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ORIGINAL RESEARCH

Endovascular treatment for acute basilar artery occlusion: descriptive analysis of the experience in a comprehensive stroke centre

Ignacio Saldaña-Inda[1,*], Herbert Tejada-Meza[1,2,3], Alberto Sainz-Pardo[4], Cristina Moreno-Loscertales[1], Javier Marta-Moreno[1,3]

[1]Stroke Unit, Department of Neurology. Hospital Universitario Miguel Servet, Zaragoza, Spain
[2]Interventional Neuroradiology Unit, Department of Radiology. Hospital Universitario Miguel Servet, Zaragoza, Spain
[3]Instituto de Investigación Sanitaria de Aragón (IISAragón), Zaragoza, Spain
[4]Department of Anaesthesia, Hospital Universitario Miguel Servet, Zaragoza, Spain

***Correspondence**
inakisaldana@gmail.com
(Ignacio Saldaña-Inda)

Abstract

Objectives: To describe the clinical and epidemiological characteristics of patients with basilar artery occlusion (BAO) treated with mechanical thrombectomy (MT) in Aragón, and to compare its anaesthetic management, technical effectivity, security, and prognosis with those of anterior circulation.

Methods: 322 patients from the prospective registry of mechanical thrombectomies from Aragon were assessed: 29 with BAO and 293 with an anterior circulation large vessel occlusion. Baseline characteristics, procedural, clinical and safety outcomes variables were compared.

Results: Out of 29 patients with BAO that underwent endovascular therapy (62.1% men; average age 69.8 $\pm$ 14.05 years) 18 (62.1%) received endovascular therapy (EVT) alone and 11 (37.9%) EVT plus intravenous thrombolysis. Atherothrombotic stroke was the most common etiology (41%). The BAO group had longer Door-to-groin (160 vs 141 min; $P = 0.043$) and Onset-to-reperfusion times (340 vs 297 min; $P = 0.005$), and higher use of general anaesthesia (60.7% vs 14.7%; $P < 0.01$). No statistically significant difference was found for Procedure time (60 vs 50 min; $P = 0.231$) nor the rate of successful recanalization (72.4% vs 82.7%; $P = 0.171$). Functional independence at 90 days was significantly worse in the BAO group (17.9% vs 38.2%; $P < 0.01$).

Conclusions: Patients with basilar artery occlusion had higher morbimortality despite similar angiographic results. Mechanical thrombectomy for BAOs is a safe and effective procedure in selected patients. A consensus about the effect of anaesthesia has yet to be reached, for BAO general anaesthesia remains the most frequently used technique.

Keywords

Mechanical thrombectomy; Acute stroke; Basilar artery occlusion; Aragón; Posterior circulation; General anaesthesia

1. Introduction

Cerebrovascular accident or stroke remains a leading cause of disability and death in the world. It has been reported as the second cause of death, and the first one for disability in adults [1]. Both the logistics of its treatment and the aftercare are cornerstone challenges for health services across the globe.

Posterior circulation strokes are defined by the occlusion of the posterior circulation arteries: vertebral, basilar, and/or posterior cerebral arteries, and their branches. They comprise 20% of all ischemic strokes. Particularly interesting are basilar artery obstructions (BAO). They comprise less than 1% of all ischemic strokes and 5% of large vessel occlusions, yet their consequences are potentially catastrophic remaining up to 70% of patients with severe disability [2]. Symptoms include loss of consciousness, hemi- and tetraplegia, ataxia, cranial nerves palsies, oculomotor disturbances and even sudden death. Usually they follow a slower, more unspecific course, which delays both the diagnosis and treatment [3].

Mechanical thrombectomy is a proven therapy for anterior circulation strokes (ACS), supported by several randomised clinical trials [4]. That is, however, not the case in posterior circulation strokes, where we are lacking clinical trials that assess the efficacy and security in comparison with the current reference treatment for BAO. Despite that, mechanical thrombectomy is frequently performed in clinical routine and more and more publications report a good security profile and high rates of recanalization when pitted against intravenous thrombolysis [5].

Another aspect to have in mind is the choice of anaesthetic management during the endovascular procedure. It has been suggested that the use of general anaesthesia (GA) is associated with poorer outcomes when compared with conscious sedation (CS) [6]. What is more, data on the kind of anaesthesia used

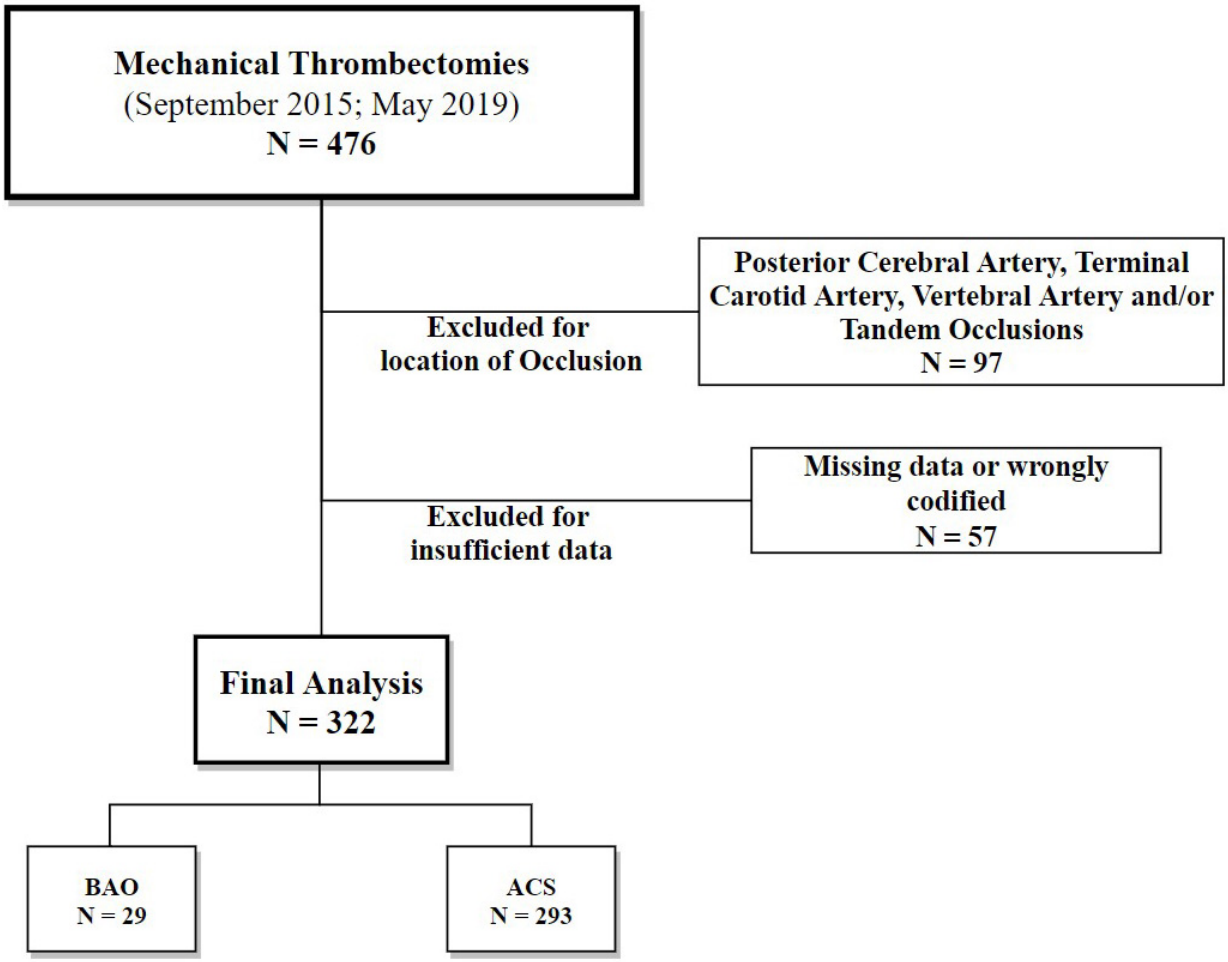

FIGURE 1. Selection and exclusion criteria.

in patients with BAO is rare making it difficult to extract conclusions.

In relation to what has been mentioned above, our aim is to describe the clinical and epidemiological characteristics of patients with a basilar artery occlusion treated with mechanical thrombectomy in Aragón, and to compare its technical effectivity, security, and prognosis with those of anterior circulation. Anaesthetic management will also be compared.

2. Methods

Data for this work was extracted from the prospective registry of mechanical thrombectomies conducted in the health area of Aragón. An observational, analytic design was followed. The study population included consecutive patients from February 2015 to May 2019.

Patients were divided into the BAO group and the ACS group. BAO group included patients with basilar artery obstruction confirmed by computed tomography angiography or magnetic resonance angiography. ACS group encompassed patients with an occlusion located at the middle cerebral artery (M1 and M2 segments) or anterior cerebral artery. Exclusion criteria for the analysis were occlusion at the posterior cerebral artery, terminal carotid artery and/or tandem occlusions.

Mechanical thrombectomy followed a stent-retriever first strategy. The Solitaire stent-retriever model was employed (Solitaire FR/Platinum/X; Covidien-Medtronic, Irvine, California, USA). Angioplasty use was left to the discretion of the neurointerventionalist.

Epidemiological variables included age, gender, cardiovascular risk factors, previous functional status (scored by the modified Rankin scale) and history of stroke. Studied cardiovascular risk factors were hypertension, diabetes mellitus, dyslipidemia, atrial fibrillation, smoking status and excessive alcohol consumption. Stroke aetiology was classified by Trial of ORG 10172 in Acute Stroke Treatment (TOAST) classification [7]. Neurological deficit was evaluated by the NIHSS scale (National Institutes of Health Stroke Scale) at admission and 24 h later. As per our region protocol, intubated patients at the moment of assessment were assigned the highest possible score of 42.

Door-to-groin times (DTG - time from hospital arrival to groin puncture), procedure times (PT), and onset-to-reperfusion times (OTR) were obtained. The use of general anaesthesia and pre-treatment with intravenous thrombolysis before MT (bridging therapy) were registered. Clinical effectiveness was measured with the modified Rankin Scale (mRS) at 90 days. Favourable functional outcome (functional independence) was defined as a mRS score of 2 or less. Technical efficacy outcomes for recanalization were defined by a modified Treatment in Cerebral Infarction score (mTICI) of 2b-3. Safety outcomes measures included

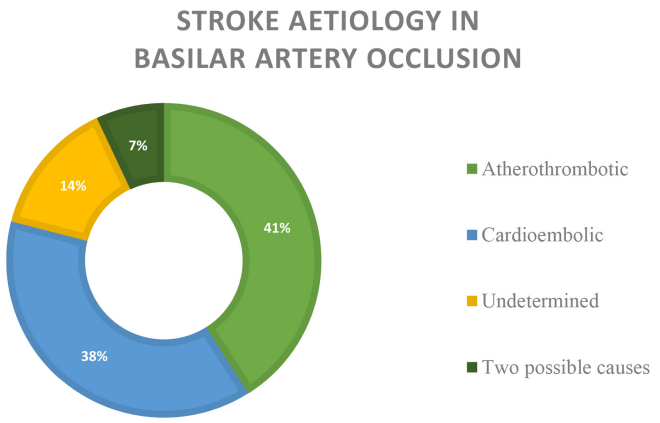

FIGURE 2. Aetiological distribution of ischemic stroke secondary to basilar artery occlusion (TOAST criteria).

rate of death within 90 days and rate of symptomatic intracerebral haemorrhage at 48 hours (sICH), as confirmed on neuroimaging (CT or MRI).

For our statistical analysis, we compared baseline, clinical, procedural, and safety variables between the BAO and the anterior circulation large vessel occlusion groups. Dichotomous variables were compared with the Pearson χ^2 test or Fisher exact test, as appropriate, and presented as proportions. Normally distributed continuous variables were compared using Student's t test and presented as mean $\pm$ standard deviation. Mann-Whitney U test was employed for continuous variables without a normal distribution and presented as their median and interquartile range (IQR). Test of hypotheses were 2-sided. Significance level was set to $P < 0.05$. SPSS 26.0 (IBM) and R-Studio 1.3.1 (R-version: 4.0.2) were used for the statistical analysis. Figures and tables were drawn using the Excel 365 package (Microsoft).

3. Results

The prospective registry of mechanical thrombectomies from Aragon included 476 patients from September 2015 to May 2019. 97 patients were excluded from our study due to the location of the occlusion and 57 due to data loss or lack of follow-up. 322 patients were screened, 29 with BAO and 293 with an anterior circulation large vessel occlusion (Fig. 1). In 181 patients (62.85%) occlusion was located at the M1 segment of the middle cerebral artery, 98 (34.03%) at the M2 segment, and in 9 patients (3.13%) at the anterior cerebral artery.

Out of 29 patients with BAO that underwent endovascular therapy 62.1% were men (average age 69.8 $\pm$ 14.05 years). In this group 18 (62.1%) patients were treated with endovascular therapy alone, whereas 11 (37.9%) were treated with EVT plus intravenous thrombolysis. Atherothrombotic stroke was the most common etiology (41%) (Fig. 2). Angioplasty was performed in 6 patients (20.7%). Use of angioplasty had no effect in functional independence at 90 days (40% vs 14.3%; $P = 0.190$), rate of successful recanalization (66.7% vs 71.4%; $P = 0.822$) nor OTR times (461.40 vs 426.84 min; $P = 0.241$), PT was significantly longer (131 vs 70.05 min; $P = 0.014$). Arterial hypertension was the main cardiovascular risk factor (75.9%) followed by dyslipidemia (55.2%). Statistical analysis found no significant difference between the two groups regarding gender, age, hypertension, diabetes mellitus, dyslipidemia, atrial fibrillation, smoking status or excessive alcohol consumption (Table 1). A significant difference of history of stroke was found (3.4% vs 21.6%; $P = 0.020$). Compared to the anterior circulation group, patients in the BAO group had higher NIHSS score at presentation (19 vs 17; $P = 0.014$). Age was the only normally distributed variable.

Table 2 shows clinical, procedural and safety variables of the two groups compared. Patients in the BAO group had longer DTG (160 vs 141 min; $P = 0.043$) and OTR times (340 vs 297 min; $P = 0.005$). No statistically significant difference was found for the PT (60 vs 50 min; $P = 0.231$) nor the rate of successful recanalization (72.4% vs 82.7%; $P = 0.171$). Use of general anaesthesia versus conscious sedation was significantly higher in the BAO group (60.7% vs 14.7%; $P < 0.01$). Regarding safety outcomes, both mortality at 90 days and mortality within hospitalisation was higher in the BAO group (46.4% vs 5.8%; $P < 0.01$). No symptomatic intracerebral haemorrhage was reported in the BAO group while 7 in the ACS group, this difference was non-significant.

Analysis of the effectiveness outcome showed lower functional independence at 90 days in the BAO group (17.9% vs 38.2%; $P < 0.01$) (Table 2). Fig. 3 illustrate the distribution of mRS score at 90 days for both groups. It is remarkable the higher proportion of patients with a mRS score of 5 or 6 in the BAO group (11% and 46.43%). Analysing non-dichotomized data, the median 90-day mRS score was 5 (IQR: 0-6) in the BAO group and 2 (IQR: 0-6) in the ACS group ($P < 0.001$; Table 2).

4. Discussion

Our work is the first to analyse strokes secondary to basilar artery occlusion in our region. This subtype of strokes is relatively uncommon (less than 30 patients in our whole registry), yet they entail a significant morbimortality. Despite being treated with mechanical thrombectomy (successful recanalization rate of 72.4%), long-term prognosis remained poor: less than 18% of patients were functionally independent at 90 days and the mortality rate at 90 days was over 45%.

Looking at the procedural variables, DTG and OTR times are significantly longer in BAO strokes. This does not come as surprise for several reason. First, compared with anterior circulation stroke, patients with a posterior circulation stroke are often harder to diagnose. Symptoms are plenty and can start like vague unspecific complains of unsteadiness or dizziness [2]. This is the reason why seeking for medical attention and the time needed to reach a diagnosis are delayed. Secondly, traditional imaging techniques such as computed tomography and neurosonology yield poorer results in posterior circulation strokes than in their anterior counterparts [8]. And third, time window eligibility for endovascular therapy in posterior circulation artery occlusion is longer [9]. That means when comparing time registries, the BAO group will contain patients with longer times than the ACS group. Those patients wouldn´t have been eligible for endovascular treatment had they had an anterior circulation occlusion. In addition, it should be noted

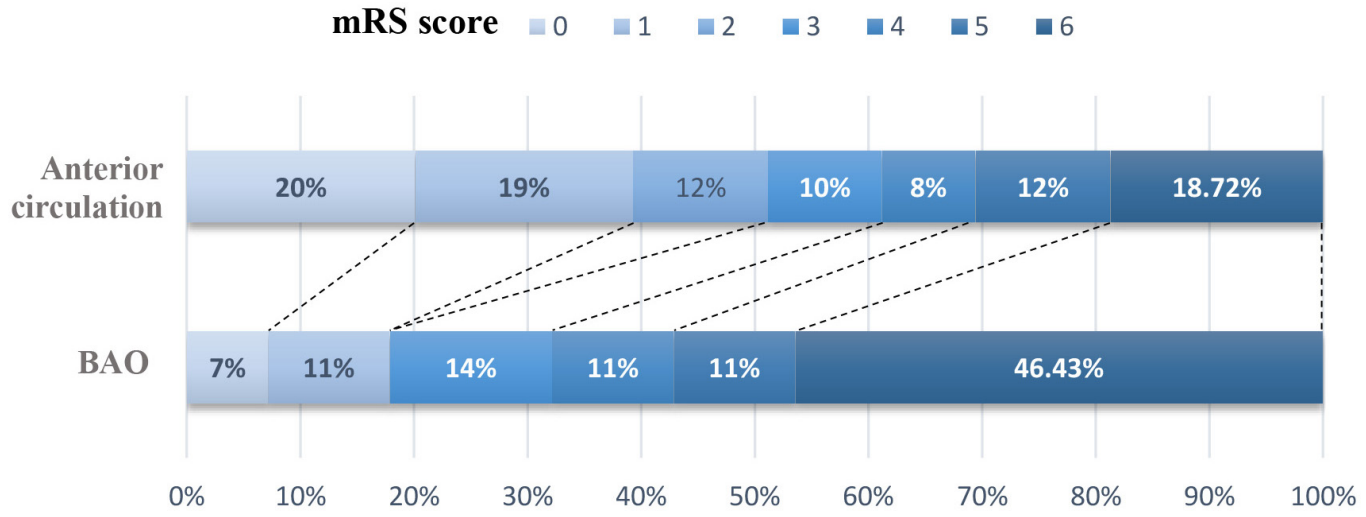

FIGURE 3. Functional outcome at 90 days (mRS).

TABLE 1. Baseline characteristics.

	Total (n = 322)	BAO (n = 29)	ACS (n = 293)	*P*-value
Gender				
Men (%)	160 (51.1)	18 (62.1)	142 (50)	0.216
Age (years)				
Average (SD)	73.2 (12.3)	69.8 (14.03)	74.08 (12.1)	0.088
Smoking				
(%)	56 (17.4)	7 (24.1)	49 (16.7)	0.315
Alcohol				
(%)	13 (4)	2 (6.9)	11 (3.8)	0.412
Dyslipidemia				
(%)	152 (50)	16 (55.2)	136 (49.5)	0.558
Diabetes mellitus				
(%)	77 (25.5)	8 (27.6)	69 (25.3)	0.786
Arterial hypertension				
(%)	206 (67.5)	22 (75.9)	184 (66.7)	0.314
Atrial fibrillation				
(%)	147 (53.6)	14 (48.3)	133 (54.3)	0.539
History of stroke				
(%)	62 (20)	1 (3.4)	61 (21.6)	**0.020**
NIHSS score at admission				
Median (IQR)	16 (0-42)	19 (4-42)	17 (0-28)	**0.007**

Bold indicates statistically significant findings.

that in BAO we often hold a lower threshold for treatment. BAOs are life-threatening lesions that when left untreated carry severe disability or death [10].

When comparing technical and safety outcomes no major differences were found between the BAO and ACS groups. Procedure times, successful recanalization's rate and haemorrhagic complications were alike. These findings were consistent with previously published works: a recent metanalysis reported [3] a rate of angiographic successful recanalization (mTICI score 2b-3) of 80%. In addition, we also observed significantly worse functional prognosis and mortality rates in the BAO group, results comparable to previous studies [3, 11, 12]. Several explanations have been postulated: longer reperfusion times, severity of stroke deficits at presentation, as well as the delicate and vital structures located in the area the basilar artery irrigates [2, 13].

In the BAO group we also observed a significantly higher use (60.7%) of general anaesthesia. Data regarding the type of anaesthesia used in patients with BAO is scarce. A recent study about the effect of anaesthesia strategy in the prognosis

TABLE 2. Clinical, procedural and safety variables.

	Total (n = 321)	BAO (n = 29)	ACS (n = 293)	*P*-value
NIHSS at 24 h				
Median (IQR)	7 (0-42)	13.5 (0-42)	7 (0-42)	**0.005**
Use of rTPA				
(%)	169 (52.5)	11 (37.9)	159 (53.9)	0.100
General Anaesthesia				
(%)	60 (18.7)	17 (60.7)	43 (14.7)	**0.001**
Successful recanalization				
(%)	251 (81.8)	21 (72.4)	230 (82.7)	0.171
Door-to-groin time (min)				
Median (IQR)	144 (22-1084)	160 (61-1084)	141 (22-392)	**0.043**
Procedure time (min)				
Median (IQR)	46 (13-300)	60 (14-300)	50 (14-240)	0.231
Onset-to-reperfusion time (min)				
Median (IQR)	295 (102-1285)	340 (169-1285)	297 (102 - 685)	**0.005**
sICHa				
(%)	7 (2.4)	0	7 (2.6)	0.377
Mortality within hospitalisation				
(%)	30 (9.3)	13 (46.4)	17 (5.8)	**0.001**
Mortality at 90 days				
(%)	54 (21.9)	13 (46.4)	41 (18.7)	**0.001**
Functional independence				
(%)	117 (47.4)	5 (17.9)	112 (51.1)	**0.001**
mRS score at 90 days				
Median (IQR)	3 (0-6)	5 (0-6)	2 (0-6)	**0.001**

a: Symptomatic intracerebral haemorrhage at 48 hours.

at 90 days in BAOs found 78% patients with BAO underwent GA [6]. Same study reported patients treated with GA were associated with worse clinical outcomes at 90 days than those treated with CS, though mortality did not differ between groups. It has been hypothesized [14] the increased mortality might be caused by hemodynamic fluctuations and a greater decrease in blood pressure. Another proposed explanation is the greater time required to induce GA. On the other hand, GA has also reported advantages [15], such as reduced procedure time and better control of patient movement. The latter being a risk factor for perforation during the procedure and other complications. This could be one of the reasons why use of GA is higher on BAO compared to ACS, together with higher NIHSS at admission and the use of intubation for airway protection [13]. In contrast, a randomised trial [16] found no difference between the 2 techniques in neurological outcome 3 months after the event, though posterior strokes were excluded from the analysis.

To date evidence supporting MT in posterior circulation strokes is not as abundant as for anterior circulation strokes [5]. Pivotal trials for mechanical thrombectomy excluded patients with posterior circulation strokes [4]. In May 2020 results for the Basilar artery international cooperation study (BASICS) [17] were released. BASICS, a phase III randomised trial, set out to assess efficacy and safety of endovascular therapy versus best medical management alone, that is, thrombolysis. Safety outcomes were satisfactory, not finding differences in mortality or haemorrhage rates between both groups. However, a better-than-expected outcome after best medical management alone caused the trial to be underpowered, thus making it unable to prove better functional outcome at 90 days in the MT group. A sub analysis did find significant differences favouring MT in patients with a NIHS score over 10 at presentations though. Another reason to bear in mind is BASIC registry started back in 2011, the trial randomised patients which were treated with techniques now deemed obsolete such as intra-arterial thrombolysis without mechanical recanalization or the use of first-generation mechanical recanalization devices [18].

Nevertheless, MT for BAOs is frequently performed in clinical routine and the evidence supporting its efficacy and security is ever growing [3, 11, 12]. Recently, one of the largest studies to date [11] reported a good security profile, with post-procedure sICH rates around 7% and angiography recanalization rates as high as 81.7%, similar to our results and to previously published meta-analysis [3, 19]. It has been reported that posterior circulation strokes have lower symp-

tomatic intracranial haemorrhage frequency, possibly due to the anatomic disposition and the procedure characteristics [12, 20]. In our sample no event of sICH was reported, probably due to its limited size. In addition, the same study compared BAOs treated with MT with those treated with fibrinolysis alone and the mortality rates observed were 42% and 71% respectively.

Our study has the limitations inherent of a nonrandomized study. Despite analysing all patients available in our regional register sample size remains limited. BAOs patients not treated with MT were not included in our register, making us unable to compare TM against best medical management alone. We offer a description of its morbimortality compared with ACS for our reference population.

5. Conclusions

The BAO group had higher morbimortality than ACS group despite similar angiographic results. Differences were found in variables related to the diagnostic process (DTG and OTR times), while procedure times, technical effectivity and complication rates were similar. If technical aspects are akin, we should focus on the extra-procedural aspects. That is: prehospital care, prompt recognition of the pathology, medical care after the event (i.e., stroke unit) and organisational and infrastructure changes that ensure a swift handling of these patients.

Our second conclusion is mechanical thrombectomy for BAOs is a safe and effective procedure in selected patients. There is growing evidence supporting its use and in the near future we are looking forward the results of the BAOCHE trial (Basilar Artery Occlusion Chinese Endovascular Trial) [21], which might shed some light on the preferred management for these patients.

Lastly, a consensus about the effect of anaesthesia has yet to be reached. There are conflicting reports regarding its influence on the outcome, yet for BAOs general anaesthesia is the technique most frequently used.

AUTHOR CONTRIBUTIONS

Ignacio Saldaña Inda and Herbert Tejada Meza designed the research study and drafted the manuscript. Ignacio Saldaña Inda collected and analysed the data. Alberto Sainz Pardo, Cristina Moreno Loscertales and Javier Marta Moreno provided help and advice on the discussion. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The institutional review board of Hospital Universitario Miguel Servet and the medical archive department approved this study and the reviewal of clinical records.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article.

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