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Atrial fibrillation with hemodynamic instability after the use of the third dose of adenosine during surgery for 7 intracranial aneurysms: case report

Fibrilación auricular con inestabilidad hemodinámica tras el uso de tercera dosis de adenosina durante cirugía de siete aneurismas intracraneales: reporte de caso

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Palabras clave: Fibrilación Atrial, Adenosina, Aneurisma Intracraneal, Informes de caso, Neurocirugía

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Abstract

Adenosine-induced asystole is a technique that prevents and controls the intraoperative rupture of cerebral aneurysm, facilitating temporary, and/or definitive clipping of the aneurysm. This is the case of a 58-year-old woman who underwent clipping of 7 intracranial aneurysms, who was induced asystole with adenosine 3 times and developed atrial fibrillation with hemodynamic instability after the last dose. Adenosine has been shown to be useful and safe, however, its use should be planned and possible cardiological complications should be considered.

Resumen

La asistolia inducida por adenosina es una técnica que previene y controla la ruptura intraoperatoria de aneurisma cerebral, facilitando el clipaje temporal y/o definitivo del mismo.

Presentamos el caso de una mujer de 58 años intervenida para clipaje de 7 aneurismas intracraneales, a quien se le indujo asistolia con adenosina en 3 oportunidades y desarrolló fibrilación auricular con inestabilidad hemodinámica tras la última dosis.

La adenosina ha demostrado ser útil y segura, sin embargo, debe planificarse su uso y considerar eventuales complicaciones cardiológicas.

Introduction

Intraoperative rupture (IOR) of an intracranial aneurysm is a complication with devastating clinical results. It occurs in up to 60%,[1] during open surgery, and 2% to 5% during in endovascular embolization. Despite the lower incidence of the latter, mortality is of concern.[2]

The development of microneurological surgery has made open surgery a safer technique with better results due to the minimal damage caused. IOR can occur during exposure, dissection, or clipping. The neurosurgeon may opt for proximal temporal occlusion of the vessel,

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decreasing the turgidity of the aneurysm and improving the visualization of the neck to reduce the risk.[3] Yet, this option remains a challenge when visualization of the proximal artery is difficult because of its location and in the case of giant aneurysms.[4]

An adenosine-induced circulatory arrest facilitates temporary clipping in these cases, even serving as an alternative to it before final clipping.[5–7]

Although the available literature has shown it to be a safe and effective technique, here, we report a complication risk in relation to the use of multiple doses.

Clinical case

A 58-year-old female, mestizo, from the Peruvian highlands (2720 masl), with a history of poorly controlled arterial hypertension.

Four months before entering our hospital, she presents an subarachnoid hemorrhage (computerized tomography, Fisher grade 3) and receives conservative management at her local hospital. She was admitted at our hospital with a World Federation of Neurosurgical Societies (WFNS) scale grade 1, and underwent an angiotomography with 3D reconstruction that revealed 7 intracranial aneurysms, 3 on the left side (left posterior communicator [the one that bled], left internal carotid and M1 segment of the left midbrain), and 4 on the right side (right anterior choroid, right posterior communicator, A1 segment of the right anterior cerebral, right midbrain bifurcation).

Clipping surgery is scheduled with open microsurgical technique and adenosine is anticipated in coordination with the neurosurgical team.

Five-lead electrocardiogram, pulse oximetry, temperature, and invasive blood pressure (BP) were monitored. Transcutaneous electrical stimulation patches were placed as a safety measure. Induction and maintenance were performed with propofol, fentanyl, and vecuronium.

After positioning, 2 supraorbital craniotomies were performed on each side for sequential clipping of the aneurysms. Adenosine was used 3 times to promote temporal clipping of the proximal artery in the larger aneurysms.

With 110/60 mm Hg BP and 65 bpm heart rate (HR), an initial bolus of adenosine (18 mg) is administered, achieving asystole for 30 seconds with subsequent recovery of sinus rhythm and renewal of hemodynamics. A second dose was administered 25 minutes later, obtaining asystole for 35 seconds, with spontaneous recovery. The third dose was administered after 30 minutes, achieving asystole for 30 seconds with immediate onset of atrial fibrillation (AF) associated with persistent deep hypotension (Table 1). Electric cardioversion is decided with 100 J, returning sinus rhythm with 75 lpm HR and 95/60 mm Hg BP. There were no more incidents. Total bleeding was 350 cm^3.

Once the surgery is over, the patient goes to the intensive care unit (ICU) in optimal conditions for extubation and postoperative control. Postsurgery electrocardiogram (ECG) and cardiac enzymes were normal. Discharge from ICU was within 24 hours without complications or deficits. Currently, the patient has no cardiological or neurological sequelae.

Discussion

The report could be about the case with most surgically treated aneurysms in a single intervention.[8]

In the presence of 3 large aneurysms at risk of rupture, adenosine was used to soften the aneurysms and improve visualization of the neck.

Adenosine is a nucleoside that binds to the A1 receptor at myocardial level, producing negative chronotropism and dromotropism. It also inhibits atrioventricular conduction and prolongs the refractory period.[9]

Adenosine has been used for 30 years in the treatment of supraventricular tachycardias (0.05–0.1 mg/kg). During surgery, its use dates from 1989, being administered initially as infusion to achieve a sustained hypotension, and later, in high-dose boluses to achieve transitory asystolia.[7]

Bebawy et al found that a dose of 0.34 mg/kg (0.29–0.44 mg/kg) achieved systolic BP < 60 mm Hg for 57 seconds (29–105 seconds).[10] With similar results, Guin et al[11] found that after a dose of 0.24 to 0.42 mg/kg, a drop in systolic BP (<60 mm Hg) and bradycardia (<40 bpm) was

Table 1. Pre-adenosine and postasystole hemodynamic parameters, and asystole and interdose times.

	Pre-adenosine blood pressure (mmHg)	Pre-adenosine heart rate (bpm)	Asystole time (seg)	Interdose time (min)	Post-asystole blood pressure (mmHg)	Post-asystole heart rate (bpm)
1° dose (18 mg)	110/60	65	30	25	90/55	68
2° dose (18 mg)	90/60	60	35	30	80/50	65
3° dose (18 mg)	90/60	70	30	–	65/35*	AF†

Bpm = beats per minute; min = minutes; seg = seconds.
* Persistent blood hypotension.
† Atrial fibrilation with non-registered ventricular response.
Source: Authors.

achieved for 30 to 60 seconds. In our patient the dose used was 0.3 mg/kg, similar to the mentioned series. However, deep hypotension lasted 30 seconds on average.

The administration of adenosine for these purposes is a safe and effective technique; as is demonstrated by Bendok et al in a retrospective work that included 40 patients, where only 2 presented significant postoperative Troponin elevation, both without clinical or echocardiographic record to support acute myocardial alteration. In addition, 5 of the patients included presented transient arrhythmias: 2 with atrial fibrillation, which reversed spontaneously, and 3 with sinus tachycardia and bradycardia in the postoperative period, which reversed completely.[12] Luostarinen et al[13] after analyzing a series of 16 cases, found no early or late adverse events after adenosine administration.

In a comparative retrospective study, Khan et al[14] found no differences in the incidence of heart complications and 30-day mortality, whether or not adenosine was used.

Repeated doses are possible because adenosine does not cause rebound hypertension or tachyphylaxis. Groff et al[15] reported a case in which they used triple doses of adenosine, without complications, for clipping a basilar artery anerurysm. Heppner et al[16] also reported a case of basilar aneurysm administering triple dose, where the death of the patient was not due to adenosine.

In the study by Guinn et al[11], 1 of 27 patients presented prolonged arterial hypotension (5.5 min), requiring chest compressions, after a rapid redose of adenosine without interdose recovery. Deb et al[17] reported a case in which after a second dose, 22 minutes after the first dose, and with previous bleeding of 1.5 L, the patient developed supraventricular tachycardia which progressed to atrial fibrillation with persistent hypotension. This report partially coincides with our finding, with the difference that the complication appeared after a third dose, with an interdose interval of approximately 30 minutes and without significant previous bleeding.

Other studies where more than 1 dose was used have not demonstrated complications.[5,10–13]

The proarrhythmic potential of adenosine can lead to ventricular and supraventricular tachycardias. AF is the most common one, and may be associated with hemodynamic collapse.[18] As in our case, such situations require electrical cardioversion, so the stimulation patches should be placed before surgery and anti-arrhythmic drugs should be available.

There is evidence in aortic aneurysm repair that adenosine may trigger transient changes in the ST segment.[19] This complication has not been reported in intracranial aneurysm surgery; however, it is appropriate to follow-up postoperatively with electrocardiogram controls and cardiac enzymes.

Conclusion

Adenosine has been proven to be effective and safe in aneurysm surgery; however, its use should be planned from the pre-operative stage and possible cardiological complications should be considered.

Recommendations

The possible use of adenosine should be planned from the pre-operative stage to anticipate possible scenarios.

More extensive studies are recommended to assess the safety of adenosine.

The patient's perspective: The patient knew the magnitude of her illness and the possible strategies from the pre-operative stage. The results were satisfactory. She currently carries out her activities as before, with no sequelae associated to the treatment.

Ethical responsibilities

Protection of humans and animals: The authors state that no human or animal experiments have been carried out for this research.

Data confidentiality: The authors state that they have followed their workplace protocols on the publication of patient data.

Right to privacy and informed consent: The authors state that no patient data appears in this article. The patient freely gave informed consent.

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Conflict of interest

The authors declare that they have no conflict of interest.

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