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Epidemiologic Profile and Clinical Outcomes of Patients with Pheochromocytoma at the University of the Philippines Philippine General Hospital (UP-PGH)

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Abstract

Objective. This study aims to describe the epidemiologic profile and determine the clinical outcomes of patients with pheochromocytoma at the University of the Philippines Philippine General Hospital (UP-PGH).

Methodology. We reviewed the medical records of 30 patients with histopathology-proven, clinical, and biochemical diagnosis of pheochromocytoma. Demographic, clinical characteristics, and clinical outcomes were collected for each patient.

Results. The median age at diagnosis of pheochromocytoma was 37.5 years (IQR 28-55) and the most common metabolic comorbidities were glucose intolerance (60%) and hypertriglyceridemia (23.3%). Majority of the patients were hypertensive (90%). Two third of the patients presented with classic features of pheochromocytoma while the remaining third presented as adrenal incidentaloma. Recurrence was found in 17% of subjects, who were significantly younger (25 years vs 46.5 years P = 0.0229), and had higher rates of bilateral pheochromocytoma (0 vs 75%), p = 0.002). Metastatic pheochromocytoma was found in 10% of the subjects.

Conclusion. Our study demonstrated that patients with pheochromocytoma in our setting exhibit great variability in terms of clinical behavior. Although majority of the patients presented with symptoms related to catecholamine excess, almost one-third of the patients were only incidentally discovered. Incidence of pheochromocytoma recurrence and metastasis in our setting are comparable with current available foreign studies.

Key words: pheochromocytoma, clinical outcomes, recurrence, metastasis

INTRODUCTION

Pheochromocytoma and paraganglioma (PPGL) are rare catecholamine-secreting neuroendocrine tumors mainly derived from chromaffin cells of the adrenal medulla (80–85%), with a minority originating from the sympathetic and parasympathetic ganglion cells (15–20%), respectively.[1] It has an incidence of two to eight per million persons per year and is found only in 0.1% to 1% of patients presenting with hypertension. Its peak incidence occurs in the third to fifth decade of life but is usually diagnosed at a younger age in hereditary cases, such as in multiple endocrine neoplasia syndrome type 2 (MEN 2), von Hippel-Lindau (vHL) syndrome, and neurofibromatosis type 1 (NF-1).[2]

Pheochromocytoma and paraganglioma are considered to be treatable causes of hypertension. Timely recognition and treatment of these tumors are important because most of these tumors hypersecrete catecholamines which can lead to high cardiovascular morbidity and mortality due to risks of uncontrolled hypertension, stroke, and arrhythmias if untreated.[3] It exhibits great variability in terms of clinical behavior which makes its diagnosis challenging. The diagnosis of pheochromocytoma at the asymptomatic stages of the disease has become more frequent in recent years due to an increase in incidental findings. Presently, available local studies of pheochromocytoma are scarce and limited to case reports only. Moreover, to date, there are still no epidemiological studies on pheochromocytoma conducted in the Philippines. Therefore, this study aims to describe the epidemiologic profile and determine the clinical outcomes of pheochromocytoma among patients admitted at the University of the Philippines Philippine General Hospital (UP-PGH). Furthermore, we will compare the clinical, biochemical, and pathologic features of patients with pheochromocytoma in remission

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versus those who developed recurrence after surgery, and lastly compare those with metastatic and nonmetastatic pheochromocytoma.

METHODOLOGY

Study design

This is a retrospective cohort study which included adult patients diagnosed with pheochromocytoma at the University of the Philippines Philippine General Hospital (UP-PGH) admitted from January 1, 2010, until December 31, 2021, using convenience sampling. Our research protocol was approved by the Technical Review Board of the Department of Medicine of the Philippine General Hospital and the Ethics Board of the University of the Philippines- Manila (UPM-REB Registration No. 2021-613-01) to ensure confidentiality of patient's information. A waiver of informed consent was approved since this study only involved a review of charts.

Inclusion criteria

This study involved adults ≥19 years old diagnosed with pheochromocytoma preoperatively using clinical, biochemical and imaging studies, and underwent adrenalectomy from January 1, 2010 - December 31, 2021, patients with confirmed histopathologic diagnosis of pheochromocytoma, and patients with pheochromocytoma diagnosed biochemically and through imaging who did not undergo surgery for any other reasons.

Exclusion criteria

Patients with adrenal metastasis from another primary cancer tumor were excluded while those patients who were lost to follow-up were excluded in the analysis of outcome.

Data collection

Patients included in the study were selected from the in-patient and outpatient census of the UP-PGH Department of Medicine, the database of adrenalectomy from the Division of Urology and adrenal histopathologic database from the Department of Laboratory. Histologically-proven pheochromocytoma and patients with preoperative diagnosis of pheochromocytoma were selected. Patients diagnosed with pheochromocytoma with normal metanephrines were confirmed through histopathologic reports after undergoing adrenalectomy. Medical records were reviewed where clinical and demographic characteristics were collected. Based on the clinical, biochemical, and radiological results, pheochromocytoma was diagnosed preoperatively . Imaging phenotype which included tumor characteristics such as size, laterality, tumor density in the Hounsfield unit and calculated washout on imaging tests performed such as adrenal CT scan, MRI or MIBG scan was collected. All the operative technique reports and intraoperative monitoring data were collected to determine the surgical approach and intraoperative morbidities. The final histopathologic report including immunohistochemical stain results, if done, was obtained and described based on tumor stage, grade and histology. Analysis of outcome only included patients who underwent surgery while patients who did not undergo surgery were only included in the analysis of clinical characteristics. The outcome of each patient was determined by doing a thorough review of inpatient and outpatient notes, biochemical tests, and imaging results on their follow-up after adrenalectomy. The outcomes measured include biochemical and/or structural cure, biochemical and/or structural recurrence, metastasis, and death. In addition, blood pressure and glycemic control after surgery were also determined to check for complete or partial resolution. Patients with missing data in outcome measures were only included in the clinical profile analysis.

Statistical analysis

Quantitative variables were summarized using the mean and standard deviation (SD) or median and interquartile range (IQR), depending on their distribution. Qualitative variables were tabulated as frequencies and percentages.

Independent samples t-test was used to compare the means of quantitative demographic and clinical variables between patients with and without clinical outcomes of interest (e.g., presence of metastasis). The normality assumption of the t-test was checked using the Shapiro-Wilk test. When the normality assumption was violated, the Mann-Whitney U test was used to compare the distribution of quantitative variables by the presence of clinical outcomes. The chi-square test was used to compare the distribution of qualitative demographic and clinical variables. When the sample size requirement for the chi-square test was not met, Fisher's exact test was used instead. The level of significance for the hypotheses tested was set at 5%. Missing observations were not imputed. Data analysis was performed using Stata SE version 13.

RESULTS

A total of 30 patients with clinically and histologically-confirmed pheochromocytoma admitted at the University of the Philippines Philippine General Hospital (UP-PGH) were included in the study. The median age of diagnosis was 37.5 years (IQR 28-55) and majority were female (70%). The most common comorbidities were glucose intolerance (prediabetes and diabetes mellitus) found in 60% of patients followed by hypertriglyceridemia (23.3%). Majority were hypertensive (90%), while 10% had normal blood pressure at diagnosis. One-third of the patients presented with target organ damage related to chronic hypertension such as ventricular hypertrophy (20%), hypertensive retinopathy (10%) and stroke (3.3%). The classic features of pheochromocytoma (triad of palpitations, diaphoresis and headache) were identified in 66.7% of the patients, and 33% of the patients were diagnosed incidentally through imaging.

Table 1. Demographic and clinical characteristics of the patients with pheochromocytoma admitted in the University of the Philippines Philippine General Hospital between 2010 to 2021 (N = 30)

Characteristics	n (%)
Age at onset (years), median (IQR)	37.5 (28-55)
Duration of symptoms (years), median (IQR)	2 (1-4)
Follow-up (months), median (IQR)	56.0 (24.7-73.8)
Females	21 (70%)
Underwent genetic testing	4 (13.3%)
Comorbidity	
Glucose intolerance	18 (60%)
Hypertriglyceridemia	7 (23.3%)
Left ventricular hypertrophy	6 (20%)
Hypertensive retinopathy	3 (10%)
Stroke	1 (3.3%)
Clinical presentation	
Classic triad of pheochromocytoma	20 (66.7%)
Incidental finding	10 (33.3%)
Anxiety/Panic attacks	7 (23.3%)
Tumor compression symptoms	7 (23.3%)
Orthostatic hypotension	2 (6.7%)
Cardiac arrhythmias	2 (6.7%)
Stage of hypertension	
Normotensive	3 (10%)
Stage 1	6 (20%)
Stage 2	15 (50%)
Resistant Hypertension	6 (20%)
Number of antihypertensive medications before surgery	
0	3 (10%)
1	1 (3.3%)
2	15 (50%)
3 or more	11 (36.7%)
Drug classes of antihypertensive medications	
Alpha blockade	24 (80%)
Beta blockade	20 (66.7%)
CCB	20 (66.7%)
ACE/ARBs	11 (36.7%)
MA	4 (13.3%)
Surgical approach	
Open	21 (75%)
Laparoscopic	3 (10.71%)
Converted	2 (7.14%)
No surgery	2 (7.14%)
Perioperative morbidity	
Hypertensive spikes	18 (72%)
Hypotension requiring vasopressor	9 (36%)
Hyperglycemia	4 (16%)
Laterality	
Unilateral	26 (86.67%)
Bilateral	4 (13.3%)
Clinical outcome	
Recurrence	4 (17.4%)
Remission	19 (82.61%)
Metastasis	3 (10%)
Mortality	2 (8%)

Table 2. Biochemical, radiologic and pathological characteristics of the patients with pheochromocytoma admitted to the University of the Philippines Philippine General Hospital between 2010 to 2021 (N = 30)

Characteristics	n (%)
Tumor diameter (cm), mean (SD)	7.0 (4.0)
Tumor density (unenhanced Hu), mean (SD)	34.7 (5.6)
Level of catecholamine excess from the ULN, median (IQR)	3.46 (2.04-5.85)
Level of catecholamine excess from the ULN	
Normal (less than 2x)	6 (22.2%)
2-5x above ULN	12 (44.4%)
5-10x above ULN	4 (14.8%)
More than 10x above ULN	5 (18.5%)
Tumor diameter (cm)	
<4 cm	5 (17.2%)
≥4 cm	24 (82.8%)
Imaging characteristics	
Heterogenous	14 (46.7%)
Necrosis	10 (33.3%)
Calcification	5 (16.7%)
Absolute wash out ≤60%	6 (60%)
Relative wash out ≤40%	7 (70%)
IHC staining	
Synaptophysin	12 (85.7%)
Chromogranin	14 (100%)
S-100	10 (66.7%)

Most of the subjects required two (50%), and three or more antihypertensive medications (36.7%) for blood pressure control. About 80% of the patients were given alpha blockade and 66.7% received beta blockade. Open adrenalectomy was performed in most of the patients because this has been the standard approach of adrenalectomy in our setting during the earlier years, and also due to larger tumor size observed in our cohort. Intraoperative blood pressure spikes (72%) were the most common perioperative morbidity. Only four patients (13.3%) underwent genetic testing for which three had positive germline mutations and all presented with bilateral pheochromocytoma. Two of the bilateral pheochromocytomas presented synchronously while the other two presented in a metachronous fashion. Four patients (17.4%) experienced recurrent pheochromocytoma. Two patients included in this study died before their scheduled surgery (Table 1).

In our institution, 24-hour-urine metanephrines and plasma metanephrines were the most common screening tests utilized and performed in 91% of tested patients. The patients' median catecholamine elevation was 3.46 times higher than the upper limit of normal values with the majority having more than two times elevation. Nevertheless, 22.2% of the patients had normal metanephrine levels. In terms of imaging phenotype, the mean tumor size was 7 cm with 82.8% of the patients having a tumor size of more than 4 cm. The mean tumor density was 34.7 Hounsfield units (Hu) and an SD of 5.6 Hu on unenhanced CT. Heterogenous enhancement (46.7%) and necrosis (33.3%) were commonly observed among these patients (Table 2).

Compared to patients with clinically suspected pheochromocytoma, those who were incidentally diagnosed through imaging were significantly older (56.4 years vs. 32.6 years, p <0.001) and had a lower prevalence of hypertension (80% vs. 95%, p = 0.005). Patients with clinically suspected pheochromocytoma had significantly higher systolic (195.5 mm Hg vs. 129 mm Hg, p <0.001) and diastolic blood pressure (106.5 mm Hg vs. 78 mm Hg, p = 0.003) at diagnosis compared to those incidentally diagnosed. However, tumor size and metanephrine elevation were not significantly different between the two groups (Table 3).

Of the twenty-three patients with available clinical outcomes, four patients (17.4%) experienced recurrent pheochromocytoma. The mean age of patients with recurrent pheochromocytoma was significantly lower than patients

Table 3. Comparison of patient's demographic and clinical characteristics according to the circumstance of the diagnosing pheochromocytoma

Characteristics	Circumstance of diagnosis		*p*-value
	Incidental (n = 10), mean (SD)	Clinically suspected (n = 20), mean (SD)	
Age at diagnosis (years) [a]	56.4 (10.4)	32.6 (13.0)	<0.001
Tumor size (cm) [a]	7.2 (2.8)	6.9 (4.6)	0.839
Systolic blood pressure upon diagnosis (mm Hg) [a]	129 (17.3)	195.5 (40.3)	<0.001
Diastolic blood pressure upon diagnosis (mm Hg) [a]	78 (7.9)	106.5 (20.8)	0.003
Level of elevation of metanephrine, median (IQR) [b]	2.6 (0-3.9)	3.8 (3.06-10.2)	0.066
Female gender, n (%) [c]	6 (60%)	15 (75%)	0.431
Prevalence of hypertension, n (%) [c]	8 (80%)	19 (95%)	0.005

[a] Independent samples t-test, [b] Mann-Whitney Test, [c] Fisher's exact test

Table 4. Comparison of the demographic and clinical characteristics of PPGL according to recurrence of pheochromocytoma

Characteristics	Recurrent pheochromocytoma		*p*-value
	Without (n = 19), n (%)	With (n = 4), n (%)	
Age (years), mean (SD) [a]	46.5 (16.8)	25 (9)	0.023[a]
Tumor diameter (cm), median (IQR) [b]	7.2 (5-9)	8.35 (5.9-10.6)	0.393[b]
Females [c]	15 (79.0%)	3 (75%)	1.000[c]
Bilateral pheochromocytoma [c]	0 (0%)	3 (75%)	0.002[c]
Genetic mutation [c]	0 (0%)	2 (100%)	0.333[c]

[a] Independent samples t-test, [b] Mann-Whitney Test, [c] Fisher's exact test

Table 5. Comparison of the demographic and clinical characteristics of pheochromocytoma with and without metastasis

Characteristics	Metastatic pheochromocytoma		*p*-value
	Without (N = 27), n (%)	With (N = 3), n (%)	
Age (years), mean (SD) [a]	41.7 (17)	30 (12.1)	0.2527
Tumor size (cm), mean (SD) [a]	6.6 (4.1)	10.1 (0.9)	0.1628
Bilateral [b]	3 (11.1%)	1 (33.3%)	0.360
Genetic mutation [b]	2 (66.7%)	1 (100%)	1.000
Tumor more than 5 cm [b]	18 (72%)	3 (100%)	0.551

[a] Independent samples t-test, [b] Fisher's exact test

who did not experience recurrence (25 years vs 46.5 years, $p = 0.0229$). Furthermore, the proportion of patients with bilateral pheochromocytoma was significantly higher among those with recurrent pheochromocytoma compared to those without (75% vs 0%, $p = 0.002$) (Table 4).

Metastatic pheochromocytoma was diagnosed in three patients (10%). There was no significant difference between the clinical and demographic characteristics of metastatic and non-metastatic pheochromocytoma (Table 5). Two patients with metastatic pheochromocytoma underwent resection of metastatic foci while the remaining patient was subjected to systemic chemotherapy because of a more disseminated disease. Two patients subjected to surgery achieved clinical and biochemical remission while the one who received systemic chemotherapy had progressive disease.

Table 6. Clinical outcome of patients with pheochromocytoma after adrenalectomy in University of the Philippines Philippine General Hospital (N = 23)

Clinical outcomes	n (%)
Number of antihypertensive medications before surgery, median (IQR)	2 (2-3)
Number of antihypertensive medications after surgery, median (IQR)	0 (0-1)
Resolution of symptoms related to catecholamine excess	17 (100%)
Within 1 month postoperatively	14 (82.3%)
Within 1-3 months postoperatively	3 (17.7%)
Improvement of glycemic control	11 (78.6%)
Resolution of hypertension	
Partial resolution	3 (15%)
Complete resolution	12 (60%)
Hypertension persistence	5 (25%)

Among the 30 patients in this study, 26 were subjected to adrenalectomy, two patients were still for surgery as of writing, and two patients died before their surgery. One patient had missing data on clinical outcomes, while the other two patients are still for follow-up after their adrenalectomy. All patients presented with symptoms of catecholamine excess experienced resolution of symptoms after surgery with the majority (82.3%) experiencing immediate resolution (<1 month) after surgery. Likewise, there was observed improvement in glycemic control (78.6%) and resolution of hypertension (75%) after surgery in most of the patients. Overall, there was an observed decline in the median number of preoperative antihypertensive medications after surgery (Table 6).

Patients with persistent hypertension after adrenalectomy were significantly older compared to patients whose hypertension was resolved (64 years vs. 34.5 years, $p = 0.0005$). Meanwhile, patients whose hypertension was resolved had significantly higher preoperative mean SBP (190.7 mm Hg vs. 138 mm Hg, $p = 0.0231$) and higher mean DBP (100 mm Hg vs. 80 mm Hg, $p = 0.0207$) compared to

Table 7. Comparison of clinical and demographic characteristics of patients according to the resolution of hypertension of patients operated for pheochromocytoma

Characteristics	Resolution of hypertension		*p*-value
	Persistent (n = 5), mean (SD)	Resolved (n = 15), mean (SD)	
Age (years) [a]	64.2 (2.2)	34.5 (15.3)	0.0005
Tumor diameter cm [a]	6.7 (3.7)	7.3 (2.5)	0.7156
Systolic BP upon diagnosis (mm Hg) [a]	138 (11.0)	190.7 (46.2)	0.0231
Diastolic BP upon diagnosis (mm Hg) [a]	80 (7.1)	100 (16.9)	0.0207
Number of medications preoperatively [a]	2 (0)	2.8 (1.5)	0.2847
Level of cathecholamine excess (from the ULN) [a]	2.2 (2.8)	8.2 (8.6)	0.1945
Bilateral pheochromocytoma, n (%) [b]	0 (0%)	3 (20%)	0.539
Symptoms of cathecholamine excess, n (%) [b]	0 (0%)	12 (86.67%)	0.001

[a] Independent samples t -test, [b] Fisher's exact test

patients with persistent hypertension. A higher proportion of patients with resolved hypertension also had symptoms of catecholamine excess compared to patients with persistent hypertension (86.67% vs. 0%, $p = 0.001$) (Table 7).

DISCUSSION

Major findings of this study demonstrated that the median age of diagnosis of pheochromocytoma was 37.5 years and the most common metabolic comorbidities detected were glucose intolerance and hypertriglyceridemia. Majority of the patients were hypertensive and had classic features of pheochromocytoma, however, about one-third were diagnosed incidentally. Patients with incidental discovery were relatively older and had a lower prevalence of hypertension. The overall recurrence rate was 17%. Those who experienced recurrence were significantly younger and had a higher proportion of bilateral pheochromocytoma. Although most of the patients had resolution of hypertension, about one-fourth of the patients had persistence of hypertension after adrenalectomy and these patients were significantly older. Metastatic pheochromocytoma was found in 10% of the subjects.

In our study, most of the patients have elevated blood pressure upon diagnosis. However, 10% of the patients have normal blood pressure consistent with the findings of Kopetske et al.[4] wherein 6% of patients with pheochromocytoma were normotensive. Some tumors may contain catechol-O-methyltransferase, which is an enzyme capable of converting active catecholamines into inactive metanephrines, which may explain the clinically silent behavior in some patients. These findings emphasize that the absence of hypertension does not rule out the presence of pheochromocytoma.[4]

In recent years, with the advent of modern imaging modalities, widespread use and increased access to cross-sectional imaging, incidental adrenal masses became increasingly detected. This may have contributed to the detection of pheochromocytoma at the presymptomatic stage where patients do not present with the classic features of pheochromocytoma and are detected even in smaller size tumors. In our study, 33% of the patients presented with adrenal incidentaloma. This finding is in line with the study of Kopetske et al.,[4] which postulates the switch in the clinical presentation of modern-era pheochromocytoma, in contrast with the traditional diagnosis based on symptoms.[5] In our study, patients with incidentally detected tumors were significantly older and presented with hypertension and blood pressure peaks less often than patients with clinically suspected pheochromocytoma, which may reflect a difference in tumor biology between the two. These findings highlight the need to establish the clinical thresholds for the diagnosis of pheochromocytoma on a case-by-case basis while taking the patient's presenting style into account. This makes the data important for clinical practice. The detection of adrenal incidentalomas will likely continue to increase, and clinicians should be aware that pheochromocytoma is possible even in adrenal incidentalomas.[4,5]

Surgery is the standard of care for pheochromocytoma.[6] Although pheochromocytoma is considered a treatable cause of hypertension, there is a small proportion of patients without recurrence who remained hypertensive even after surgery. In our study, those subjects with persistent hypertension after surgery were significantly older. One study demonstrated that age and underlying predisposition such as family history of essential hypertension are potential predictors for nonresolution of hypertension. Individuals with increasing age often lose the ability to reverse the structural vascular changes brought about by the excess catecholamine production which may explain the persistence of hypertension.[7]

Hyperglycemia and diabetes mellitus, known to be brought about by excessive catecholamine production, were also observed in around 23-50% of patients with pheochromocytoma. Similar rates of glucose intolerance were observed in our study population. Tumor resection resulted in the resolution of glucose intolerance in 78.6% of patients in the study of Beninato et al.,[8] which was comparable to our study. Hyperglycemia in pheochromocytoma results from inhibited insulin secretion, stimulated glucagon secretion, and increased peripheral insulin resistance which often resolves after adrenalectomy.[9,10]

Overall recurrence rate in our study was consistent with the recurrence rate of 6.5% to 16.5% in other foreign studies.[7,11] This study demonstrated that those with recurrent pheochromocytoma were significantly younger and had a

higher proportion of bilateral pheochromocytoma which was consistent with the study of Caprino et al.[12] This emphasizes the need for a more proactive approach and closer monitoring of these patients for early detection of disease recurrence. Genetic mutation has been shown as a strong independent predictor of recurrence because PPGL associated with genetic mutations are more frequently bilateral or extra-adrenal, associated with multiple synchronous or metachronous tumors and therefore implying a higher risk of recurrence. However, this was not observed in our study and can likely be explained by the low rates of genetic testing and our small sample size.[2,3,12,13]

The incidence of metastatic pheochromocytoma in our study was consistent with current available observational studies. Metastatic pheochromocytoma was seen more among male patients, those with higher plasma norepinephrine levels and urinary metanephrine excretions, and those with larger tumors (more than 5 cm), but this was not observed in our study likely due to our small sample size, and low rates of genetic testing. Certain genetic mutations such as SDHB mutation have been identified to have a higher rate of metastatic disease reaching 30-70%. The rising number of genetic-related PPGLs reaching approximately 40% of cases and the clinical implications of positive genetic testing with the outcome have been one of the bases why recent international guidelines have recommended genetic testing to be routine in all patients with PPGL.[3,12,14]

The main strength of this study is that this is so far the largest cohort of patients with pheochromocytoma conducted in the Philippines which analyzed clinical characteristics and outcomes of pheochromocytoma among Filipinos. Moreover, most of the patients in our study were managed by a multidisciplinary team in a referral center with expertise in adrenal diseases ensuring homogeneous management of this endocrine tumor. Through this study, the clinical profile of Filipinos with pheochromocytoma and their clinical outcomes were explored and better understood. This can help us improve our case detection, and guide in surveillance monitoring of this rare endocrine tumor in our setting, which could translate to early and appropriate management leading to a more favorable prognosis and better outcomes.

This study's limitations include its retrospective nature, which led to typical issues with secondary data, such as missing or incomplete patient information. Additionally, the small sample size reduced the statistical power of our tests, affecting the detection of significant results. Consequently, care should be taken when interpreting the study's non-significant findings. Lastly, only a small number of patients underwent genetic testing, and the absence of other biochemical tests for pheochromocytoma, such as methoxytyramine and chromogranin A, limited our ability to determine specific biochemical phenotypes that might impact clinical presentation and outcomes.

CONCLUSION

Our study demonstrated that patients with pheochromocytoma in our setting have variable clinical behavior. Although the majority of the patients presented with classic symptoms, almost one-third of the patients were incidentally discovered. Clinical outcomes after surgery generally showed improvement of symptoms related to catecholamine excess, and resolution of hypertension and hyperglycemia. Our study also showed comparable rates of remission, recurrence and metastasis with the other foreign studies. Those who developed recurrence were significantly younger and had higher rates of bilateral pheochromocytoma. The low rate of genetic testing in our study is attributed to its limited availability and constraints in cost. Overall, the results of this study provided a better understanding of how these tumors present clinically and of their outcomes, which can help improve case detection and surveillance monitoring tailored to our setting.

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Statement of Authorship
All authors certified fulfillment of ICMJE authorship criteria.

CRediT Author Statement
EFH: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data Curation, Writing – original draft preparation, Writing – review and editing, Visualization, Supervision, Project administration; **CAJ:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data Curation, Writing – original draft preparation, Writing – review and editing, Visualization, Supervision, Project administration; **EPP:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data Curation, Writing – original draft preparation, Writing – review and editing, Visualization, Supervision, Project administration.

Author Disclosure
Elizabeth Paz-Pacheco is the Editor-in-Chief of JAFES and Cecilia Jimeno is the Vice Editor-in-Chief. They did not participate in the editorial review or decision-making process for this manuscript. Dr. Hernandez has nothing to disclose.

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Datasets generated and analyzed are included in the published article.

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