniotomy, Surgical Instruments. (source: MeSH NLM)*

RESUMEN

Objetivo: Proporcionar información sobre la experiencia en el manejo de los aneurismas de la circulación anterior rotos y no rotos mediante el abordaje interfascial minipterional, describir la técnica, resultados clínicos, quirúrgicos, complicaciones y ventajas.
Métodos: Se realizó un estudio observacional retrospectivo, de enero a diciembre del 2018. De 59 pacientes con aneurismas rotos y no rotos operados, 33 fueron mediante abordaje minipterional. Se analizaron variables clínicas, localización, complicaciones y resultados quirúrgicos.
Resultados: En total, fueron 33 pacientes operados por abordaje minipterional, fueron clipados 35 aneurismas: 14 ACM (40%), 13 AComP (37%), 6 AComA (17%), 1 bifurcación of ACI (2%), 1 arteria coroideo (2%). Del total, 11 fueron hombres (33%), 22 Mujeres (66%). El Hunt y Hess de ingreso: I en 16 casos (48%), II en 11 casos (33%) y III en 6 casos (18%). Hubieron 3 casos de ruptura intraoperatoria y 8 casos de vasoespasmo clínico radiológico. La escala de Rankin al alta fue: Rankin 0 en 2 pacientes (6%), Ranking 1 en 11 pacientes (33%), Rankin 2 en 10 pacientes (30 %), Rankin 3 en 2 pacientes (6%), Rankin 4 en 1 paciente (3%), Rankin 5 en 1 paciente (3%) y Rankin 6 en 1 paciente (3%).
Conclusiones: El abordaje Minipterional, es confiable, menos invasivo, mantiene las ventajas del abordaje pterional, pero evita una mayor exposición del parénquima y la manipulación de tejidos. Los aneurismas de la circulación anterior, rotos y no rotos, se pueden tratar de manera segura y efectiva con extracción limitada de hueso, buen resultado cosmético y buena función temporomandibular.

Palabras clave*: Aneurisma intracraneal, Craneotomía, Instrumentos Quirúrgicos. (fuente: DeCS Bireme)*

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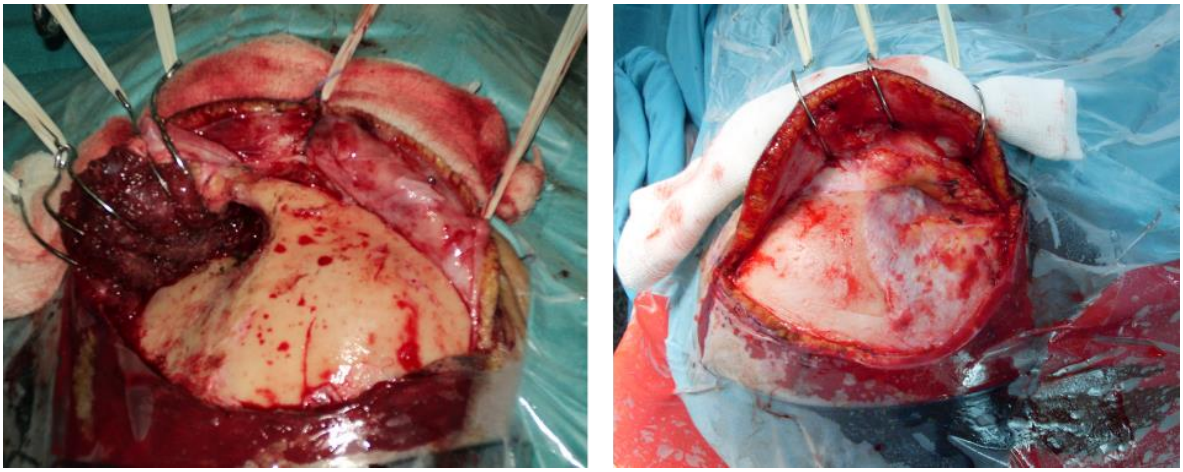


Fig. 1. Classic Pterional Approach showing temporal muscle retraction and wide bone exposure.

The classical pterional approach is used for the treatment of cerebral aneurysms [1]. However, it requires a wide incision of the skin and the temporal muscle, being able to bring aesthetic problems, due to temporal atrophy [2]. Due to new radiological techniques, surgery of unruptured aneurysms is on the rise and with a tendency to reduce surgical complications. To address this problem, minimally invasive techniques have been introduced [3, 4].

Pterional craniotomy provides optimal microscopic exposure and allows ample workspace for intracranial structures, considered the standard method for the treatment of cerebral aneurysms [5] (**Fig. 1**)

Undoubtedly, surgical clipping is the best treatment option with the lowest probability of recurrence. However, endovascular treatment also gained popularity due to its lower invasion and procedure time [6].

Fig. 2. Minipterional Approach: Curvilinear incision 1 cm above the zygomatic arch and 1 cm inside the external auditory canal that extends to the superior temporal line and behind the hair implantation edge.

The pterional approach is associated with morbidity, such as lesions of the frontal branch of the facial nerve, temporal muscle dysfunction, depression of the craniotomy site, opening of the frontal sinus and great skin exposure [7]. With the need to overcome these complications, they have reported several minimally invasive approaches that reduce the size of the craniotomy and improve the aesthetic result; however, in some the exposure is suboptimal [4].

With the advance in microscopic techniques, many surgical modifications have been added to simplify the process [8,6]. Currently, minipterional craniotomy (MPT) and supraorbital craniotomy are used [4, 5,9].

The MPT approach provides advantages over the pterional, without compromising microsurgical exposure, offers minimal trauma to brain tissue, smaller craniotomy, shorter surgical time, better cosmetic results and shorter hospital stays [6]. The present study aims to describe the experience initial in the management of aneurysms of the anterior circulation, ruptured and unruptured by the interfascial minipterional approach.

METHODS

In 2018, a total of 59 patients with aneurysms of the anterior circulation, between ruptured and unruptured, were operated in the Neurosurgery Department of the Dos de Mayo National Hospital, of which in 33 a minipterional interfascial approach (MPT) was performed and in these, 35 aneurysms were clipped. Patients admitted to emergency with ruptured and unruptured aneurysms were included. Posterior circulation aneurysms, large aneurysms, patients with severe endocranial hypertension and with intracerebral hematoma that required a broader approach were excluded.

Data such as age, sex, place of origin, bleeding time, clinical picture at admission, aneurysm characteristics, perioperative complications and surgical results were reviewed. A clinical evaluation was performed at admission, at discharge as well as at the first, third and sixth month. In this evaluation the Glasgow Coma Scale (GCS), the Hunt and Hess Scale (HHS), the modified Rankin Scale (mRS) and the WFNS scale were used.

The location and characteristics of the aneurysms were established by angioTEM and / or angiography, Fisher's grade at admission was recorded. All studies were supervised by neurosurgeons and surgical decision making was based on the consensus of the service, along with the preference of the patient and his family.

Minipterional interfascial surgical technique

The original technique described by Figueiredo et al [4]. After positioning the head, a curvilinear incision of the scalp is made at 1 cm. above the zygomatic arch and 1 cm. of the external acoustic meatus. The incision extends upward and curves until it reaches the upper temporal line and behind the edge of the hairline (**Fig. 2**)

The cutaneous flap is reflected above, lesions in the frontotemporal peripheral branches of the facial nerve are avoided with interfascial dissection [7, 10]. The dissection should extend to the insertion of the upper and deep laminae of the superficial temporal fascia at the upper edge of the zygomatic arch (**Fig. 3 A-C**)

In the temporal muscle and the fascia an incision is made between the superior temporal lines leaving a myofascial cuff to approximate it later, the temporal incision ends at 3 cm. above the swallow, to avoid postoperative chewing symptoms and temporomandibular dysfunction (TMD). The muscle is retracted exposing the pterion by subperiosteal dissection, which presents slight difficulty due to the suture lines of the sphenoid wing [11] (**Fig. 3 D-F**)

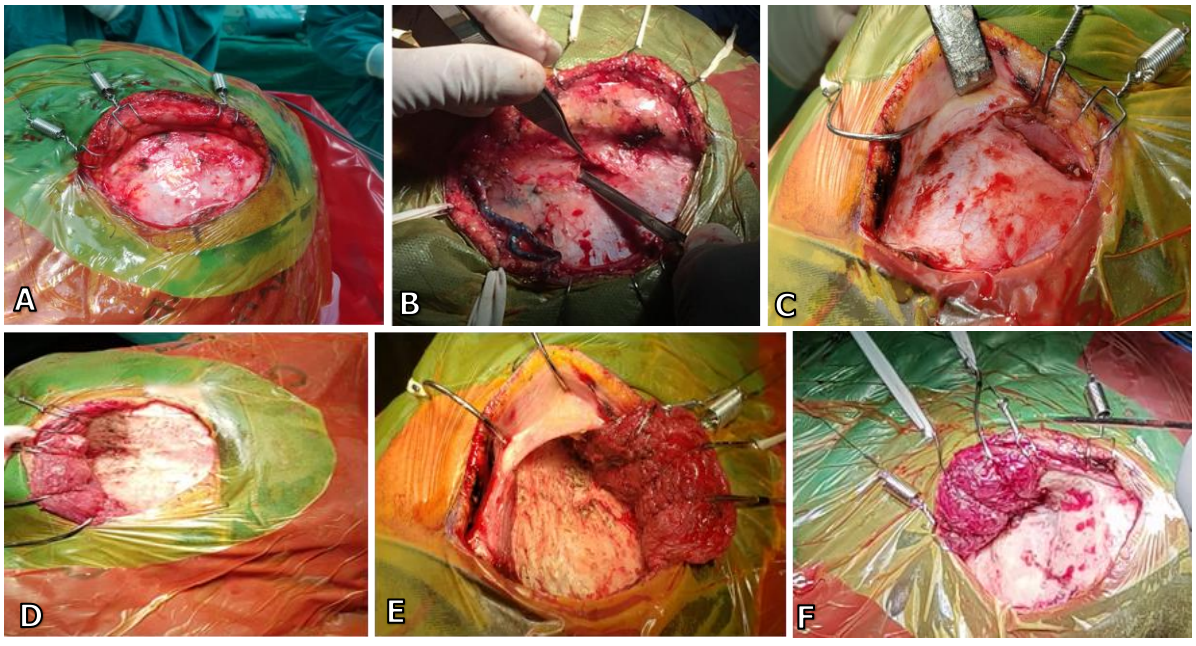


Fig. 3. (A-C) Retraction of the skin flap and interfacial dissection to protect the frontal branches of the facial nerve. **(D-F)** The incision of the temporal muscle ends 3 cm above the tragus to avoid postoperative chewing symptoms and temporomandibular dysfunction. The muscle flap is dissected subperiosteally.

The Keyhole is performed in the pterion, between the sphenophrontal and sphenoescamosal sutures, dissected to the dura and then the craniotomy is performed with the help of the craniotome which is directed up and back towards the stephanion (point where the upper temporal line with the coronal suture). Then it curves down and extends to the pterion. The dimensions of the craniotomy should not exceed 4 cm long or wide (**Fig. 4 A-D**)

Then the sphenoid crest is drilled and flattened. The dura opens semilunarly with the base of the incision toward the supraorbital edge (**Fig. 4 E-H**)

Silvio fissure dissection is exposed and initiated proximally to the optic-carotid and chiasmatic cisterns, this allows CSF drainage and brain relaxation. It is possible to expose the internal carotid (ICA), the middle cerebral artery (MCA), the anterior cerebral artery (ACA) and the anterior communicating artery (AComA) (**Fig. 5 A-D**)

The aneurysm is identified, the neck is dissected, and clipping is performed according to the usual technique. (**Fig. 6**)

Haemostasis is performed followed by duroplasty. The bone platelet is repositioned, the temporal muscle and the fascia rejoin along the muscular cuff. Finally, the closure is made by planes to the skin (**Fig. 5 E-H**)

RESULTS

Our study included 22 women and 11 men between the ages of 30 and 80, with the average age being 55 ± 5 years. 52% of patients were from Lima. The clinical picture at admission was severe headache (100%), vomiting (30%), sensory disorder (45%), hemiparesis (15%), involvement of the III cranial nerve (6%), among others. The most frequent comorbidity in our study was arterial hypertension (49%), followed by obesity and type 2 Diabetes mellitus (**Table 1**).

During 2018, 59 patients with anterior circulation aneurysms were operated in our hospital, finding 64 aneurysms, between ruptured and unruptured. Of these 59 patients, 33 patients were operated through a minipterional interfascial approach, with the clipping of 35 aneurysms: 14 MCA aneurysms (40%), 13 PcomA (37%), 6 AComA (17%), 1 bifurcation from ICA (2%) and 1 choroidal artery (2%).

Table 1. Characteristics of patients with cerebral aneurysm operated by Minipterional craniotomy.

NRO	EDAD MASC.	EDAD FEM.	PROCEDENCIA	COMORBILIDAD	CLINICA	HSA AL INGRESO (DIAS)
1	40		Lima		Cefalea intensa	1
2		70	Lima	HTA	Cefalea intensa	2
3		49	Cajamarca		Cefalea intensa. Transtorno del sensorio, Vómitos.	7
4		49	Lima	HTA, obesidad morbida	Cefalea intensa, vómitos.	9
5	43		Trujillo		Cefalea intensa	7
6	46		Lima	HTA	Cefalea intensa, vómitos.	3
7	40		Lima		Cefalea intensa, vómitos, hemiparesia der.	2
8		70	Lima		Cefalea intensa, transtorno del sensorio	1
9	55		Lima	HTA,HBP. ANEMIA, VHB	Cefalea intensa, transtorno del sensorio	1
10		77	Trujillo	HTA	Cefalea intensa, hemiparesia izq.	23
11		65	Lima	DBT descompensada	Cefalea intensa, transtorno del sensorio, hemiparesia	1
12		61	Sullana	HTA, obesidad morbida	Cefalea intensa, transtorno del sensorio.	15
13		57	Pisco		Cefalea intensa, paresia IIIpar OD	7
14		50	Chimbote	HTA	Cefalea intensa, plejia III par OI	11
15		69	Lima		Cefalea intensa, vómitos, hemiparesia izq.	1
16	32		Lima		Cefalea intensa, vómitos.	5
17		36	Lima		Cefalea intensa, neumonía	7
18		69	Chincha		Cefalea intensa, vómitos, transtorno del sensorio	5
19	34		Lima		Cefalea intensa, vómitos	5
20	60		Huanuco	Acromegalia	Cefalea post trauma, transtorno de conciencia.	3
21		64	Lima	Parkinson	Cefalea subita, transtorno del sensorio	15
22		66	Lima	HTA	Cefalea intensa, transtorno del sensorio	8
23		65	Lima	HTA, Cardiopata.	Cefalea intensa, tranasotorno del sensorio.	1
24	48		Pucallpa		Cefalea intensa, transtorno del sensorio, hemiparesia	9
25	34		Cusco		Cefalea intensa, transtorno del sensorio, afasia.	20
26		77	Trujillo	HTA	Cefalea	1
27		50	Pucallpa	HTA	Cefalea intensa, transtorno del sensorio	3
28		55	Huaraz	HTA	Cefalea intensa	26
29	81		Lima	HTA	Cefalea intensa, transtorno del sensorio	3
30		45	Lima		Cefalea intensa, vómitos	1
31		68	Cajamarca	HTA	Cefalea intensa, vómitos	10
32		56	Piura	HTA	Cefalea intensa, transtorno del sensorio	1
33		49	Cajamarca	ACM,ACoA rotos	Cefalea	1

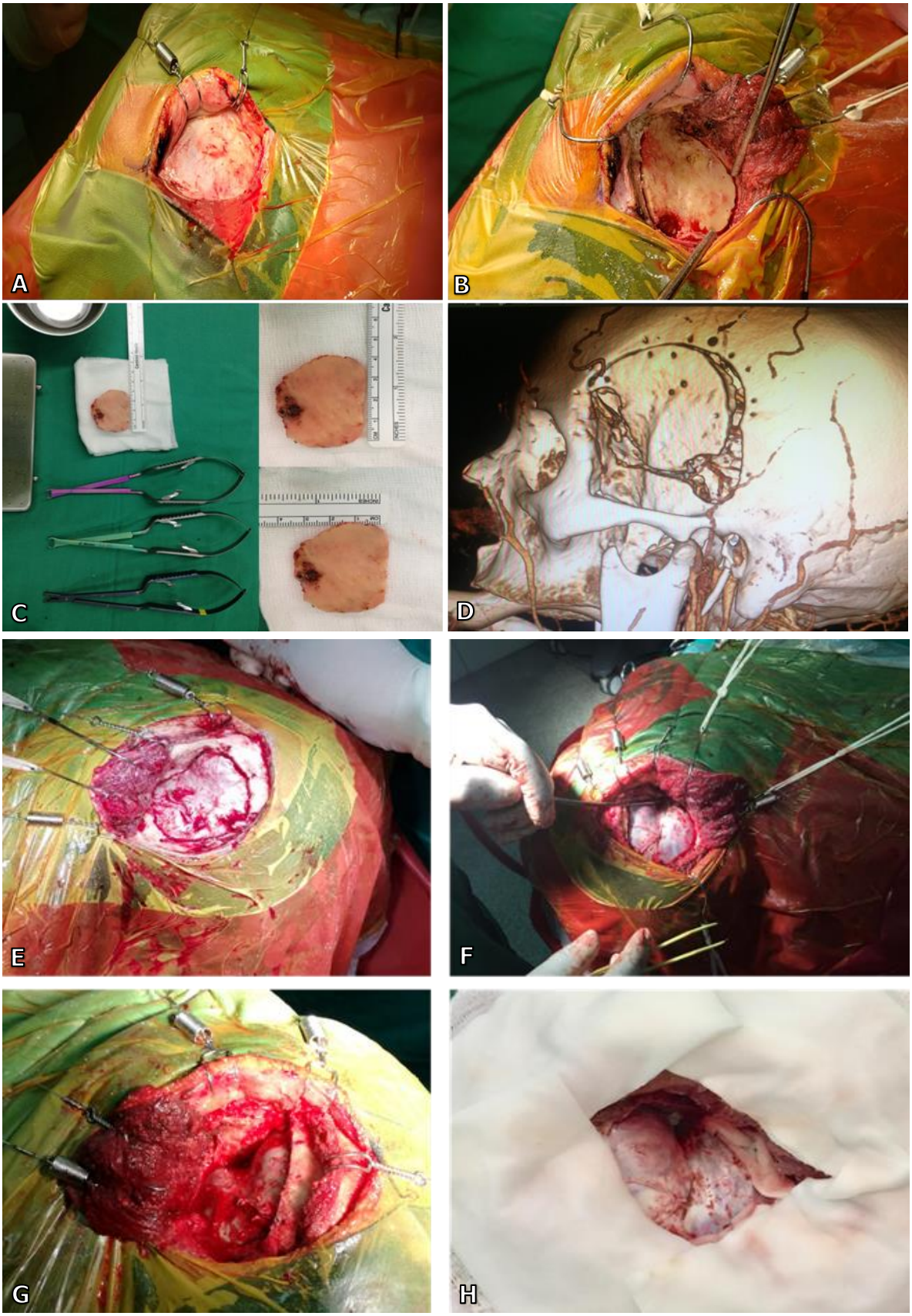


Fig. 4. (**A-D**) Minipterional Craniotomy (E-H) Different cases that show craniotomy and exposure of the dura after drilling of the anterior base where the Silviano valley is visualized.

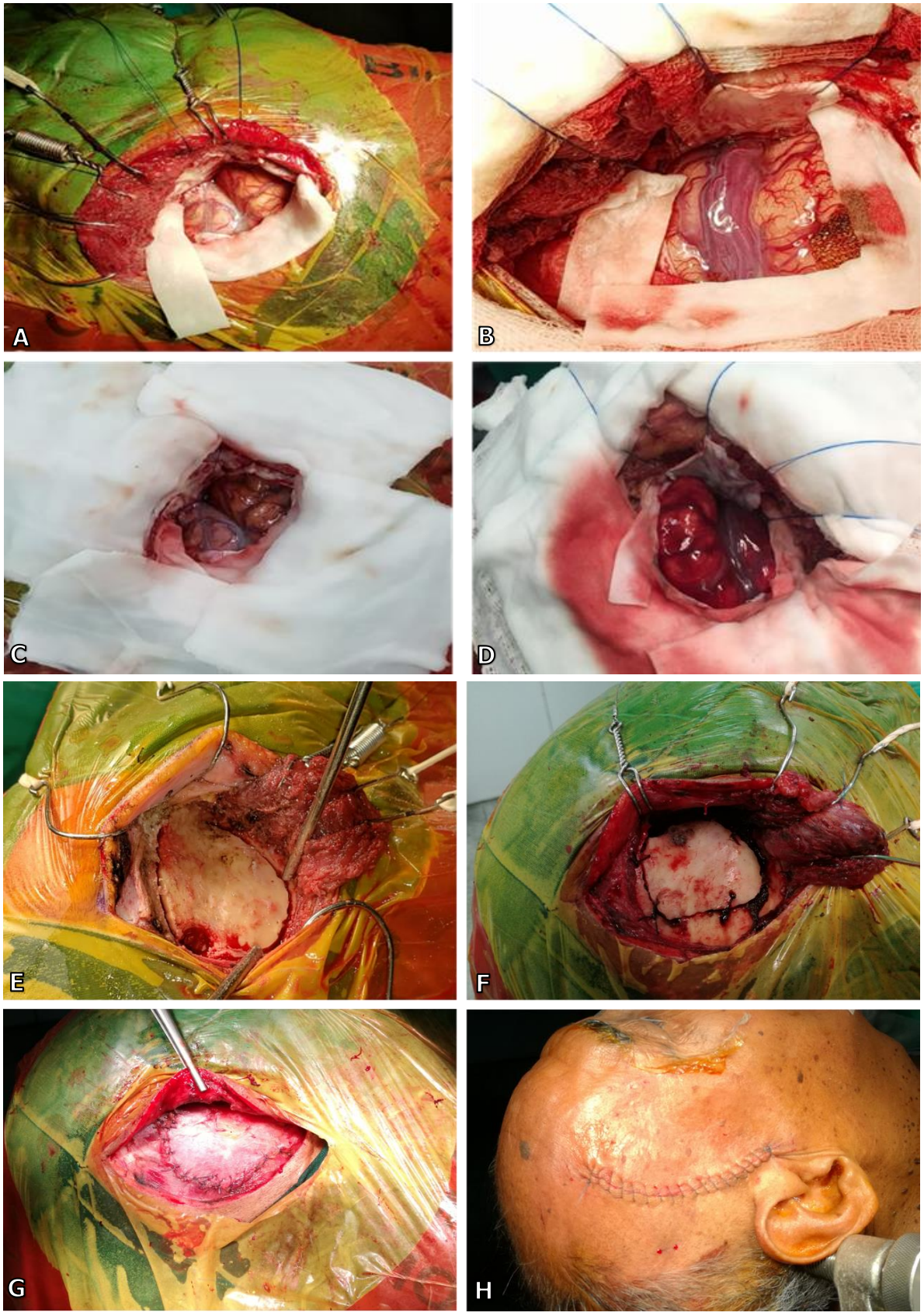


Fig. 5. (A-D) Dural opening, inferolateral exposure of the frontal lobe, Silvio fissure and superior temporal gyrus. Then it is directed towards the dissection of the proximal fissure of Silvio that provides the exposure of the optic-carotid and chiasmatic cistern. (E-H) Cranioplasty, temporal approach and interfascial closure, skin closure.

Regarding the Hunt and Hess admission scale, this was I in 16 cases (48%), II in 11 cases (33%) and III in 6 cases (18%). There were 3 cases of intraoperative aneurysm rupture, 8 cases of radiological clinical vasospasm. Rankin's scale at discharge was 2 patients with Rankin 0 (6%), 11 with Rankin 1 (33%), 10 with Rankin 2 (30%), 2 with Rankin 3 (6%), 1 with Rankin 4 (3%), 1 with Rankin 5 (3%) and 1 with Rankin 6 (3%). (**Table 2**).

As for the post-surgical cosmetic results of the skin wound: 2 patients presented a wound infection which was satisfactorily resolved with antibiotics, 2 patients presented a CSF-containing fistula that improved with medical treatment and lumbar drainage. No patient had chronic pain, temporo-mandibular dysfunction or palpebral ptosis. **Tables 3 and 4** show us the time of surgery and Rankin values during follow-up.

Table 2. Clinical-surgical characteristics, complications and results of patients operated by means of an interfascial Minipterional approach.

NRO	DIAGNOSTICO	FISHER	HH	WFNS	SCG INGRESO	CIRUGIA (DIAS DE HSA)	COMPLICACIONES	VASOESPASMO	CLINICA AL ALTA
1	ACM der. Roto	III	I	I	15	18			SCG:15
2	ACM izquierdo roto , Aneurisma Coroideo izq no roto	III	I	I	15	7			SCG:15
3	ACM Izq roto , Aneurisma ACM der. No roto; Aneurisma ACoA no roto	IV	II	II	13	5	Ruptura intrasop	Clinico - Radiológico	SCG:13, hemiparesia derecha
4	ACoA roto	IV	II	III	13	20			SCG:15
5	ACoA roto	II	I	I	15	15			SCG:15
6	ACoA roto	III	I	II	13	16	Ruptura intrasop	Clinico - Radiológico	SCG:15. Deficit visual OI
7	ACM izquierdo roto	III	II	II	13	12			SCG:15
8	Pcom der. Roto	IV	III	III	13	6			SCG:14
9	ACoA roto	IV	II	II	13	2			SCG:14
10	Pcom der roto; Coroideo Izq no roto	III	III	III	14	10		Clinico - Radiológico	SCG;14, hemiparesia izq.
11	ACM Izq. Roto	IV	III	III	12	14		Clinico - Radiológico	SCG:12, disfasia, hemiparesia der.
12	Gigante Oftalmico Izq. Roto	III	I	I	15	18			SCG:14, hemiparesia der.
13	Pcom der. roto	III	II	II	14	8			SCG:15, paresia III OD.
14	Pcom Izq. Roto	IV	II	I	15	1			SCG:15.
15	Pcom der. roto	IV	I	I	15	14			SCG:15
16	Pcom der. roto	III	I	I	15	18			SCG:15
17	Pcom der. roto	IV	II	II	14	26	Ruptura intrasop	Clínico - Radiológico	Coma- Muerte
18	Pcom der. Roto	II	II	II	14	4		Clínico - Radiológico	SCG:15, hemiparesia 4/5 izq.
19	ACM der. Roto	III	I	I	15	2			SCG:15
20	ACM Izq. roto	III	II	II	14	17			SCG:15
21	ACM Izq roto	II	I	I	15	15			SCG:15
22	Pcom izq. roto	III	I	I	13	3			SCG:15
23	Pcom der. Roto	III	I	I	15	12		Clinico - Radiológico	Coma
24	ACM Izq. roto	IV	II	II	13	1			SCG:14, hemiparesia der. 4/5, Sd Terson
25	ACM Izq. Roto; Pcom Izq. no roto	III	III	III	14	5			SCG:15
26	Coroideo Izq. no roto	III	I	I	15	5			SCG:14
27	ACI bifurcación derecho roto	III	I	I	15	21			SCG:14. hemiparesia izq.paresia III OD
28	ACM der. Roto	III	I	I	15	22			SCG:15
29	Pcom der. Roto	II	II	II	12	4			SCG:13
30	ACoA roto; ACM der. No roto; ACho der no roto.	II	I	I	15	3			SCG:15
31	Pcom der. roto	III	III	III	13	2		Clinico - Radiológico	SCG:13
32	ACM der. Roto	IV	III	III	15	2			SCG:15
33	ACM der. no roto	II	I	I	15	3			SCG:15

Figura 6. Microsurgical view of aneurysm clipping through a minipterional approach.

DISCUSSION

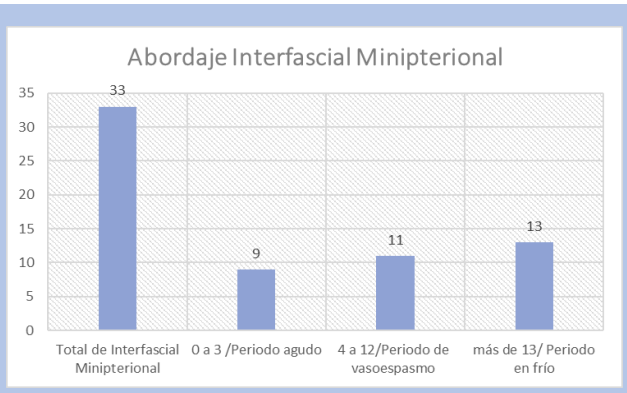
Many pose the balance between maximizing exposure and minimizing the degree of brain manipulation. Yaşargil said: "It would be ideal if the brain could remain completely intact while dissection and clipping is performed. Therefore, a craniotomy must take advantage of natural planes and spaces to expose the base of the brain without significant retraction" [12].

Pterional craniotomy is performed for vascular lesions, tumors of the sellar and parasellar region, the sphenoid wing and the cavernous sinus; it allows an adequate approach [13,14]. It provides excellent exposure but is associated with a variety of complications, facial asymmetry, depression of the temporal fossa, TMJ dysfunction, risk of injury to the facial nerve branches and exposing large areas of cerebral cortex [15,16].

A minipterional craniotomy according to Figueiredo et al.; represents a balance between size, extent of temporal muscle dissection, division of Silvian fissure and microsurgical exposure "[12].

We observe that the minipterional craniotomy provides planes that allow the preservation of the temporal muscle, prevents injury to the facial nerve branches, minimizes exposure and manipulation of the parenchyma, aesthetically with better results, reduces the risk of lesions in the superficial temporal artery, reduces postoperative temporal atrophy and facial asymmetry [17].

Table 3. Shows the time elapsed from the moment of bleeding until the time of surgery with the minipterional approach



In minipterional craniotomy the exposure time is shorter compared to pterional craniotomy, these relatively shorter periods of muscular ischemia make the muscle less vulnerable to ischemic atrophy [18]. Since the muscle incision ends 3 cm above the joint pain, the limitation for chewing, symptoms of malocclusion and difficulties in lateral movement of the jaw are also avoided from the swallow 18.

In the minipterional craniotomy, the frontal sinus does not open, which reduces the risk of fistula and postoperative infection. The use of retractors is avoided, which also means less edema and bruising. What is sought is to have an area necessary for dynamic retraction.

Tabla 4. Neurological assessment with WFNS and modified Rankin Scale (mRS) at 1m, 3m and 6m follow-up.

	WFNS		mRS				
			Score	Alta	1 mes	3 meses	6 meses
					n=33	n=33	n=33
Score	Ingreso n=33	Alta n=33	0	2	7	11	15
			1	16	16	15	12
I	16	20	2	10	7	4	4
II	10	5	3	2	0	1	0
III	7	5	4	1	2	1	1
IV	0	1	5	1	0	0	0
V	0	2	6	1	1	1	1

CONCLUSION

We conclude by showing the results of our initial experience in the management of ruptured and unruptured anterior circulation aneurysms, through minimally invasive techniques, the revision of the surgical technique used in the 33 operated cases and the clinical results evaluated at 6 months suggests that the inter-facial mini-territorial approach offers a reliable alternative.

The interfascial minipterional approach offers a smaller craniotomy compared to the classic pterional approach, with less tissue trauma, adequate vascular anatomical vision and the possibility of microsurgical clipping, with an excellent aesthetic result and temporal muscle function.

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Disclosures
The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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