World J Urol (1999) 17: 35–39 

McClellan M. Walther · Harry R. Keiser
W. Marston Linehan

# Pheochromocytoma: evaluation, diagnosis, and treatment

**Abstract** Pheochromocytoma is a catecholamine-producing tumor of the sympathetic nervous system. Signs and symptoms are generally related to catecholamine excess; these include hypertension, sweating, palpitatione, headaches, and anxiety attacks. Abdominal imaging and 24-h urine collection for catecholamines are usually be sufficient for diagnosis. Catecholamine blockade with phenoxybenzamine and metyrosine generally ameliorates symptoms and is necessary to prevent hypertensive crisis during surgery. Standard treatment is laparoscopic adrenalectomy, although partial adrenalectomy is gaining enthusiastic support in familial forms of pheochromocytoma.

Pheochromocytoma is a catecholamine-producing tumor of the sympathetic nervous system. As such, pheochromocytoma can occur anywhere between the glomus jugulare at the base of the skull and the bladder. About 95% of pheochromocytomas, however, occur in the adrenal glands. Other catecholamine-producing tumors include chemodectomas, derived from the carotid body, and ganglioneuromas, derived from postganglionic sympathetic neurons. The clinical manifestations of pheochromocytomas arise from their excessive production of catecholamines, with over half of patients developing marked hypertension.

M. M. Walther (✉) · W. M. Linehan
Urologic Oncology Branch,
DCS/NCI/NIH, Building 10, Room 2B-43,
10 Center Drive MSC 1501,
Bethesda, MD 20892-1501, USA
e-mail: macw@nih.gov, Tel.: +1-301-402-2251,
Fax: +1-301-402-0922

H. R. Keiser
National Heart, Lung, and Blood Institute,
National Institutes of Health, Bethesda, Maryland, USA

Pheochromocytomas have been estimated to be present in approximately 0.3% of patients undergoing evaluation for secondary causes of hypertension [41]. Pheochromocytomas are usually curable if diagnosed and treated properly, but they can be fatal if they are not diagnosed or are managed inappropriately. Autopsy series suggest that many pheochromocytomas are not clinically suspected and that the undiagnosed tumor can be associated with morbid consequences [42].

## Pathology

Pheochromocytomas are composed of small round nests of cells surrounded by richly vascular septa. The cells can be small and regular or have marked pleomorphism. The cytoplasm varies from clear to granular. Some tumors have a less orderly arrangement of cells but maintain the rich vascular septa. The presence of necrosis, cytologic atypia, increased mitotic atypia, or vascular invasion can occur in benign tumors, making histologic determination of malignancy impossible [29]. A malignant tumor, which occurs in 7–15% of patients, is defined by the presence of metastases [12, 22, 34, 35, 42]. Metastases usually occur in the bone, regional lymph nodes, liver, lung, or brain, in decreasing order [34].

In all, 72–82% of pheochromocytomas are reported to occur in a solitary adrenal gland, 3–11% are bilateral, and 9–19% occur outside the adrenal gland [12, 22, 23, 34, 35, 42]. Pheochromocytomas occur at all ages but are most common in the fourth through sixth decades of life [12, 22, 23, 34, 35, 42]. Women and men are similarly affected.

## Clinical features

Although the presentation of patients with pheochromocytoma can be variable, most present with hypertensive crisis, paroxysmal symptoms suggestive of

seizure disorder, anxiety attacks, or essential hypertension that responds poorly to conventional treatment [23, 35, 39].

Hypertension, the hallmark clinical finding, is detected in 61–100% of patients with pheochromocytoma [12, 23, 34, 35, 42]. Hypertension may be sustained or paroxysmal, with a similar occurrence of each [23, 34, 35]. Significant blood pressure lability is usually present, demonstrated as distinct crises in patients with sustained hypertension. These hypertensive episodes can be severe or malignant and are resistant to standard maneuvers used in the treatment of essential hypertension [27].

As pheochromocytomas are not innervated, catecholamine release is thought to occur secondary to changes in blood flow, with tumor necrosis, or in association with physical stimuli. A hypertensive crisis may be precipitated by abdominal trauma, physical activity, general anesthesia, surgical manipulation, or, in the case of bladder pheochromocytoma, voiding.

A hypertensive crisis may occur frequently or at intervals as long as weeks or months. These episodes have a tendency to increase in frequency, duration, and severity over time. The crisis is usually sudden in onset and can last from minutes to hours. Headache, profuse sweating, palpitations, and tachycardia are common (Table 1). Pallor is commonly seen in association with marked vasoconstriction. Chest pain or abdominal pain, a feeling of apprehension or impending doom, nausea, and vomiting can also occur [35]. Occasionally, myocardial infarction, congestive heart failure, cardiac arrhythmias, cerebrovascular accident, hemorrhage into the tumor, renal failure, or dissecting aortic aneurysms have been observed in patients with a hypertensive crisis. Flushing occurs rarely with vasodilation.

The chronic release of catecholamines in patients with pheochromocytoma may be associated with symptoms and signs of increased metabolic rate and weight loss. At least half of patients have suppression of insulin production and increased hepatic glucose output, leading to hyperglycemia. Chronic exposure to catecholamine production can lead to myocardial fibrosis, arteriosclerosis, and ischemic enterocolitis.

**Table 1** Pheochromocytoma symptoms: incidence of symptoms in 324 patients presenting with pheochromocytoma [24, 35, 39]

| Symptom | Range (%) |
|---|---|
| Headache | 43–80 |
| Anxiety | 15–72 |
| Sweating | 37–71 |
| Palpitations | 44–71 |
| Abdominal pain | 14–62 |
| Chest pain | 0–50 |
| Pallor | 42–44 |
| Nausea | 10–42 |
| Dyspnea | 15–39 |
| Tremor | 13–38 |
| Weight loss | 7–23 |
| Flushing | 4–19 |
| Visual disturbance | 11–22 |

The high circulating levels of catecholamines found in patients with pheochromocytoma are also associated with constriction of the vascular volume, leading to diminished plasma volume and elevations of hematocrit. Sympathetic reflexes can be blunted, leading to orthostatic hypotension or hypotension or shock during surgery.

Evaluation of children, newly diagnosed patients with hypertension, patients with hypertension that is resistant to conventional therapy, or patients with a familial syndrome associated with pheochromocytoma should exclude the above-mentioned findings by history and physical examination [25]. Any patient with a hereditary form of pheochromocytoma should be evaluated before pregnancy is contemplated, as a high incidence of maternal or fetal death has been observed in undiagnosed patients [23, 30].

## Associated diseases

Hereditary forms of pheochromocytoma have been described in association with multiple endocrine neoplasia (MEN) type II, von Hippel-Lindau (VHL) disease, and von Recklinghausen's neurofibromatosis [2, 23, 42].

Genetic screening and correlation of genotype with clinical phenotype is just beginning. Pheochromocytomas have been found to be associated with missense mutations in the VHL gene in patients with VHL disease [11, 46]. High-risk mutations in MEN II and neurofibromatosis have not been described.

Hypercalcemia, erythrocytosis, and Cushing's syndrome have been reported as part of pheochromocytoma-associated paraneoplastic syndromes [23]. Cholelithiasis is described in 3–23% of patients with pheochromocytoma [12, 23, 34].

## Special clinical situations

### Epinephrine-producing tumors

Whereas epinephrine accounts for about 80–85% of adrenal medullary catecholamine production, most pheochromocytomas secrete an excess of norepinephrine [29]. In contrast to most pheochromocytomas, the uncommon epinephrine-secreting tumors are associated with hypotension and shock after alpha-blockade due to the powerful beta-adrenergic effects of epinephrine [30, 47]. Sweating, palpitations, nausea, and impaired glucose tolerance are also commonly seen in patients with these tumors [47].

### Malignant tumors

The treatment of malignant pheochromocytoma consists of surgical resection of recurrences, when possible, and adequate alpha-blockade to minimize symptoms. Chemotherapy using cyclophosphamide, vincristine, and

dacarbazine has resulted in a 57% tumor response and a 79% biochemical response, although the duration of response has been limited [4]. Palliation of bony metastases with radiation has been successful. Attempts to take advantage of pheochromocytoma uptake of MIBG by labeling of the compound with $^{131}I$ has had mixed results. A partial response has been observed in as many as a third of patients treated in this fashion [36].

## Diagnostic evaluation

### Function studies

A 24-h collection of urine for analysis of catecholamines and metabolites is performed for the diagnosis of pheochromocytoma. Urine should be properly acidified and chilled until evaluation is performed. Measurement of urine creatinine excretion can be used to ensure that an adequate collection is obtained. The enzyme phenylethanolamine-*N*-methyl transferase, which converts norepinephrine to epinephrine, is found largely in the adrenal gland or organ of Zuckerkandl. Most pheochromocytomas, therefore, predominantly secrete norepinephrine and its metabolites. Tumors located in these sites are associated with 20% or more of the total catecholamines secreted as epinephrine.

The usefulness of urinary catecholamine excretion as well as the higher cost and limited sensitivity and specificity of plasma catecholamine determinations have contributed to their infrequent use. Plasma metanephrines may represent a more accurate test for pheochromocytoma [19]. Plasma catecholamine testing is enhanced by suppression of sympathetic nervous activity. Clonidine, an alpha-2 agonist, does not suppress plasma levels in patients with pheochromocytoma and is used to exclude patients with essential hypertension [7, 8]. A provocative test is used when there is clinical suspicion of pheochromocytoma, but catecholamine secretion is not diagnostic. Glucagon has no effect on blood pressure in patients with essential hypertension but can cause release of catecholamines and/or hypertensive crisis in patients with pheochromocytoma [17, 38]. Plasma catecholamines, glucagon stimulation, and clonidine suppression are felt to be complementary in patients in whom the diagnosis of pheochromocytoma is not clear [8, 14].

### Imaging and localization studies

Computed tomography yields excellent imaging of abdominal and thoracic pheochromocytoma [12, 40]. Magnetic resonance imaging (MRI) has also been found to be very sensitive in pheochromocytoma detection [21]. The $T_2$ -weighted image of MRI gives a high intensity signal in patients with pheochromocytoma, which is seen as a very bright image. Arteriography is contraindicated because of the high incidence of hypertensive crisis [10].

Meta-iodobenzylguanidine (MIBG) is a physiologic analog of norepinephrine and is taken up and stored in neurosecretory granules. When labeled with radioactive iodine – $^{123}I$ or $^{131}I$ – it is useful in imaging the adrenal medulla and related tumors such as pheochromocytoma [6, 25]. MIBG imaging is thus a diagnostic test for pheochromocytoma and is useful for the detection of extra-adrenal, metastatic, or recurrent sites of disease or when whole-body imaging is important [21, 37].

Adrenal vein sampling for norepinephrine and epinephrine is occasionally helpful when other testing is not diagnostic for pheochromocytoma [9, 26].

## Differential diagnosis

Patients with essential hypertension, renovascular hypertension, hypertension of pregnancy, anxiety attacks, pressor crises associated with the withdrawal of some antihypertensive agents, self-administration of sympathomimetic amines, intracranial tumors, and epilepsy can present with signs or symptoms similar to those displayed by patients with pheochromocytoma.

## Current management

### Preoperative blockade

In the era prior to the introduction of adrenergic blockade, pheochromocytoma surgical mortality ranged from 24% to 50% [20, 32]. Catecholamine release related to induction of anesthesia or tumor manipulation often led to severe hypertension, arrhythmias, or stroke. Medical blockade of tumor catecholamines has been associated with a significant decrease in mortality (Table 2). Alpha-adrenergic blockade with phenoxybenzamine is routinely performed with 10 mg every 12 h for 2 weeks prior to surgery. The drug dose may be increased to control hypertensive episodes. The average dose is

**Table 2** Preoperative medical blockade of pheochromocytoma

| |
|---|
| 2 weeks before surgery: |
| Oral phenoxybenzamine |
| 10 mg two times daily |
| Increase the dose to 0.5 mg/kg given daily in two divided doses to control blood pressure or symptoms |
| Beta-adrenergic blockers |
| Given to patients with tachycardia (pulse greater than 100) after adequate alpha-blockade. Administration of propranolol before alpha-blockade can worsen hypertension secondary to unopposed vasoconstriction |
| Metyrosine |
| 250 mg every 6 h |
| Increase dose to 250–500 mg/day to control blood pressure or symptoms (maximal dose 4 g/day) |
| Night before surgery: |
| At 12 a.m. give phenoxybenzamine at 1 mg/kg and metyrosine at 1 g |

0.5 mg/kg per day. At midnight on the night before surgery, patients are given a final preoperative dose. Because of associated orthostatic hypotension the patient must remain in bed with the side rails up. A beta-blocker can be added to blunt the reflex tachycardia sometimes associated with alpha-blockade.

Metyrosine, a tyrosine hydroxylase inhibitor, has been an important addition to the preoperative medical blockade of pheochromocytoma [3, 31]. Metyrosine blocks the conversion of tyrosine to DOPA by the enzyme tyrosine hydroxylase the rate-limiting step in the production of catecholamines [32]. This blockade can decrease catecholamine production by 50–80%. At 2 weeks prior to surgery the patients is begun on metyrosine at 250 mg every 8 h. The night before surgery a 1-g dose is given at midnight. Metyrosine has been associated with the need for less intraoperative medication for the control of blood pressure, lower intraoperative fluid requirements, and lower blood loss [31]. Fewer than 10% of patients have poor tolerance of metyrosine with excessive sedation, depression, hallucinations, extra pyramidal signs, sleep disturbances, or tremor. High doses, greater than 4 g/day, are associated with urinary crystal formation. Combined blockade with a liberal salt diet allows restoration of the contracted plasma volume, making surgery safer.

## Surgery

In the operating room, in addition to routine anesthetic monitoring, two large-bore venous catheters and an arterial blood-pressure-monitoring line are inserted. Patients with cardiac disease may require a Swan-Ganz catheter for monitoring of pulmonary capillary wedge pressure. Anesthetic agents that do not sensitize the heart to catecholamines, such as enflurane or isoflurane, are used. Maneuvers that are especially associated with the outpouring of catecholamines by pheochromocytoma are intubation and tumor manipulation.

If the plasma volume has not been adequately reexpanded by pre-operative blockade, hypotension can occur after the tumor, the source of circulating catecholamines, has been removed. This is best treated with fluid replacement. Pharmacologic treatment of hypotension is blunted by the preoperative blockade.

Modern imaging techniques and medical blockade have supplanted the need for full abdominal exploration and palpation as part of the examination for pheochromocytoma [28]. This localization has allowed the use of more focused surgical approaches, such as laparoscopy. As compared with open surgical approaches, laparoscopic techniques have been shown to be associated with lower narcotic requirements, a shorter hospital stay, and a more rapid return to normal activity [15, 44, 45]. There has been no difference in hemodynamic changes or need for intra-operative antihypertensive treatment among open and laparoscopic techniques for the removal of pheochromocytoma [44]. The operative time, blood loss, and intraoperative transfusion requirement in patients undergoing laparoscopic or open adrenalectomy do not differ [5, 15, 33, 44]. Patients with pheochromocytoma can safely undergo laparoscopic removal of their tumors [5, 15, 33, 44].

Patients with hereditary forms of pheochromocytoma are predisposed to develop bilateral tumors. In an effort to preserve adrenal cortical function and maintain quality of life, some clinicians have recommended partial adrenalectomy [1, 18, 43]. Only recently have these techniques been attempted laparoscopically [16].

## Postoperative care

Careful monitoring of volume status and reexpansion of the contracted plasma volume are needed to prevent hypotension. The effect of pressor drugs is blunted until the preoperative blockade wears off at about 24 h after surgery. The half-life of phenoxybenzamine is 24 h and that of metyrosine is 4 h [32]. Hypoglycemia may be transiently observed until increased insulin production caused by elevated levels of plasma catecholamines normalizes. The use of 5% dextrose intravenous solution is usually sufficient to prevent this problem [32, 34].

Residual nonparoxysmal hypertension is seen in 27–38% of patients after removal of a pheochromocytoma [12, 34, 36]. In the initial postoperative period this may be related to overcorrection of fluid volume or pain, whereas its later occurrence has been attributed to essential hypertension [32, 34, 36].

Follow-up after surgical removal of sporadic pheochromocytoma is recommended at 3 and 6 months after surgery. Thereafter, yearly catecholamine determinations and physical examination for at least 5 years are recommended. The 5-year patient survival after removal of benign pheochromocytoma has ranged from 84% to 96% [20, 23, 34].

## References


1. Albanese CT, Wiener ES (1993) Routine total bilateral adrenalectomy is not warranted in childhood familial pheochromocytoma. J Pediatr Surg 28: 1248
2. Aguilo F, Tamayo N, Vazguez-Quintana E, Rabell V, Haddock L, Allende M, Pagan H, Gonzalez A (1991) Pheochromocytoma: a twenty year experience at the University Hospital. P R Health Sci J 10: 135
3. Atuk NO (1983) Pheochromocytoma: diagnosis, localization, and treatment. Hosp Pract [off] 18: 187
4. Averbuch SD, Steakley CS, Young RC, Gelmann EP, Goldstein DS, Stull R, Keiser HR (1988) Malignant pheochromocytoma: effective treatment with a combination of cyclophosphamide, vincristine, and dacarbazine. Ann Intern Med 109: 267
5. Binkovitz LA, Johnson CD, Stephens DH (1990) Islet cell tumors in von Hippel-Lindau disease: increased prevalence and relationship to the multiple endocrine neoplasias. AJR 155: 501
6. Bomanji J, Levison DA, Flatman WD, Horne T, Bouloux PM, Ross G, Britton KE, Besser GM (1987) Uptake of iodine-123

MIBG by pheochromocytomas, paragangliomas, and neuroblastomas: a histopathological comparison. J Nucl Med 28: 973
7. Bravo EL, Tarazi RC, Fouad FM, Vidt DG, Gifford RW Jr (1981) Clonidine-suppression test: a useful aid in the diagnosis of pheochromocytoma. N Engl J Med 305: 623
8. Bravo EL (1991) Diagnosis of pheochromocytoma. Reflections on a controversy. Hypertension 17: 742
9. Chew SL, Dacie JE, Reznek RH, Newbould EC, Sheaves R, Trainer PJ, Lowe DG, Shand WS, Hungerford J, Besser GM, et al (1994) Bilateral phaeochromocytomas in von Hippel-Lindau disease: diagnosis by adrenal vein sampling and catecholamine assay. Q J Med 87: 49
10. Christenson R, Smith CW, Burko H (1976) Arteriographic manifestations of pheochromocytoma. AJR 126: 567
11. Crossey PA, Richards FM, Foster K, Green JS, Prowse A, Latif F, Lerman MI, Zbar B, Affara NA, Ferguson-Smith MA, et al (1994) Identification of intragenic mutations in the von Hippel-Lindau disease tumour suppressor gene and correlation with disease phenotype. Hum Mol Genet 3: 1303
12. Ellison GT, Mansberger JA, Wray CH, Mansberger AR (1988) Diagnosis and treatment of pheochromocytomas: part I. Surg Rounds 39
13. Gagner M, Pomp A, Heniford BT, Pharand D, Lacroix A (1997) Laparoscopic adrenalectomy. Lessons learned from 100 consecutive procedures. Ann Surg 226: 238
14. Grossman E, Goldstein DS, Hoffman A, Keiser HR (1991) Glucagon and clonidine testing in the diagnosis of pheochromocytoma. Hypertension 17: 733
15. Guazzoni G, Montorsi F, Bocciardi A, Da Pozzo L, Rigatti P, Lanzi R, Pontiroli A (1995) Transperitoneal laparoscopic versus open adrenalectomy for benign hyperfunctioning adrenal tumors: a comparative study. J Urol 153: 1597
16. Janetschek G, Lhotta K, Gasser R, Finkenstedt G, Jaschke W, Bartsch G (1997) Adrenal-sparing laparoscopic surgery for aldosterone-producing adenoma. J Endourol 11: 145
17. Lawrence AM (1967) Glucagon provocative test for pheochromocytoma. Ann Intern Med 66: 1091
18. Lee JE, Curley SA, Gagel RF, Evans DB, Hickey RC (1996) Cortical-sparing adrenalectomy for patients with bilateral pheochromocytoma. Surgery 120: 1064
19. Lenders JW, Keiser HR, Goldstein DS, Willemsen BS, Friberg P, Jacobs M-C, Kloppenborg PW, Thien T, Eisenhofer G (1995) Plasma metanephrines in the diagnosis of pheochromocytoma. Ann Intern Med 123: 101
20. Levine SN, McDonald JC (1984) The evaluation and management of pheochromocytomas. Adv Surg 17: 281
21. Maurea S, Cuocolo A, Reynolds JC, Tumeh SS, Begley MG, Linehan WM, Norton JA, Walther MM, Keiser HR, Neumann RD (1993) Iodine-131-metaiodobenzylguanidine scintigraphy in preoperative and postoperative evaluation of paragangliomas: comparison with CT and MRI. J Nucl Med 34: 173
22. Melicow MM (1977) One hundred cases of pheochromocytoma (107 tumors) at the Columbia-Presbyterian Medical Center, 1926–1976: a clinicopathological analysis. Cancer 40: 1987
23. Modlin IM, Farndon JR, Shepherd A, Johnston ID, Kennedy TL, Montgomery DA, Welbourn RB (1979) Phaeochromocytomas in 72 patients: clinical and diagnostic features, treatment and long term results. Br J Surg 66: 456
24. Moorhead EL II, Caldwell JR, Kelly AR, Morales AR (1966) The diagnosis of pheochromocytoma. Analysis of 26 cases. JAMA 196: 1107
25. Nakajo M, Shapiro B, Copp J, Kalff V, Gross MD, Sisson JC, Beierwaltes WH (1983) The normal and abnormal distribution of the adrenomedullary imaging agent *m*-[I-131]iodobenzylguanidine (I-131 MIBG) in man: evaluation by scintigraphy. J Nucl Med 24: 672
26. Newbould EC, Ross GA, Dacie JE, Bouloux PM, Besser GM, Grossman A (1991) The use of venous catheterization in the diagnosis and localization of bilateral phaeochromocytomas. Clin Endocrinol (Oxf) 35: 55
27. Newell KA, Prinz RA, Pickleman J, Braithwaite S, Brooks M, Karson TH, Glisson S (1988) Pheochromocytoma multisystem crisis. A surgical emergency. Arch Surg 123: 956
28. Orchard T, Grant CS, Heerden JA van, Weaver A (1993) Pheochromocytoma – continuing evolution of surgical therapy. Surgery 114: 1153
29. Page DL, DeLessis RA, Hough AJ (1986) Tumors of the Adrenal. Pheochromocytoma. Second Series. Washington D.C. Armed Forces Institute of Pathology, Fascicle 23. Atlas of tumor pathology, p 183
30. Page LB, Copeland RB (1968) Pheochromocytoma. Dis Monogr 1
31. Perry RR, Keiser HR, Norton JA, Wall RT, Robertson CN, Travis W, Pass HI, Walther MM, Linehan WM (1990) Surgical management of pheochromocytoma with the use of metyrosine. Ann Surg 212: 621
32. Pullerits J, Ein S, Balfe JW (1988) Anaesthesia for phaeochromocytoma. Can J Anaesth 35: 526
33. Reinig JW, Doppman, JL, Dwyer AJ, Johnson AR, Knop RH (1986) Adrenal masses differentiated by MR. Radiology 158: 81
34. Remine WH, Chong GC, Heerden van JA, Sheps SG, Harrison EG Jr (1974) Current management of pheochromocytoma. Ann Surg 179: 740
35. Ross EJ, Griffith DN (1989) The clinical presentation of phaeochromocytoma. Q J Med 71: 485
36. Shapiro B, Fig LM (1989) Management of pheochromocytoma. Endocrinol Metab Clin North Am 18: 443
37. Shapiro B, Copp JE, Sisson JC, Eyre PL, Wallis J, Beierwaltes WH (1985) Iodine-131 metaiodobenzylguanidine for the locating of suspected pheochromocytoma: experience in 400 cases. J Nucl Med 26: 576
38. Siqueira-Filho AG, Sheps SG, Maher FT, Jiang NS, Elveback LR (1975) Glucagon-blood catecholamine test: use in isolated and familial pheochromocytoma. Arch Intern Med 135: 1227
39. Starkman MN, Zelnik TC, Nesse RM, Cameron OG (1985) Anxiety in patients with pheochromocytomas. Arch Intern Med 145: 248
40. Stewart BH, Bravo EL, Haaga J, Meaney TF, Tarazi R (1978) Localization of pheochromocytoma by computed tomography. N Engl J Med 299: 460
41. Streeten DH, Anderson GH Jr, Wagner S (1990) Effect of age on response of secondary hypertension to specific treatment. Am J Hypertens 3: 360
42. Sutton MG, Sheps SG, Lie JT (1981) Prevalence of clinically unsuspected pheochromocytoma. Review of a 50-year autopsy series. Mayo Clin Proc 56: 354
43. Telenius-Berg M, Ponder MA, Berg B, Ponder BAJ, Werner S (1989) Quality of life after bilateral adrenalectomy in MEN 2. Henry Ford Hosp Med J 37: 160
44. Vargas HI, Kavoussi LR, Bartlett DL, Wagner JR, Venzon DV, Fraker DL, Alexander HR, Linehan WM, Walther MM (1997) Laparoscopic adrenalectomy: a new standard of care. Urology 49: 673
45. Walther MM (1997) Laparoscopic surgery for adrenal disease. Principles Pract Oncol Updates 11: 1
46. Walther MM, Reiter R, Keiser HR, et al (1999) A clinical and genetic characterization of pheochromocytoma in von Hippel-Lindau kindreds. Comparison with sporadic pheochromocytoma gives insight into natural history of pheochromocytoma (in press)
47. Watson JP, Hughes EA, Bryan RL, Lawson N, Barnett AH (1990) A predominantly adrenaline-secreting phaeochromocytoma. Q J Med 76: 747