ANDES PEDIATRICA
REVISTA CHILENA DE PEDIATRÍA
www.scielo.cl

Andes pediatr. 2025;96(2):268-276
DOI: 10.32641/andespediatr.v96i2.5458

CLINICAL CASE

# Perioperative management of hypertensive emergency in a patient with new onset of pheochromocytoma

## Manejo perioperatorio de emergencia hipertensiva en paciente con debut de feocromocitoma

**Gianfranco Tomarelli R.[a], Alejandro Donoso F.[a], Camila Ampuero A.[a], Ignacio Morales G.[b], Dagoberto Morales T.[c]**

[a]Unidad de Paciente Crítico Pediátrico, Hospital Clínico Dra. Eloísa Díaz I. La Florida. Santiago. Chile
[b]Servicio de Anestesiología, Hospital Clínico Dra. Eloísa Díaz I. La Florida. Santiago. Chile.
[c]Universidad Diego Portales. Santiago, Chile.

Received: September 16, 2024; Approved: December 16, 2024

**What do we know about the subject matter of this study?**

Pheochromocytoma in pediatric patients may occur in genetic disorders such as Von Hippel-Lindau disease. It can potentially lead to a lethal hypertensive emergency caused by the effects of excessive catecholamine release.

**What does this study contribute to what is already known?**

Meticulous preoperative medical preparation is essential for a successful intraoperative and postoperative course. Optimal perioperative pharmacologic control of blood pressure and heart rate is essential.

## Abstract

Pheochromocytoma is a rare neuroendocrine tumor in pediatrics. It usually appears in the context of a genetic syndrome and is a potentially curable cause of secondary arterial hypertension. Perioperative management of blood pressure (BP), as well as other clinical aspects, is a challenge for the health team. **Objective:** To emphasize therapeutic particularities specific to Intensive Care and perioperative care of patients with pheochromocytoma. **Clinical Case:** An 8-year-old schoolboy with a one-year history of headache associated with precordalgia and hyperhidrosis. He was hospitalized for hypertensive emergency secondary to a confirmed diagnosis of right pheochromocytoma. Six weeks later, a successful laparoscopic adrenalectomy was performed after alpha adrenergic blockade with doxazosin associated with propranolol and calcium antagonists. Von Hippel-Lindau disease (type 2C) was confirmed, heterozygous variant c.482G>A in the VHL gene. The patient had an uneventful evolution until the time of follow-up, one year after surgery. **Conclusion:** BP control is crucial prior to surgery, with α1 adrenergic blockers and calcium channel antagonists being the fundamental therapeutic measures. β-blockers are reserved for the management of secondary tachycardia. Intraoperatively, it is essential to be prepared for variations in heart rate and BP both during anesthetic induction and tumor manipulation.

**Keywords:**
Pheochromocytoma;
Von Hippel-Lindau disease;
Arterial hypertension;
Catecholamines;
Metanephrines

Correspondence:
Gianfranco Tomarelli R.
gianfrancotomarelli@gmail.com

Edited by:
Luisa Schonhaut Berman

How to cite this article: Andes pediatr. 2025;96(2):268-276. DOI: 10.32641/andespediatr.v96i2.5458

## Introduction

The prevalence of clinical arterial hypertension (AHT) in children is 3.5%[1] and secondary causes are frequent. Only 6% of them have endocrinological etiology, including pheochromocytoma and paraganglioma[2,3].

Pheochromocytoma is a neuroendocrine tumor located in the adrenal medulla arising from the chromaffin cells of the neural crest cells and commonly secreting one or more catecholamines (epinephrine, norepinephrine, and dopamine), which are responsible for most of the clinical manifestations. Catecholamines are partially or totally converted within the tumor by catechol-O-methyltransferase into inactive metabolites, metanephrines, and normetanephrine. Consequently, the release of active catecholamines into the circulation may be scanty, absent, or paroxysmal.

Although pheochromocytoma is a pathology of very low frequency in the pediatric population, with a prevalence of 0.2 to 0.5 cases per million[3], it is the most frequent endocrine tumor in childhood. Approximately 20% of pheochromocytomas and paragangliomas occur in the pediatric age group[3]. In this population, the highest incidence is found between 11 and 13 years of age with a preponderance of male patients (2:1), with a significant percentage of bilateral involvement and the existence of a genetic mutation, thus up to 80% of pediatric pheochromocytomas are associated with a genetic origin[2,4].

Von Hippel-Lindau syndrome (VHL) is an autosomal dominant inherited disorder characterized by the development of multiple tumors in different organs, including pheochromocytomas, hemangioblastomas, neuroendocrine tumors, and central nervous system tumors, among others. It is caused by mutations in the VHL tumor suppressor gene located on chromosome 3p25-26[5].

Due to surveillance in individuals with VHL syndrome, pheochromocytoma related to this condition is more likely to be detected incidentally by abdominal imaging in asymptomatic individuals with normal levels of blood pressure[2].

The perioperative management of blood pressure (BP), considering the risk of catecholaminergic release secondary to the administration of some drugs and intraoperative tumor manipulation, as well as other clinical aspects of this infrequent pathology, is a challenge for the treating multidisciplinary team.

The objective of this report is to emphasize the therapeutic special characteristics of intensive care and perioperative management of the patient with pheochromocytoma.

## Clinical Case

8-year-old male patient, 28 kg, eutrophic, with no known morbid history, who consulted the emergency department due to occipital headache, photophobia, and drowsiness. The patient's mother reported that in the last year, he had presented episodes of headaches of similar characteristics associated with precordial pain and hyperhidrosis, for which he was prescribed paracetamol.

On admission, the patient had no fever, with blood pressure (BP) 196/120 mmHg, mean arterial pressure 150 mmHg (p95+12, 126/86 mmHg), heart rate 112/min, respiratory rate 24/min, oxygen saturation 100% with ambient air $FiO_2$. Physical examination showed a Glasgow Coma Scale score of 15, mid-systolic murmur II/VI without irradiation, lungs with a normal vesicular murmur, liver under costal ridge, no palpable abdominal mass, firm symmetrical pulses, and normal capillary refill time.

Electrocardiogram showed sinus rhythm, heart rate 110/min, with signs of left ventricular hypertrophy. Initial laboratory parameters showed normal renal function, and normal blood count, without elevation of acute phase reactants. Plasma sodium and potassium 138 and 3.6 mEq/L, respectively. Complete urine analysis without alterations. Urine screening for drug abuse was negative (including amphetamines, tricyclic antidepressants, barbiturates, benzodiazepines, cocaine, methamphetamine, opiates, tetrahydrocannabinoids, methylenedioxymethamphetamine). A brain CT scan (without contrast) showed no findings of pathological significance.

The patient was admitted to the Intensive Care Unit (ICU) for study and antihypertensive therapy was started with continuous infusion of labetalol at 0.36 mg/kg/h, remaining with BP > 95th percentile (p), without involvement of other target organs. Echocardiogram showed a slightly dilated left ventricle, with good biventricular function. Fundus examination was normal. On the second day of hospitalization, a chest CT scan was performed, which showed no pathological findings, and abdominal CT showed a hypervascular right adrenal mass (4x3 cm), compatible with pheochromocytoma (Figure 1). Given this finding, antihypertensive therapy was modified (48 hours after admission) to sodium nitroprusside and doxazosin (α1 blocker) and propranolol was added 24 hours later due to a tendency to sustained sinus tachycardia.

After 5 days, nitroprusside was discontinued, and the patient remained with propranolol, doxazosin, and amlodipine for BP p90 and adequate heart rate. The suspicion of pheochromocytoma was confirmed by urinary metanephrines test which showed: urinary

metanephrines 140 ug/24 hours (NV: 49-408 ug/24 hours), urinary normetanephrines 14,400 ug/24 hours (NV: 31.8-398 ug/24 hours), and 3-Methoxytyramine 949 ug/24 hours (NV: 90-400 ug/24 hours).

The study was extended with brain and spinal cord MRI, which showed no alterations.

The mother indicated that she was unaware of the patient's father's morbid antecedents; however, upon direct questioning in an interview with the paternal grandmother, we obtained the antecedent that two of her daughters and their respective sons had a genetic study confirming VHL disease. A genetic study was performed on the patient (sequencing of the c.482G>A mutation) which was positive for the heterozygous variant in the VHL gene. VHL disease type 2C (pheochromocytoma as the only manifestation of VHL disease) was concluded.

On the 17th day after admission, BP stabilization was achieved. On the 19th day of hospitalization, the patient was discharged asymptomatic, with normal BP, receiving doxazosin (12 mg/day), amlodipine (10 mg/day), and propranolol (90 mg/day) with indication to maintain a diet rich in sodium (3-5 g/day), abundant fluid intake, and relative rest to reduce the risk of orthostatic hypotension.

**Perioperative stages**

***Preoperative management:*** after 3 weeks of outpatient management with α and β, associated with calcium channel blockers, the patient was admitted for elective surgery. He received 0.9% saline infusion (2,300 ml/m$^2$/d) for 48 hours before surgery.

***Intraoperative management (laparoscopic right adrenalectomy):*** the patient entered the operating room awake, calm, and cooperative. Non-invasive BP measurement system (PANI), electrocardiogram DII, saturometer, and depth of anesthesia monitor (Bispectral Index, BIS) were installed. His vital signs were: PANI 152/80 mmHg, heart rate 70 bpm, and $O_2$ saturation 98% with ambient air $FiO_2$. Before pre-oxygenation, anesthesia induction was performed with remifentanil, propofol, and rocuronium. Post induction PANI 125/65 mmHg, heart rate 80 bpm. Before gentle laryngoscopy, nitroglycerin 0.2 mcg/kg/min was administered, and endotracheal intubation was performed. Post intubation PANI 127/70 mmHg, heart rate 85 bpm. Invasive mechanical ventilation was started. A left radial arterial line and ultrasound-guided right jugular central venous catheter (CVC) were placed. To achieve multimodal analgesia and reduce

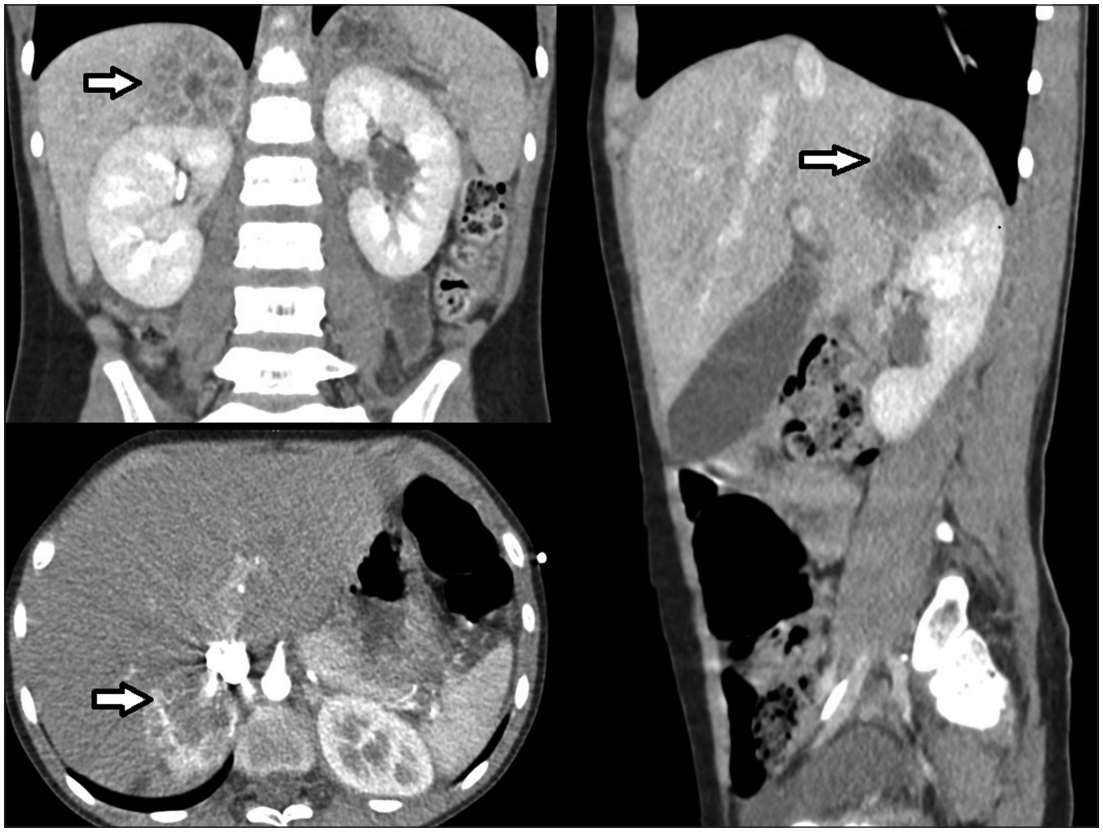

**Figure 1.** Abdominal CT scan. A heterogeneous hypervascular right adrenal mass measuring 4 x 3 cm is observed (white arrow).

the need for remifentanil, the following drugs were added: methadone, ketorolac, paracetamol, and metamizole. Dexamethasone was used as prophylaxis for nausea and vomiting. Before the surgical incision, dexmedetomidine 1mcg/kg/h with bolus 0.5 mcg/kg was started, well tolerated hemodynamically. Trocars were inserted into the peritoneum with slow $CO_2$ insufflation but when the adrenal gland was handled, the patient responded with hypertension, maximal systolic BP 173 mmHg and maximal diastolic BP 98 mmHg, so nitroglycerin was increased to 0.5 mcg/kg/min and sodium nitroprusside was added at 4 mcg/kg/min. When dissecting the adrenal vein, the patient presented bleeding of approximately 500 ml, thus was managed with 100 ml of lactated Ringer's solution (LRS) and 1 unit of red blood cells. After adrenal vein clamping, he presented with arterial hypotension, so the use of hypotensors was suspended, 500 ml LRS was administered, and noradrenaline was started at 0.15 mcg/kg/min. Given the successful completion of surgery, sustained hemodynamics with moderate requirement of noradrenaline in the context of abrupt suppression of catecholamines, and no ventilatory impairment, it was decided to extubate. He was transferred after 3 hours and 30 minutes to the ICU under sedation with dexmedetomidine, ventilating spontaneously, and with noradrenaline at 0.12 mcg/kg/min (Figure 2).

***Early postoperative management:*** On admission to ICU with central venous oxygen saturation of 75%, lactatemia 7.5 mg/dL (NV: 5-15 mg/dL). After 12 hours, noradrenaline infusion was suspended and doxazosin was restarted with good BP control (p50-90) at 48 hours. Analgesia with continuous infusion of metamizole and paracetamol by schedule. Postoperative glycemia always remained in a normal range.

**Hospital discharge and outpatient follow-up**

The patient was discharged on day 7 of hospitalization. In the postoperative check-up, the patient was asymptomatic and with BP values in p50, therefore the use of hypotensive drugs was suspended. Urine normetanephrine values at 10 days postoperative were 151 mcg/24 h and at 6 weeks 115 mcg/24 h (NV: 31.8-

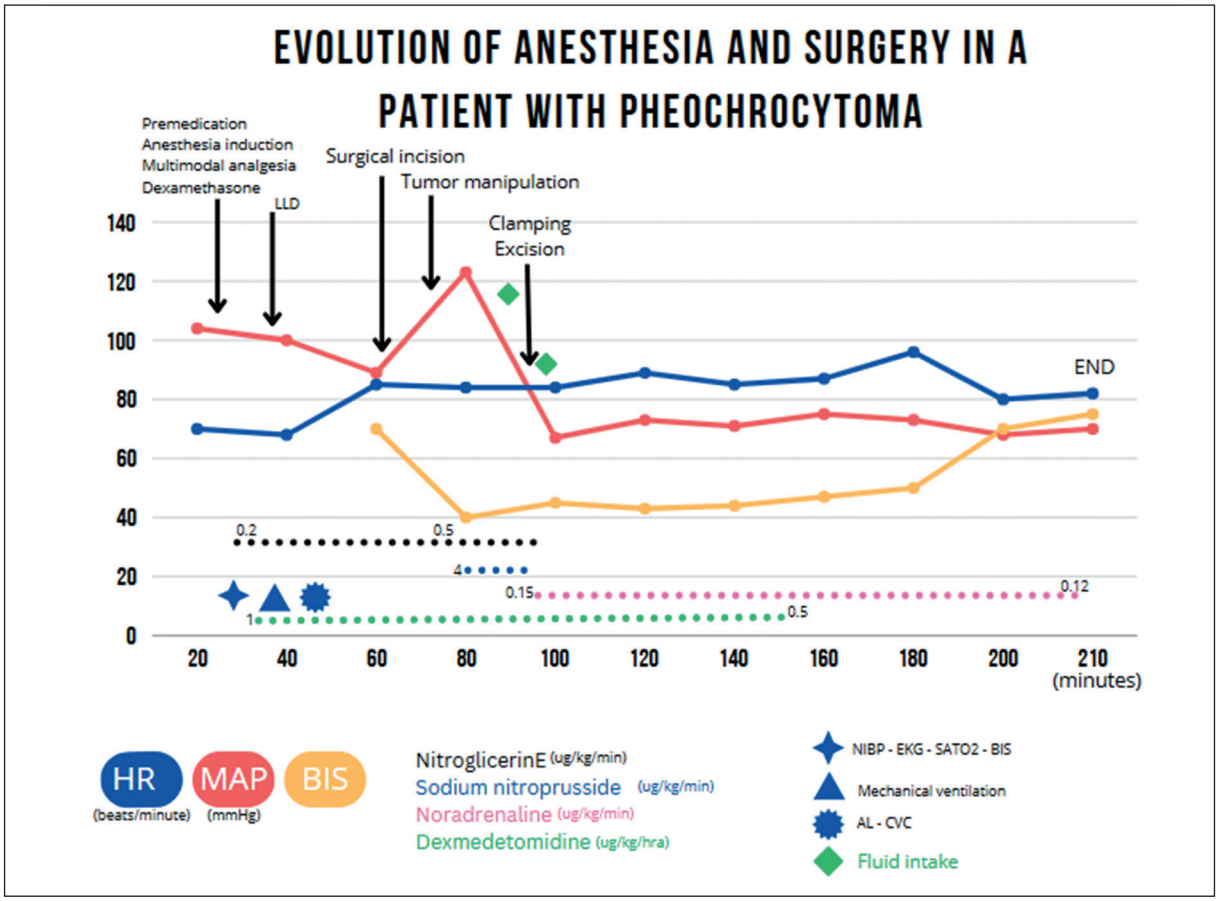


**Figure 2.** Laparoscopic Adrenalectomy Timeline. LLD: Left lateral decubitus; HR: Heart rate; MAP: Mean arterial pressure; BIS: Bispectral index; NIBP: Noninvasive blood pressure; ECG: Electrocardiogram; AL: Arterial line; CVC: Central venous catheter; SATO2: Oxygen saturation.

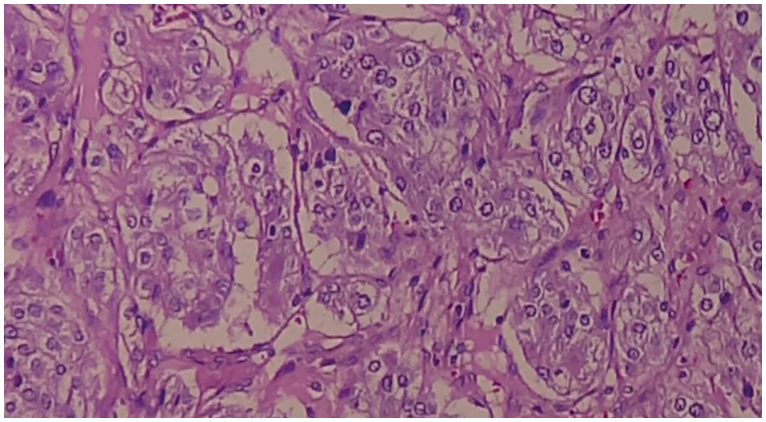

**Figure 3.** Histopathological study of surgical specimen. Histological specimen at 10x magnification, hematoxylin and eosin staining showing adrenal gland tissue with development of neoplasia made up of cells with granular amphophilic cytoplasm, round to oval nuclei with prominent nucleoli.

398 ug/24 hours). The evolution was successful at one year of follow-up after surgery.

The anatomopathological study confirmed right adrenal pheochromocytoma. Macroscopically, a yellow nodule of 4 x 3 x 2 cm was recognized. Microscopically, it showed nests and trabeculae of cells with granular amphophilic cytoplasm, nuclei with prominent nucleoli, and some cells with enlarged and hyperchromatic nuclei (Figure 3). The immunohistochemical study was positive for S100 and Ki-67 (Pheochromocytoma of the adrenal gland Scale Score 4).

## Discussion

In our patient, the long-standing symptomatology derived from sympathetic hyperactivity, consisting of headache, sweating, and tachycardia, should have allowed a firm diagnostic suspicion to be established on time before the hypertensive emergency that led to his hospitalization developed. In addition, on reviewing the BP values at that time, these were at p95. The prevalence of the symptomatic triad of headache, hyperhidrosis, and palpitations has been observed in 47-77% of pediatric patients[2,6,7].

Other symptoms include pallor, visual disturbances, nausea, diarrhea, vomiting, abdominal pain, tremors, and weight loss[3]. High BP is usually sustained[8] and does not occur as a crisis as in adults, although it may present episodes of exacerbation.

The diagnosis of pheochromocytoma may be delayed due to several reasons. First, high BP may be absent for prolonged periods since active catecholamines may be converted to biologically inactive metanephrines within the tumor. Second, both symptoms and signs are nonspecific, as the release of catecholamines may be due to neurogenic causes (anxiety or panic episode, cerebral vascular accident), all of which may delay diagnosis, and it is not unusual for the tumor to be discovered incidentally during studies not necessarily related to the adrenal gland[9,10]. In addition, in this patient, there was the particularity of not knowing the family history of VHL disease.

After clinical suspicion of pheochromocytoma, the next step is its biochemical confirmation by a 24-hour urinary- or plasma-free metanephrines test, which are more sensitive (~100%) and specific (~95%) than urinary or plasma catecholamines or urinary vanillylmandelic acid (VMA) tests, being currently the gold standard for its diagnosis[2]. For tumor localization, the initial imaging study, either by CT scan or MRI, should be of the abdomen and pelvis, as this is where most tumors are located[11].

After identification by laboratory tests and imaging, the definitive treatment of pheochromocytoma is surgical. Perioperative mortality is currently low (< 3%), so it is essential to have less invasive surgical techniques and the optimization of the perioperative management of BP[12], as follows:

**Preoperative stage. Management in ICU.**

BP should be normalized as soon as possible after surgery since the incidence of perioperative complications is strongly related to preoperative BP values[13].

The first aspect to recognize is that the development of hypertension is primarily caused by the increase in total peripheral vascular resistance mediated by noradrenaline on adrenergic receptors, which is secreted by most pheochromocytomas[13]. However, when measuring plasma catecholamines, the correlation between BP and circulating noradrenaline is poor[14]. Based on the above, β blocking treatment should never be used before effective α blockade has been achieved due to the risk of triggering a hypertensive crisis given the unopposed action on the α receptors. This situation was corrected when tests suggestive of pheochromocytoma were obtained (Table 1), modifying the initial therapy.

Blocking the effect caused by excess catecholamines is the cornerstone of antihypertensive control using an α adrenergic receptor antagonist such as doxazosin (selective α1-postsynaptic). However, the α blockade sometimes causes tachycardia secondary to β stimulation, which requires the addition of a β blocker to the therapy (Table 2). In the case reports of Deregibus et al.[7] the preoperative therapeutic option of doxazosin + atenolol for 7-14 days was chosen. It has been pointed out that pediatric patients sometimes may require a longer treatment time to achieve the desired heart rate and blood pressure (p50-90 and close to p50 in the days before surgery)[8]. If this scheme is insufficient, a dihydropyridine can be added (Table 2). It is suggested to monitor the response to antihypertensive therapy with outpatient BP follow-up.

It is recommended that patients receive a sodium intake between 6-10 g/day and be hydrated with intravenous fluids (1.5 times the maintenance fluids) to prevent the occurrence of postural hypotension or post-resection arterial hypotension caused by the α blockade (condition of relative hypovolemia). Recently, the real usefulness of this measure has been questioned, since it has not shown a beneficial effect on perioperative hemodynamics or early prognosis[15,16]. However, this issue has not yet been explained. The patient should be admitted to the ICU 48 hours before surgery for evaluation, monitoring of hemodynamic parameters, and intravenous fluids before surgery.

**Intraoperative stage**

Invasive hemodynamic monitoring devices such as arterial line and CVC should ideally be placed after anesthesia induction, with propofol together with fentanyl being an option for this, as both have a good hemodynamic profile. Vecuronium is the preferred muscle relaxant given its cardiovascular stability.

During anesthesia induction, as well as during endotracheal intubation and surgery itself, large variations in BP (hypertensive crisis) and heart rate can occur[17], so the anesthesiologist must be prepared to use a short half-life vasodilator or other drugs with hypotensive effect (Table 2). In addition, it is important to be attentive to control glycemia fluctuations.

It is necessary to consider not using drugs that cause histamine release (morphine, atracurium, among others) since they can cause a hypertensive crisis because of the increase of circulating catecholamines. It is recommended not to use halothane due to its myocardial sensitization effect on catecholamines[18].

Laparoscopic surgery is the treatment of choice and is curative, with up to 90% of complete remission described[19]. In case of unilateral pathology, total adrenalectomy is performed and subtotal surgery is reserved for tumors smaller than 5 cm. In case of bilateral involvement, subtotal adrenalectomy or unilateral total adrenalectomy plus contralateral subtotal adrenalectomy are performed.

Surgical manipulation can cause a massive release of catecholamines, leading to complications such as stroke, arrhythmias, myocardial ischemia, or pulmonary edema[20]. Once the tumor is removed, significant arterial hypotension may occur when the catecholaminergic load is eliminated[21]. An epidural infusion of bupivacaine plus fentanyl can be used for postoperative analgesia.

**ICU management**

Once the patient is admitted to the ICU, careful monitoring is required for potential vasopressor support due to the appearance of arterial hypotension, which may be due to the abrupt drop in circulating catecholamines, a decrease in cellular adrenergic receptors, residual effect of the adrenergic antagonists used, or hypovolemia. Another possible immediate complication (< 6 h) is the appearance of hypoglycemia due to hyperinsulinism due to the end of pancreatic β suppression[22].

In the first days after surgery, the patient may continue with hypertension caused by the increase in circulating catecholamines, but this should not last more than a few weeks unless there is functional residual disease, extra-adrenal tumor, or metastasis[23]. Normalization of plasma or urinary metanephrines should be measured 10 days after surgery. If the concentration remains high, functional imaging could be considered in the suspicion of occult metastases, recurrence, and/or multiple tumors[24].

Given the relapse of this pathology (16% at ten years)[25], patients who have undergone surgery should have a prolonged follow-up, with annual measurement of urinary metanephrines. Younger patients with large tumors and familial genetic syndromes are at higher risk[26].

## Conclusion

Pheochromocytoma is an uncommon cause of secondary HT in childhood. It is in this age group where the association with genetic familial syndromes is relevant. BP monitoring is crucial before surgery. At present, this is based on catecholaminergic blockade through α adrenergic receptor antagonist, where doxazosin is the first option. Once this therapy is established, β blockade can be added, which is determined by the magnitude of the existing tachycardia.

**Table 1. Drugs implicated in patients with pheochromocytoma that may precipitate a catecholaminergic crisis**

| Drug class | Examples |
|---|---|
| Dopamine D2 receptor antagonists | Metoclopramide, haloperidol, chlorpromazine |
| β-adrenergic receptor antagonists | Propranolol, labetalol |
| Sympathomimetics | Ephedrine, amphetamine, methylphenidate |
| Opioids | Morphine, pethidine |
| Norepinephrine reuptake inhibitors (includes TCAs) | Amitriptyline, imipramine |
| Corticosteroids | Dexamethasone, prednisone, hydrocortisone |
| Neuromuscular blocking agents | Succinylcholine, atracuronium |
| Anesthetics | Ketamine, halothane |
| Peptide hormones | Glucagon, ACTH |

ATC: Antidepresivos tricíclicos; ACTH: hormona adrenocorticotrópica.

**Table 2. Drugs used in the management of high blood pressure in patients with pheochromocytoma**

| | Drug | Class | Dose Range | Side Effects |
|---|---|---|---|---|
| Preoperative | Doxazosin | BS β1 | 2-4 mg/day, 1 dose, máx. 16 mg | Orthostatic hypotension, dizziness |
| | Amlodipine | Antagonista canales Ca | 0,1-0,6 mg/kg/day, 1 dose, max 10 mg | Peripheral edema |
| | Nifedipine | Antagonista canales Ca | 0,25-0,5 mg/kg/day, 1-2 doses | Tachycardia, headache |
| | Propranolol* | BNS β1 and β2 | 1-4 mg/kg/day, 2-3 doses | Dizziness, asthma exacerbation |
| | Atenolol* | BNS β1 and β2 | 1-5 mg/kg/day, 1-2 doses | Dizziness, fatigue |
| | | BS β1 | 0,5-1 mg/kg/day | |
| Intraoperative | Sodium nitroprusside | Vasodilator | 0,5-4 mcg/kg/min | Hypotension, CN toxicity |
| | Magnesium sulfate | Vasodilator | 40-60 mg/kg in 10 min | Use with caution in NMD |
| | | Inhibits CA release | 15-30 mg/kg/h infusion | QT and PR prolongation |
| | | B adrenergic receptor | | Hypocalcemia |
| | Dexmedetomidine | Central agonist α2 | 0,2-0,7 mcg/kg/h | Bradycardia, respiratory depression |
| | Labetalol* | B α β (relation 1:7 iv) | 0,25-3 mg/kg/h | Dizziness, orthostatic hypotension |
| | Urapidil | BS α1<br>B receptor 5-hydroxytryptamine | 1-2 mg/kg in bolus followed by 0,8-3,3 mg/kg/h infusion | Hypotension |

B: blocker; S: selective; Ca: calcium; NSB: nonselective blocker; CA: catecholamines; NMD: neuromuscular disease; CN-: cyanide. *Give after α blockade. Adapted from the tables of Jain (2020) [3] and Seamon (2021)[8].

## Ethical Responsibilities

**Human Beings and animals protection:** Disclosure the authors state that the procedures were followed according to the Declaration of Helsinki and the World Medical Association regarding human experimentation developed for the medical community.

**Data confidentiality:** The authors state that they have followed the protocols of their Center and Local regulations on the publication of patient data.

**Rights to privacy and informed consent:** The authors have obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the correspondence author.

## Conflicts of Interest

Authors declare no conflict of interest regarding the present study.

## Financial Disclosure

Authors state that no economic support has been associated with the present study.

## Acknowledgments

We thank Dr. Juan Aguirre, anatomic pathologist at the *Hospital Clínico Dra. Eloísa Díaz I*. La Florida, for his collaboration in the incorporation and interpretation of the histologic image.

## References

1. Flynn JT, Kaelber DC, Baker-Smith CM, et al. Subcommittee on screening and management of high blood pressure in children. Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents. Pediatrics. 2017;140(3):e20171904. doi: 10.1542/peds.2017-1904.
2. Bholah R, Bunchman TE. Review of Pediatric Pheochromocytoma and Paraganglioma. Front Pediatr. 2017;5:155. doi: 10.3389/fped.2017.00155.
3. Jain A, Baracco R, Kapur G. Pheochromocytoma and paraganglioma-an update on diagnosis, evaluation, and management. Pediatr Nephrol. 2020;35(4):581-594. doi: 10.1007/s00467-018-4181-2.
4. Pamporaki C, Hamplova B, Peitzsch M, et al. Characteristics of Pediatric vs Adult Pheochromocytomas and Paragangliomas. J Clin Endocrinol Metab. 2017; 102 (4):1122-1132. doi: 10.1210/jc.2016-3829.
5. Shanbhogue KP, Hoch M, Fatterpaker G, Chandarana H. von Hippel-Lindau Disease: Review of Genetics and Imaging. Radiol Clin North Am. 2016;54(3):409-22. doi: 10.1016/j.rcl.2015.12.004.
6. Barontini M, Levin G, Sanso G. Characteristics of pheochromocytoma in a 4- to 20-year-old population. Ann N Y Acad Sci. 2006;1073:30-7. doi: 10.1196/annals.1353.003.
7. Deregibus MI, Pompozzi LA, Sansó G. Feocromocitoma y paraganglioma en un hospital pediátrico de Argentina. Serie de casos. Arch Argent Pediatr. 2024;122(2):e202310099. doi: 10.5546/aap.2023-10099.eng.
8. Seamon ML, Yamaguchi I. Hypertension in Pheochromocytoma and Paraganglioma: Evaluation and Management in Pediatric Patients. Curr Hypertens Rep. 2021;23(5):32. doi: 10.1007/s11906-021-01150-9.
9. Lenders JW, Eisenhofer G. Pathophysiology and diagnosis of disorders of the adrenal medulla: focus on pheochromocytoma. Compr Physiol. 2014;4(2):691-713. doi: 10.1002/cphy.c130034.
10. Ilias I, Thomopoulos C. Addressing delays in the diagnosis of pheochromocytoma/paraganglioma. Expert Rev Endocrinol Metab. 2019;14(5):359-363. doi: 10.1080/17446651.2019.1657007.
11. Peard L, Cost NG, Saltzman AF. Pediatric pheochromocytoma: current status of diagnostic imaging and treatment procedures. Curr Opin Urol. 2019;29(5):493-499. doi: 10.1097/MOU.0000000000000650.
12. Groeben H, Nottebaum BJ, Alesina PF, Traut A, Neumann HP, Walz MK. Perioperative α-receptor blockade in phaeochromocytoma surgery: an observational case series. Br J Anaesth. 2017;118(2):182-189. doi: 10.1093/bja/aew392.
13. Bima C, Lopez C, Tuli G, et al. Prevention and management of hypertensive crises in children with pheochromocytoma and paraganglioma. Front Endocrinol (Lausanne). 2024;15:1460320. doi: 10.3389/fendo.2024.1460320.
14. Plouin PF, Gimenez-Roqueplo AP. Pheochromocytomas and secreting paragangliomas. Orphanet J Rare Dis. 2006;1:49. doi: 10.1186/1750-1172-1-49.
15. Kim JH, Lee HC, Kim SJ, et al. Perioperative hemodynamic instability in pheochromocytoma and sympathetic paraganglioma patients. Sci Rep. 2021;11(1):18574. doi: 10.1038/s41598-021-97964-3.
16. Niederle MB, Fleischmann E, Kabon B, Niederle B. The determination of real fluid requirements in laparoscopic resection of pheochromocytoma using minimally invasive hemodynamic monitoring: a prospectively designed trial. Surg Endosc. 2020;34(1):368-376. doi: 10.1007/s00464-019-06777-z.
17. Lentschener C, Gaujoux S, Tesniere A, Dousset B. Point of controversy: perioperative care of patients undergoing pheochromocytoma removal-time for a reappraisal? Eur J Endocrinol. 2011;165(3):365-73. doi: 10.1530/EJE-11-0162.
18. Naranjo J, Dodd S, Martin YN. Perioperative Management of Pheochromocytoma. J Cardiothorac Vasc Anesth. 2017;31(4):1427-1439. doi: 10.1053/j.jvca.2017.02.023.
19. Iglesias P, Santacruz E, García-Sancho P, et al. Pheochromocytoma: A three-decade clinical experience in a multicenter study. Rev Clin Esp. 2021;221(1):18-25. English, Spanish. doi: 10.1016/j.rce.2019.12.016.
20. Tariel F, Dourmap C, Prudhomme T, et al. Adrenalectomy for Pheochromocytoma: Complications and Predictive Factors of Intraoperative Hemodynamic Instability. Am Surg. 2023;89(11):4772-4779. doi: 10.1177/00031348221135774.
21. Peramunage D, Nikravan S. Anesthesia

for Endocrine Emergencies. Anesthesiol Clin. 2020;38(1):149-63.
22. Rajappa GC, Anandaswamy TC. Laparoscopic cortical sparing adrenalectomy for pediatric bilateral pheochromocytoma: anesthetic management. Anesth Pain Med. 2014;4(2):e15460. doi: 10.5812/aapm.15460.
23. Mamilla D, Araque KA, Brofferio A, et al. Postoperative Management in Patients with Pheochromocytoma and Paraganglioma. Cancers (Basel). 2019;11(7):936. doi: 10.3390/cancers11070936.
24. Casey RT, Hendriks E, Deal C, et al. International consensus statement on the diagnosis and management of phaeochromocytoma and paraganglioma in children and adolescents. Nat Rev Endocrinol. 2024. doi: 10.1038/s41574-024-01024-5.
25. Amar L, Servais A, Gimenez-Roqueplo AP, Zinzindohoue F, Chatellier G, Plouin PF. Year of diagnosis, features at presentation, and risk of recurrence in patients with pheochromocytoma or secreting paraganglioma. J Clin Endocrinol Metab. 2005;90(4):2110-6. doi: 10.1210/jc.2004-1398.