

Outcomes Following Laparoscopic Adrenalectomy as Treatment for Patients with Adrenal Nodules

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Abstract

Background: Adrenal nodules can either be non functioning or hormone secreting. Once proven functional, adrenalectomy is warranted. Laparoscopic adrenalectomy has been the popular intervention for these nodules. There is no local literature citing the clinical outcomes, particularly on symptom and medication reduction. Considering that these tumors present with hypertension, such condition may be under diagnosed in a population with a hypertension prevalence of 22.3%. This study reviewed the outcomes of the procedure particularly on the improvement of signs and symptoms and medication use.

Methodology: This is a retrospective review describing the post-operative outcomes of patients who underwent laparoscopic adrenalectomy conducted in a tertiary medical center from 2010 – 2015.

Results: Twenty-three (23) patients were categorized according to pathology – primary hyperaldosteronism – (17), pheochromocytoma – four (4) and Cushing's syndrome – two (2). Post-operatively, there was a reduction in the systolic blood pressure of patients with primary hyperaldosteronism ($p = 0.156$). A mean reduction of 20-30 mmHg in the blood pressure was documented in

patients who had pheochromocytoma ($p = 0.625$). There was a reduction in the number and dosages of anti-hypertensive medications (primary hyperaldosteronism $p = <0.001$, pheochromocytoma $p = 0.095$). Potassium levels of patients with primary hyperaldosteronism improved ($p = 0.004$). Patients with Cushing's syndrome had improvement in blood pressure, glycemic profile and cortisol. The mean operative time is four hours with minimal blood loss and no major complication was documented. Discontinuation of antihypertensive medications and potassium supplementation was noted in 13 (56.5%) patients. Median hospital day was four days. There was no morbidity and mortality that occurred during the peri-operative and post-operative period (median = 42 days, $r = 30$ -240 days).

Conclusion: Laparoscopic adrenalectomy, being employed as treatment for adrenal nodules, is safe and effective. Significant improvement in the signs and symptoms and number of medications in the management of these patients was documented.

Keywords: Laparoscopic adrenalectomy, adrenal nodules

Introduction

Adrenal gland nodules can either be an incidentaloma or hormone secreting masses. Functional nodules are associated with varied signs and symptoms, which can lead to significant morbidity if left untreated. Common adrenal pathologies include primary aldosteronism (aldosterone producing adenoma), pheochromocytoma and Cushing syndrome which often causes endocrine hypertension (secondary). In all situations, adrenalectomy is warranted to be done.¹

Throughout the years, the surgical procedure of adrenalectomy is done by an open technique. The difficulty with open surgical exposure by large flank incision lead to increased morbidity. The small size of nodules, most of it being benign and of the adrenal gland, made these conditions particularly amenable to minimal invasive procedure. Laparoscopy then became the standard approach in adrenal gland removal. Compared with the traditional open surgery, the benefits of shorter hospital stay, rapid recovery time and improved patient satisfaction made this procedure more appealing. However, critical steps of the operation must be maintained to ensure expected outcomes and success. More than a decade after the procedure has been introduced in the country, there has been a paucity of studies in the local literature, particularly highlighting the clinical outcomes of the procedure. Cited in HERDIN are case reports and series that focused only on the surgical aspect of the procedure. This study aims to contribute to the existing literatures for timely diagnosis and appropriate management.

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We present a single institution experience on the laparoscopic adrenalectomy as intervention and its impact in the medical treatment of such diseases. This study was undertaken to present the demographic, clinical, biochemical profile of patients and to compare pre-operative and post-operative clinical variables of patients who underwent laparoscopic adrenalectomy.

Methodology

This is a retrospective review of patients who underwent laparoscopic adrenalectomy performed at the Makati Medical Center from 2010 – 2015.

Inclusion criteria

- All adult patients, ages 18 years old and above with confirmed diagnosis of functioning adrenal nodule – pheochromocytoma, Cushing's syndrome, primary hyperaldosteronism who underwent laparoscopic adrenalectomy (Table I and II).

Exclusion criteria

- Patients who underwent adrenalectomy in conjunction with another procedure (ie radical nephrectomy).
- Patients who underwent adrenalectomy due to non-primary adrenal lesion (ie hemorrhage).

This study reviewed patients' hospital records and clinic charts to gather the needed demographic profile which include: age, gender and presence of co-morbid conditions and metabolic diseases (i.e., Diabetes, Obesity, Thyroid Problems etc).

Clinical features such as moon facies, hirsutism, acanthosis nigricans, abdominal striae, blood pressure, heart rate, electrolytes were included in the review.

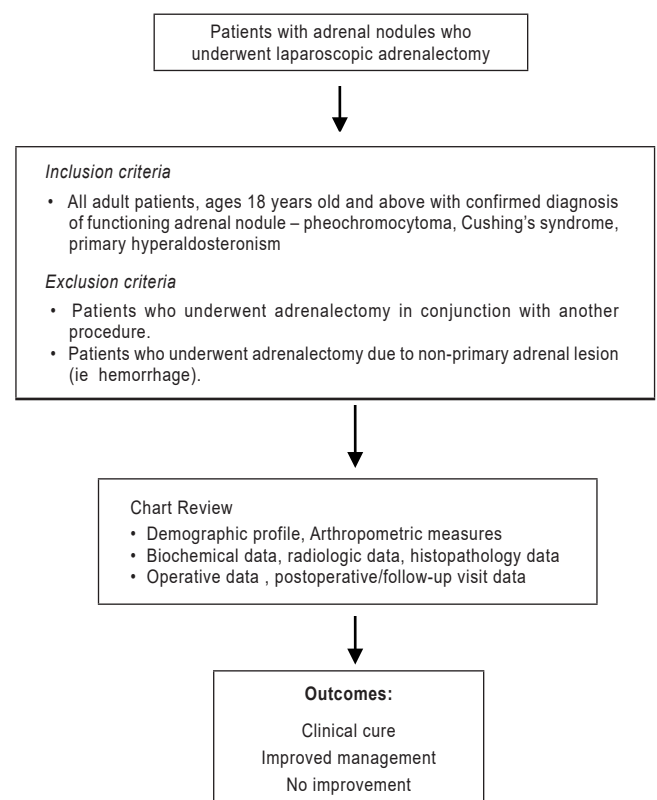
The radiologic images were reviewed thru the center's PACS system, particularly noting the measurement and description of the adrenal nodule. The size of the nodule was measured using the largest dimension of the tumor.

To investigate secreting tumors, hormonal assays were reviewed if the information is available. The following tests may include the following: potassium, plasma aldosterone and renin for primary hyperaldosteronism; plasma catecholamines, urine metanephrines and Vanillyl Mandelic Acid for pheochromocytoma; plasma cortisol level, Dexamethasone suppression Test for Cushing's syndrome.

Plasma renin and aldosterone were taken in an upright position after an eight-hour fast. Plasma cortisol levels were determined at 0800H and 0900H. Dexamethasone suppression test was done by administering 1.0 mg Dexamethasone at 2300H and cortisol levels were determined 0800H the following day. 24 hour urine metanephrine was collected on a special collecting bottle. Patients were instructed to discard the first urine at 0600H and start collecting urine samples for the next 24 hours.

Operative technique, surgical time, perioperative and post-operative complications and hospital stay were reviewed as recorded in the patients' chart as well as the histopathologic diagnosis.

Flowchart for the Study Procedure



Descriptive statistics was used to summarize the clinical characteristics of the patients. Frequency and proportion was used for nominal variables, median and IQR for ordinal variables, and mean and SD for interval/ratio variables. Paired T-test and Wilcoxon Sign-Ranked test was used to determine the difference of the pre and post for mean and median type of variable, respectively. Missing variables was neither be replaced nor estimated. Null hypothesis was rejected at $< 0.05 \alpha$ level of significance. STATA 12.0 was used for data analysis.

Determination of Outcomes

Table II. Parameters defining clinical resolution for benign adrenal problems:

Endocrine Problem	Expected Outcome
Primary Hyperaldosteronism	• Return of blood pressure to normal level, normalization of potassium level • Reduction in the number and dosage of anti-hypertensive medications
Pheochromocytoma	• Return of blood pressure to normal levels • Reduction in the number and dosage of anti-hypertensive medications
Cushing's Syndrome	• Return of blood pressure to normal levels • Improvement in glycemic level, • Improvement on weight, body mass index. • Reduction in Cortisol levels

Table II. Categories of patients based on blood pressure and medication use as follows:

Clinical cure	Primary Hyperaldosteronism: • Blood pressure less than or equal to 140 mmHg / 90 mmHg • No anti-hypertensive medications • Improvement in Potassium level with no supplementation Phaeochromocytoma • Blood pressure less than or equal to 140 mmHg / 90 mmHg • No anti-hypertensive medications • Normal catecholamine levels Cushing's syndrome • Blood pressure less than or equal to 140 mmHg / 90 mmHg diastolic • Improvement on weight, body mass index . • Normal cortisol levels
Improved management	Primary Hyperaldosteronism: • Blood pressure less than 140 mmHg / 90 mmHg • Less anti-hypertensive medications • Improvement in potassium level Phaeochromocytoma • Blood pressure less than 140 mmHg / 90 mmHg • Reduced number and dosage of antihypertensive medications • Reduction in catecholamine levels from baseline Cushing's syndrome • Blood pressure less than 140 mmHg / 90 mmHg • Reduced number and dosage of antihypertensive medications • Reduction of cortisol levels
No improvement	Primary Hyperaldosteronism: • Blood pressure more than or equal to 140 / 90 mmHg • Same or more than the initial anti hypertensive medications • Low potassium level Phaeochromocytoma • Blood pressure more than or equal to 140 / 90 mmHg • Same or more than the initial anti- hypertensive medications • No reduction in the initial catecholamine level Cushing's syndrome • Blood pressure more than or equal to 140 / 90 mmHg • Same or more than the initial anti hypertensive medications • Cortisol levels still elevated

The study was not designed to categorically identify erroneous surgery. Should there be patients wherein there were no improvement or cure, as there may be circumstantial or confounding factors (i.e., continuous diuretic use, presence of essential hypertension or development of hyperthyroidism) that may have affected the outcome, the attending physicians shall have the final decision regarding the next medical or surgical care for the patient.

Results

A total of 23 patients who underwent laparoscopic adrenalectomy were analyzed. Of the 23 patients, 17 had primary hyperaldosteronism, four had pheochromocytoma, and two had Cushing's syndrome. Table III presents the clinical profile of the patients with complete biochemical results and data.

Majority of patients included in the study were females (69.5%). Most of the patients have hypertension (91.3%). Thirteen (56.5%) had family history of hypertension while eight (34.8%) had positive family history of diabetes mellitus.

Presenting Symptoms

The most common presenting symptoms among patients diagnosed with primary hyperaldosteronism were generalized body/muscle weakness and hypertension (47.1%). Two patients both had muscle weakness and elevated blood pressure as their presenting symptoms.

Two patients with Cushing's syndrome both had hypertension as their presenting symptom. One patient manifested with weight gain and characteristic moon facie. Patients with pheochromocytoma presented with a combination of symptoms, such as profuse sweating, palpitations and hypertension.

Biochemical Diagnosis

Patients initially considered to have primary hyperaldosteronism have their plasma renin and aldosterone levels analyzed however only 15/17 and 16/17 patient data were available for review respectively. The mean value for plasma renin is 0.21 ng/dl/hr $\pm$ 0.3 (n.v. 0.48-4.88 ng/dl/hr) and the mean value of plasma aldosterone 43.4 ng/dl $\pm$ 34.5 (n.v. 2.7-27.2 ng/dl). 15/17 patients had Aldosterone Renin Ratio of more than 20 (Table IV).

Only three out of four cases of pheochromocytoma presented with elevated 24 hour urine metanephrines were available for review which demonstrated two to three times

above the upper limit of the normal. (8,629 nmol/24 hours and 2,946 nmol/24 hours, one case reporting 22.2 ug/day).

Only one patient with Cushing's syndrome had complete data for review. The cortisol level was elevated at 748 umol/L and was only suppressed to 677.57 umol/L after 1.0 mg Dexamethasone test.

Radiologic profile

Twenty (20) patients underwent CT scan of the abdomen with IV contrast while two patients had MRI of the abdomen done. Nodule size (largest dimension) were noted to be smaller for patients with primary hyperaldosteronism with a mean size of 1.7 cm + 0.7 compared to patients diagnosed with pheochromocytoma and Cushing's syndrome measuring 3.2 cm + 1.3 and 3.2 cm + 1.2 cm respectively. Hounsfield unit were reported in 10 patients with primary hyperaldosteronism with a mean value of 10.1 (range = -2 to 35). Only one patient with pheochromocytoma reported Hounsfield unit of 35-62. No Hounsfield data were reported for patients with Cushing's syndrome. Most of the lesions of patients with primary hyperaldosteronism were identified on the right adrenal gland while patients with Cushing's syndrome had their nodules on the left adrenal gland.

Onset of symptoms to surgical intervention

Majority of patients diagnosed with a functional adrenal nodule had a surgical intervention done within the year. Earlier surgical interventions were sought by patients diagnosed with pheochromocytoma and Cushing's syndrome as compared to patients with primary hyperaldosteronism. All patients underwent laparoscopic adrenalectomy.

Histopathologic Diagnosis

The histopathology report of 16 patients diagnosed with of primary hyperaldosteronism and two patients with Cushing's syndrome were signed out as adrenocortical adenoma confirming the autonomous secretion of aldosterone and cortisol by these nodules. One patient with primary hyperaldosteronism was reported as micronodular hyperplasia. Patients operated due to pheochromocytoma had histopath report confirming pre-operative diagnosis.

CLINICAL OUTCOMES

Primary hyperaldosteronism

Patients with primary hyperaldosteronism were all diagnosed to have hypertension. They were treated by a number of antihypertensive medications prior to intervention. The most common type of anti-hypertensive

Table III. Clinical profile of patients with adrenal nodules who underwent laparoscopic adrenalectomy

	Primary Hyperaldosteronism (n = 17)	Pheochromocytoma (n = 4)	Cushing's syndrome (n = 2)
	Mean $\pm$ SD; Frequency (%); Median (range)		
Age	42 $\pm$ 10.6	32 $\pm$ 20.2	44 $\pm$ 2.9
Female sex	10 (58.8%)	3 (75.0)	2 (100.0)
Co-morbid conditions			
- Hypertension	17 (100.0)	4 (100.0)	2 (100.0)
- Diabetes mellitus	2 (11.8)	1 (33.3)	1 (33.3)
- Kidney disease	0 (0.0)	0 (0.0)	0 (0.0)
Body Mass Index	26.2	22.8	25.8
Presenting symptoms			
- Tremors	1 (5.9)	0 (0.0)	0 (0.0)
- High blood pressure	8 (47.1)	2 (66.7)	2 (66.7)
- Palpitations	0 (0.0)	3 (75.0)	0 (0.0)
- Weakness	8 (47.1)	0 (0.0)	0 (0.0)
- Sweating	0 (0.0)	3 (75.0)	0 (0.0)
- Edema	1 (5.9)	0 (0.0)	0 (0.0)
- Dizziness	1 (5.9)	0 (0.0)	0 (0.0)
Adrenal Nodule size (cm)	1.7 $\pm$ 0.7	3.2 $\pm$ 1.3	3.2 $\pm$ 1.2
Time from onset of symptoms to operation (years)	1 (0.08 to 6)	0.9 (0.25 to 1)	0.43 (0.04 to 0.08)

Table IV. Levels of Plasma Aldosterone and Plasma Renin Activity, Radiologic profile

Patient	Plasma Renin Activity (ng/dl/hr)	Plasma Aldosterone (ng/dl/hr)	Aldosterone Renin Ratio	Size in imaging (cm)	Attenuation (Hounsfield Units)
01	0.02	44.4	2210	3	21
02	0.03	45.45	1515	2.5	14
03	0.09	37.013	411.26	0.8	6
04	0.02	19.285	1015	1.6	-2
05	0.13	28	215.35	1.2	NA
06	0.1	4.363	43.63	2.1	8
09	0.48	11.46	23.88	1.5	-3
11	0.126	9.458	75.06	2.3	NA
12	0.045	49.283	109.52	3.1	NA
13	0.202	61.2	302.97	1.8	35
14	NA	158.86	NA	1.6	0
15	0.04	48.214	1205.35	0.77	4
16	0.008	20.99	2623.75	1.4	14
17	0.33	49.457	150.78	1.9	NA
19	0.06	53.9	898.33	2.2	14
20	NA	NA	NA	NA	NA
21	1.14	54.027	47.39	1	NA

Table V. Comparison of pre-operative and post operative clinical variables of patients with Primary Hyperaldosteronism

Patient	Pre- operative				Post-operative			
	# of Anti hypertensives	BP systolic (mmHg)	BP Diastolic (mmHg)	Potassium	# of Anti hypertensives	BP systolic (mmHg)	BP Diastolic (mmHg)	Potassium
01	4	120	90	3.9	0	120	70	4.2
02	6	165	90	2.56	0	130	90	4.7
03	4	160	90	1.7	1.5	120	80	4.1
04	6	170	100	3.3	2	140	90	4.3
05	6	120	90	2.5	0	120	80	3.5
06	3.5	150	110	2.1	0	130	80	3.7
09	3	120	80	3.4	0	110	80	3.3
11	5	130	70	4	1	120	70	4.2
12	5	130	80	2.9	0	130	80	3.7
13	2	100	70	4.6	0	120	80	4.2
14	9.5	130	50	2.9	3	120	80	3.7
15	3	120	80	3.5	1	120	80	3.4
16	3	140	70	2.7	2	140	90	5.5
17	2	120	40	4.7	2	130	80	3.8
19	6	110	90	3.1	0	130	90	4
20	3	140	70	NA	4	140	80	3.7
21	2	140	85	3	2	140	90	4.7

NA = Data not available

Table VI. Comparison of pre-operative and post-operative patient data for Primary Hyperaldosteronism patients (n = 17)

	Pre-operative	Post-operative	P-value
	Mean $\pm$ SD; Median (range)		
Systolic blood pressure	133.2 $\pm$ 19.4	127.1 $\pm$ 9.2	0.156
Diastolic blood pressure	79.7 $\pm$ 17.2	81.8 $\pm$ 6.4	0.625
Number of medicines	4.3 $\pm$ 2.0	1 (0 to 4)	< 0.001
Serum potassium	3.2 $\pm$ 0.8	4.1 $\pm$ 0.6	0.004

Statistical test used: Paired t-test

drugs were Calcium channel blockers (64.7%), Mineralocorticoid antagonist – Spironolactone (52.9%) and Angiotensin receptor blockers (52.9%) (Table V).

After undergoing laparoscopic adrenalectomy, the average systolic blood pressure decreased from 133.2 $\pm$ 19.4 to 127.1 $\pm$ 9.2 mmHg, while the average diastolic blood pressure increased from 79.7 $\pm$ 17.2 to 81.8 $\pm$ 6.4 mmHg.

Table VII. Comparison of pre-operative and post-operative patient data for pheochromocytoma patients (n = 4)

	Pre-operative	Post-operative	P-value
	Mean $\pm$ SD; Median (range)		
Systolic blood pressure	147.5 $\pm$ 29.86	122.5 $\pm$ 12.58	0.182*
Diastolic blood pressure	97.5 $\pm$ 12.5	77.5 $\pm$ 2.5	0.267*
Number of medicines	5.5 (4 to 6)	2 (0 to 6)	0.095§

Statistical test used: * - Paired t-test; § - Wilcoxon Signed Rank Test

The mean reduction in the systolic blood pressure is 6.2 mmHg and is not statistically significant. However, significant decrease in the number of anti-hypertensive medicines was noted. Nine out of 17 patients (52.9%) were discharged without anti-hypertensive medications while the remaining patients were discharged with reduced dosage and number to control blood pressure (Table VI).

Table VIII. Surgical outcomes of Laparoscopic adrenalectomy for patients with adrenal nodules

	Primary Hyperaldosteronism (n = 17)	Pheochromocytoma (n = 4)	Cushing's syndrome (n = 2)
	Mean $\pm$ SD; Frequency (%); Median (range)		
Length of operative time (minutes)	225.4 $\pm$ 60.3	241.0 $\pm$ 42.6	235.7 $\pm$ 27.0
Blood loss (ml)	19.8 $\pm$ 22.7	80.0 $\pm$ 70.0	10.0 $\pm$ 0.0
Mortality	0	0	0
Length of hospital stay	5.2 $\pm$ 1.9	4.7 $\pm$ 1.5	3.0 $\pm$ 0.0
Outcomes			
- Clinical cure	11 (64.7)	0	1 (50.0)
- Improved management	6 (35.3)	4 (100.0)	1 (50.0)
- No improvement	0 (0.0)	0 (0.0)	0 (0.0)

Pre-operatively, the potassium levels of these patients were below normal. Six out of 17 (35.2%) patients were maintained on potassium supplementation. Post-operatively, there was a significant increase in the levels of serum potassium (Table IV). Only six patients with low normal potassium levels (range = 3.4 to 3.5 mEq/L) were discharged with potassium supplementation. These patients had normal potassium levels on their post-operative clinic follow-up (one to six months).

Pheochromocytoma

All patients with pheochromocytoma diagnosed with hypertension pre-operatively had their blood pressure returned to normal levels post-surgery. The control was persistent until their post-operative clinic visit (one to six months). There was a 30 mmHg mean reduction in systolic and 20 mmHg reduction in diastolic pressure. The number of anti-hypertensive medications was likewise reduced. These findings were not statistically significant (Table VII).

Post operative 24-hour urine metanephrines, on the three patients (one to five months) demonstrated reduction although still above normal limit. (2,946 nmol/d, 1,237 nmol/d, 3.34 ug/day). These patients were advised by their attending endocrinologist for regular follow-up to document remission.

Cushing's syndrome

Two patients with Cushing's syndrome underwent surgery. One patient is controlled with only one medication

while the other patient was controlled by more than four tablets. Only one patient had complete data for review. Post-surgery, the patient noted improvement in weight, from 60.4 to 54.2 kg and BMI from 27.1 to 22.5 over a period of three months. The blood pressure likewise decreased from 140 / 90 to 130/90 mmHg and has no maintenance medications for hypertension upon discharge. The glycemic profile also improved from 119.94 mg/dl (fasting) to 86.82 mg/dl on the first follow-up (three months). The cortisol levels also returned to normal, from 748 umol/L to 280.15 umol/L (Table VIII).

Surgical Outcomes

In our series of 23 patients, all underwent the said procedure successfully without any conversion to open adrenalectomy. The mean operative time was noted to be shorter in patients with primary hyperaldosteronism as compared to the pheochromocytoma group and Cushing's syndrome group. Blood loss was also noted to be minimal for both primary hyperaldosteronism and Cushing's syndrome group. The length of hospital stay was relatively short across all groups ranging three to five days.

There were no severe complications of the procedure peri-operatively and post-operatively. One patient with pheochromocytoma had blood pressure elevation peri-operatively but was controlled by Nicardipine drip. There was no reported mortality secondary to procedure.

Table IV showed that 64.7% of patients with primary hyperaldosteronism attained clinical cure, requiring no anti-hypertensive medications on discharge and persisted

until the first clinic follow-up. All patients diagnosed with pheochromocytoma noted improvement in the management while the results for Cushing's syndrome was equivocal.

Discussion

We aim to present the clinical & biochemical features of patients with functioning adrenal nodules and the outcomes and effectivity of laparoscopic adrenalectomy. The investigators recognized the paucity of data as presented in this study. Unfortunately, charts earlier than 2010, which could have adrenalectomy cases, could not be retrieved hence these cases were excluded. There were other adrenalectomies performed as part of en bloc radical nephrectomy and these were also excluded. There were 23 charts retrieved for review that is further subdivided into three disease states. These cases do not reflect the true incidence of such diseases, however, it is reflective of the true nature of the disease. Jimeno et al. cited prevalence of primary hyperaldosteronism to be 0.5 to 2.0%³ while Castilho et al. reported an estimated incidence of pheochromocytoma of 0.005% to 0.1 % of the general population.⁴

These adrenal gland pathologies, as reported in literatures is usually diagnosed in third to 5th decade of life and is predominantly on female population.^{3,4,5} In this study, female predominance was also observed. The presenting symptoms of patients varied but clues suggestive of these diseases were as follows: Hypertension and hypokalemia for hyperaldosteronism; sweating, palpitations and hypertension for pheochromocytoma; hypertension, moon facie and hirsutism for Cushing's syndrome. The most common symptom across all the adrenal pathologies described above was hypertension. As such, other specialists may have treated these patients initially as a case of essential hypertension initially before being referred to the subspecialty for evaluation. These patients may present with sustained blood pressure levels history of early onset hypertension or cerebrovascular accident (<40 years old), spontaneous or diuretic induced hypokalemia.¹⁰ Plasma renin and aldosterone, can be requested to detect primary hyperaldosteronism. Other pertinent symptoms described as spells, such as but not limited to, profuse sweating, anxiety, palpitations, headache, and pallor and physical examination findings of obesity, moon facies, abdominal striae, and hirsutism should also be taken into account and the cause of secondary hypertension should be pursued. It is expected that these patients shall be referred to endocrinologist for further evaluation and treatment recommendation.

The mean blood pressure of patients with primary hyperaldosteronism documented in these series fall

within all stages of hypertension (JNC8) in contrast to other reports that these patients would have moderate to severe hypertension. The varied blood pressure levels compared to other studies can be attributed to the use of anti-hypertensive medications even before the investigation for possible adrenal problem is carried out. The feature of hypokalemia, reported as generalized muscle weakness on all patients with primary hyperaldosteronism was documented in this study. The suspicion was further strengthened by presence of suppressed renin and elevated aldosterone levels. The mean Aldosterone Renin ratio of the group was > 20, fulfilling the screening criteria for primary hyperaldosteronism. Post-operatively, there was noted reduction in the blood pressure. Being curative, 52% of the patients were discharged without any hypertensive medications. This is compatible with the report of Herd et al. where 50% of patients had some form of improvement in the management of hypertension.² The other 50% may improve as Herd also reported significant reductions being attained over medium to longer term, as long as 59 mos. Some would still have persistent hypertension, most likely due the vascular damage brought about by the long standing hypertension. The over-all outcome of laparoscopic adrenalectomy in this study was also comparable to the clinical cure rate reported by Pang et al. and Meria of 34% and 58% respectively.^{6,7} This study was only able to present short term outcomes of the procedure as documented in one to eight months post procedure follow-up. The desired outcome regarding hypertension management may still be observed over long term.

The improvement in potassium levels of the studied patients is also congruent with the study of Pang, where none of the patients were maintained on potassium supplementation on post-operatively and of Goh et al. where hypokalemia is cured in 96 to 100% of patients. Patients with pheochromocytoma had their blood pressure returned to normal levels after surgery, although 75% need to be on reduced number of anti-hypertensive medications. Similar results were reported by Castilho et al with 90% reduction of blood pressure to normal among patients with pheochromocytoma post-operatively.⁴

Surgery for pheochromocytoma is associated with increased risk of bleeding due to possible hemodynamic complications. Tsuru et al. reported that the duration of the procedure for this disease is three hours, with a blood loss of 160 ml. The mean hospital stay was reported to be four days. Our study reported an operative time of one hour longer but with minimal blood loss and similar hospital stay.⁹ Documentation of recurrent disease even after surgery is done via annual plasma and urine metanephrines determination. Aggressive investigation is recommended if elevations are noted.

The impact of laparoscopic adrenalectomy in our patient with Cushing's syndrome also proved to be beneficial following the procedure, either in the attainment of cure or improving management despite some patients may still be on anti-hypertensive medications on short term follow-up. The hypertension may be resolved over time or may persist as an effect of prolonged blood pressure elevation. The positive effect on the biochemical tests as reflected post-operatively was also documented on the improvements of the patients' clinical status. This was documented with the reversal of blood pressure and improvement in the weight, BMI and glycemic profile of the patient. The surgical outcome in this subset of disease, although limited, was able to document a longer operative time with minimal blood loss as compared to the review of Gill et al where the mean operating time was 2.5 hours and a blood loss of 177 ml.⁸

Laparoscopic intervention has been one of the advancements in surgery, and in particular, adrenal surgery. Our study showed that laparoscopic adrenalectomy is a safe and effective treatment for functional adrenal nodules providing cure rate and improved management among these patients. Although the average operative time done in the center was noted to be longer, compared with other reports, the safety of the procedure was well illustrated by the absence of perioperative and intraoperative mortality and morbidity.

Conclusion

Despite the limited sample size, this study was able to describe patients with adrenal nodules comparable with the results obtained from previous reports. Adrenal nodules are more seen in female population. These nodules, depending on underlying pathology, present with varied symptoms, with hypertension as the most common manifestation. Considering a 22.3% prevalence of hypertension as reported in 2013 National Nutrition Health Survey such conditions can be missed out. High index of suspicion, coupled with appropriate tests, are necessary to allow prompt diagnosis and offer immediate surgical treatment of such diseases. . Laparoscopic adrenalectomy is an effective intervention for functional adrenal nodules particularly in the management of hypertension. The awareness of the disease and of the intervention might improve early diagnosis, leading to prompt treatment considering this is a surgically correctable cause of hypertension. Long-term follow-up is likewise recommended to further establish remission and/or improvement from the disease after the said surgery.

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