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Laparoscopic adrenalectomy for nonmalignant disease: improved safety, morbidity, and cost-effectiveness

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Abstract
Background: Laparoscopic adrenalectomy has rapidly gained widespread acceptance for treatment of benign adrenal neoplasms. A number of authors have compared various anatomic approaches to laparoscopic adrenalectomy, comparing length of inpatient stay, transfusion requirements, and perioperative complications. Separate studies have found inpatient stay reduced 40–60% with the use of laparoscopic adrenalectomy vs. an open procedure.
Methods: There have been no studies designed specifically to examine and compare perioperative morbidity, length of stay, and patient charges in patients undergoing laparoscopic adrenalectomy. This report examines the Johns Hopkins Hospital experience with laparoscopic adrenalectomy in 22 patients, comparing length of stay, perioperative morbidity, and patient charges. These data are compared with those seen in 17 patients undergoing open adrenalectomy within our institution and 70 patients at all other nonfederal hospitals in the state of Maryland.
Results: Outcomes after laparoscopic versus open adrenalectomy were compared. Resumption of diet (1.6 vs. 6.1 days), independent activity (1.6 vs. 7.9 days), inpatient length of stay (1.7 vs. 7.8 days), and total hospital patient charges ($8,698 vs. $12,610) were all significantly reduced in patients undergoing laparoscopic adrenalectomy at our institution. Similar findings were obtained when our data were compared against adrenalectomy performed at other hospitals within the state of Maryland. Length of stay (1.7 vs. 8.9 days) and total hospital patient charges ($8,698 vs. $13,867) were both significantly reduced compared to statewide data in patients treated with laparoscopic adrenalectomy.
Conclusions: Although a technically challenging procedure, laparoscopic adrenalectomy provides clear advantages over open procedures for the vast majority of adrenal neoplasms. Our data support the conclusion that laparoscopic adrenalectomy should be considered for all patients with benign adrenal neoplasms.

Key words: Laparoscopic adrenalectomy — Outcome data — Cost analysis data — Benign adrenal neoplasms — Inpatient length of stay — Perioperative complications — Transfusion requirements

Previously, the surgical approach to management of benign and malignant adrenal neoplasms involved a large surgical incision and extensive dissection in order to safely reach and excise a small retroperitoneal structure. The anterior transabdominal approach, using either a transverse or midline incision, allowed for exploration of the entire abdominal cavity and was favored for cases of pheochromocytoma and large adrenal tumors. Although the morbidity associated with a major thoracic incision was high, the transthoracic approach provided the widest exposure for exploration, and was used to resect large tumors of the retroperitoneum. Finally, the posterior retroperitoneal approach provided direct, but limited, access for approaching small adrenal tumors, and was commonly employed in cases of bilateral hyperplasia.

The advent of minimally invasive techniques has revolutionized the field of surgery. The successful application of laparoendoscopic techniques to cholecystectomy, Nissen fundoplication, and nephrectomy has proved advantageous compared with open techniques with regard to postoperative morbidity. Laparoscopic adrenalectomy clearly exemplifies another successful application of minimally invasive techniques to an organ that is relatively inaccessible due to its location in the retroperitoneum.

The first laparoscopic adrenalectomy was performed by Dr. Lamar Snow (Mobile, AL, USA), and the first report of the anterior approach to laparoscopic adrenalectomy was reported at the Second International Congress of Endoscopic Surgery (1992, Bordeaux, France) by Dr. Joseph Petelin (personal communication, Dr. Petelin). Subsequently, the lateral approach to laparoscopic adrenalectomy

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was published by Gagner et al. in 1992 [6], in patients with Cushing's syndrome and pheochromocytoma. Since the initial report, this procedure has been performed with increasing frequency, and the world literature has grown to nearly 200 reports of the application and modification of this procedure. Subsequent reports describe expanded indications, alternative approaches to the adrenal gland, and refinements in laparoendoscopic techniques. It seems likely that the laparoscopic technique will become the preferred procedure for the majority of adrenalectomies.

The indications for laparoscopic adrenalectomy have expanded, allowing this technique to be used for virtually all nonmalignant neoplasms of the adrenal gland. Recent reviews suggest that tumor size and malignancy remain the significant limiting factors to laparoscopic resection [1, 5, 13, 16].

In skilled hands, transition to laparoscopic adrenalectomy has reduced transfusion requirements and postoperative patient recovery times. Patients with glucocorticoid-producing adrenal tumors represent increased technical challenges and risk for postoperative morbidity and mortality due to their large deposition of fat, poor tissue quality, and metabolic abnormalities. Avoidance of a large incision in these patients by using laparoscopic techniques, combined with ultrasound visualization and safe use of the argon-beam coagulator [9, 23], have resulted in reductions in morbidity and mortality [3, 8, 9, 23]. Likewise, laparoscopic resection of pheochromocytomas, with the attendant risk of hemodynamic instability, has met with excellent success [1, 2, 6–8, 10, 11, 14, 15, 17, 18, 20–22].

Various authors have compared different anatomic approaches to laparoscopic adrenalectomy [1, 2, 16], examining, among other parameters, patient length of stay and perioperative complications. Guazzoni and Rutherford [11, 19] also found that patients undergoing laparoscopic adrenalectomy require inpatient stays that are 40–60% shorter than those undergoing an open procedure. To date, however, studies designed specifically to examine and compare perioperative morbidity, length of stay, and patient charges in patients undergoing laparoscopic adrenalectomy have not shown significant differences in all areas when comparing open and laparoscopic adrenalectomy [12].

This report reviews the initial series of laparoscopic adrenalectomies performed at the Johns Hopkins Hospital, and examines comparisons of length of stay, perioperative morbidity, and patient charges. These data are analyzed and compared with findings for patients undergoing open adrenalectomy at our institution. Comparisons were also made with adrenalectomies performed at all other nonfederal hospitals in the state of Maryland.

Patients

Our series examined laparoscopic adrenalectomy for a variety of adrenal neoplasms compared with transabdominal, transthoracic, or retroperitoneal open adrenalectomy during the period from September 1992 through July 1997. The first laparoscopic adrenalectomy performed at our institution took place in 1994. Figure 1 shows the frequency of both open and laparoscopic procedures during this interval.

This study included 39 patients, with 22 patients undergoing attempted laparoscopic resection and the remaining 17 undergoing standard open procedures. Two patients required conversion from laparoscopic to open procedures. As the intended treatment for these patients was the laparoscopic procedure, they were analyzed with the laparoscopic treatment group. Of the remaining 20 patients, 65% were female ($n = 13$) and 35% were male ($n = 7$). Their ages ranged from 15 to 69 years, with a mean of 44.4 ± 14.2 years. Patient demographic data are described in Table 1. The indications for adrenalectomy are depicted in Table 2.

The state of Maryland has compiled and maintained a database of diagnosis, patient charge, and clinical outcome data for all admissions to all 52 nonfederal hospitals in the state. All hospitals included are required to submit these data directly to the state database, designated as the Health Services Cost Review Commission (HSCRC) database, which is blinded to prevent disclosure of patient or surgeon identity. We analyzed this database for patients undergoing open adrenalectomy during the period subsequent to 1994.

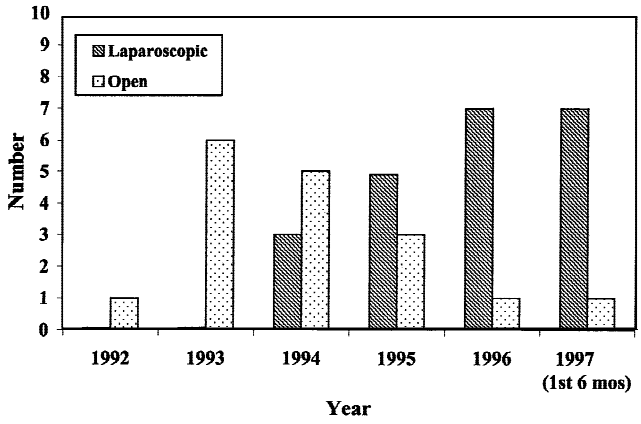

Fig. 1. Frequency of open versus laparoscopic adrenalectomy.

Table 1. Patient demographics

Demographics	Laparoscopic (%)	Open (%)
Male	6 (30)	6 (32)
Female	13 (65)	13 (68)
White	16 (80)	15 (79)
Black	3 (15)	2 (11)
Other	1 (5)	2 (11)

Table 2. Indications for adrenalectomy

Diagnosis	Laparoscopic	Open
Cushing's adrenal adenoma	3	0
Cushing's disease	1	0
Nonfunctioning	4	5
Pheochromocytoma	4	7
DHEAS secreting adrenal adenoma	1	1
Aldosteronoma	7	1
Cancer	0	4
Other	0	1
Totals	20	19

DHEAS, dehydroepiandrosterone.

Our review provided 70 patients who were analyzed in comparison with the outcome and patient charge at our hospital.

Methods

To assess potential function of an adrenal mass, a detailed history and physical examination was performed before operation, with careful detail paid to systemic symptoms, changes in vital signs, and alterations in body habitus and skin. Detailed review of imaging studies was undertaken to determine the location, size, and extension of the adrenal mass.

In patients without clinical signs and symptoms of hormonal excess, biochemical screening was employed to detect aldosteronomas, pheochromocytomas, and glucocorticoid-producing adrenal adenomas. In patients with hormone-producing adrenal tumors, preoperative treatment was undertaken during the weeks before the operation, including use of alpha- and beta-receptor-blocking agents in patients with pheochromocytomas and correction of metabolic derangements in patients with Cushing's syndrome and aldosternonomas.

With the exception of patients with pheochromocytomas, patients without significant comorbid pathology, were admitted to the hospital on the morning of surgery. Patients undergoing open adrenalectomy received full bowel preparation using polyethylene glycol solution. Those undergoing laparoscopic adrenalectomy required limited bowel preparation and received Fleet's enemas the night before surgery and on the morning of surgery. Patients with pheochromocytoma were initially admitted 24 hours before surgery to ensure adequate intravenous volume expansion. We have subsequently admitted these patients on the morning of surgery.

Open adrenalectomies were performed by an abdominal, thoracoabdominal, or retroperitoneal approach, as determined by tumor size, location, and functional status. All laparoscopic adrenalectomies were performed by the transperitioneal lateral approach described previously [4–8, 24]. After induction of general endotracheal anesthesia, a nasogastric tube and Foley catheter were inserted, and in selected cases, notably those involving pheochromocytoma, an arterial line and central venous access was established.

At the conclusion of both open and laparoscopic procedures, patients were admitted to the recovery room for observation before transfer to general surgical floors. Postoperative intensive care was reserved for patients experiencing severe symptoms from their endocrine tumors, particularly patients with poorly controlled pheochromocytomas and severely Cushingoid patients.

Results

No postoperative complications occurred within the group of patients who underwent laparoscopic adrenalectomy. Three patients experienced postoperative complications after open adrenalectomy. One patient developed fat necrosis and wound-edge dehiscence that was successfully treated with packing. One patient experienced urinary retention after removal of pheochromocytoma, requiring several days of urinary bladder decompression without further sequelae. Finally, one debilitated female patient with metastatic adrenal adenocarcinoma required a prolonged period to be weaned successfully from the ventilator, and eventually required a tracheostomy. After discharge, she was readmitted with an intra-abdominal fluid collection that was drained.

There was no mortality during the perioperative period in either group. However, the aforementioned patient with metastatic adrenal adenocarcinoma succumbed to her disease at home 47 days after open adrenalectomy. One patient treated with laparoscopic adrenalectomy during the study period was excluded from our analysis. This patient presented with ongoing profound Cushing's disease after failed trans-sphenoidal resection of a pituitary adenoma. This presentation was complicated by severe steroid-induced myopathy that rendered him too weak to move or sit in bed unassisted. He underwent bilateral laparoscopic adrenalectomy without complication, and his immediate perioperative period was uneventful. However, his preoperative myopathies necessitated a prolonged hospital stay (58 days). On the day of transfer to a rehabilitation facility, he was found unresponsive. His lengthy stay and hospital charges arose largely from his preexisting debilitation, and not his operative procedure. His operative times and charges were not significantly different from those of other patients treated with laparoscopic adrenalectomy. No other patients were excluded. There were no other patients in any group with similar preoperative morbidity.

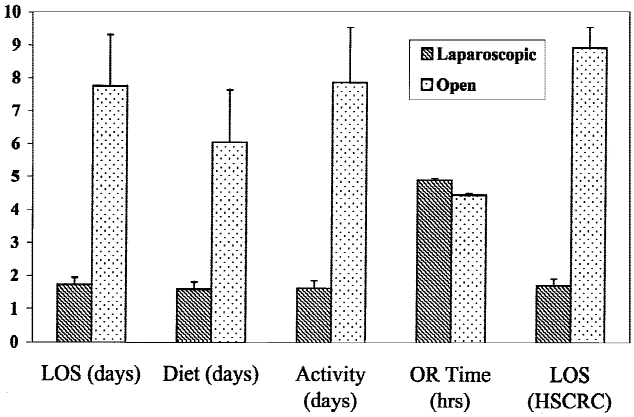

Fig. 2. LOS, diet, activity, and OR time comparison. LOS (length of stay), diet (days until resumption of regular diet), activity (days until resumption of regular activity), OR (operating room), HSCRC (Health Services Cost Review Commission).

A single patient with severe preoperative anemia, required a two-unit blood transfusion after laparoscopic adrenalectomy. The intraoperative blood loss was estimated to be less than 100 ml. Two patients undergoing open adrenalectomy required 4 units and 16 units of blood, respectively.

The mean length of stay for laparoscopic adrenalectomy was significantly shorter than that of patients treated with open adrenalectomy (1.7 ± 1.0 days vs. 7.8 ± 6.7 days, $p < 0.0001$), representing an improvement over previously reported series [1, 16, 19]. Patients resumed regular diet (1.6 ± 1.0 days vs. 6.1 ± 6.9, $p < 0.0001$) and independent activity (1.6 ± 1.0 days vs. 7.9 ± 7.3 days, $p < 0.0001$), much sooner after laparoscopic adrenalectomy than patients in the open group. Independent activity was based on the patient's ability to ambulate, provide their own personal care, and feed themselves without assistance. There was no significant difference in operative times between the laparoscopic and open groups. These data are summarized in Fig. 2.

As managed care has assumed an increasing role affecting surgeons' care decisions, issues of patient cost frequently arise. Laparoscopic surgery has previously been criticized as overly expensive due to reliance on sophisticated operating room equipment, the frequent use of disposable instrumentation, and prolonged operative times. Accordingly, we compared patient charges relating to both the operative procedure and total hospitalization in patients undergoing laparoscopic adrenalectomy. The operating room charges were similar for both laparoscopic and open adrenalectomy ($3,501 ± $727 vs. $3,317 ± $1,821), respectively. However, comparison of total hospitalization charges revealed laparoscopic adrenalectomy to be significantly less

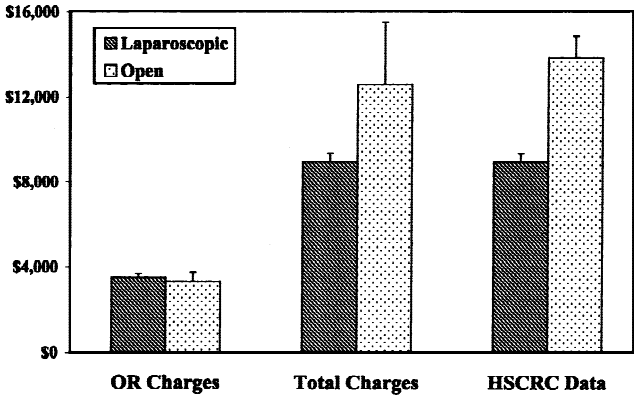

Fig. 3. Patient charges for operating room and total hospitalization. HSCRC, Health Services Cost Review Commission.

expensive than the open procedure ($8,698 ± $1,739 vs. $12,610 ± $12,656, $p = 0.03$). These results are summarized in Fig. 3.

Finally, using the data provided by the HSCRC database, we compared the results of our laparoscopic adrenalectomies with open procedures performed among the 52 other nonfederal hospitals located in the state of Maryland. Because the HSCRC database does not provide detailed patient histories, demographics, or selection criteria, patients were analyzed solely on the basis of CPT procedure codes for adrenalectomy. This analysis yielded 70 patients who underwent adrenalectomy during the period from 1994 through 1996. These data were analyzed for postoperative length of stay, operating room charges, and charges for the entire hospitalization and compared with our laparoscopic adrenalectomy series.

The mean length of stay for laparoscopic adrenalectomy was significantly shorter than that of patients in the HSCRC database with open adrenalectomy (1.7 ± 1.0 days vs. 8.9 ± 5.3 days, $p < 0.0001$). Although operating times for patients in the HSCRC database were unknown, comparison of operating room charges revealed no significant difference between laparoscopic adrenalectomy at Johns Hopkins and the HSCRC data ($3,501 ± $727 vs. $2,831 ± $1,593, respectively). Finally, comparison of patient charges for the entire hospitalization revealed that our laparoscopic series was significantly less expensive than those included in the HSCRC data ($8,968 ± $1,739 vs. $13,867 ± $8,456, $p < 0.0001$), as summarized in Fig. 2 and 3.

Conclusions

Since its introduction in 1992, laparoscopic adrenalectomy has been embraced as the operative procedure of choice for a variety of functioning and nonfunctioning benign adrenal neoplasms. During the 5 years after its introduction, the world literature has increased to nearly 200 reports, providing insight and analysis for the selection and refinement of operative technique as well as the application of this procedure to a broadening range of patients.

Laparoscopic adrenalectomy appears to be a safe, well-tolerated procedure, with significantly less perioperative morbidity than open procedures performed for the same indications. Although several previous series have examined postoperative stay, complications, and measures of perioperative pain in open versus laparoscopic procedures, our series is the first designed to compare these procedures directly for operating room and total hospital patient charges in addition to patient length of stay and resumption of diet and activity. The HSCRC database offers a powerful tool for comparison of our results with those obtained in all nonfederal hospitals within the state of Maryland.

We have shown that laparoscopic adrenalectomy results in significantly decreased time required for patients to resume a regular diet and independent activity. Also, inpatient length of stay is shorted nearly fivefold. Issues of resource use and cost containment are becoming more frequent as managed care continues to have an impact on surgical practice. Although laparoscopic procedures have previously been regarded as ‘‘equipment and OR expensive,’’ in comparing open and laparoscopic procedures, we did not find significant differences in either operating room charges or operating time. However, as a result of markedly reduced hospital stays and fewer postoperative complications, total hospitalization charges are significantly reduced.

Comparisons of procedures within a single institution can be complicated by issues relating to surgeons’ technical skill and bias in selection of procedures. The Maryland HSCRC provides a valuable database of ‘‘blinded’’ procedure, cost, and outcome data for the other hospitals in our state. Comparison of our series against the HSCRC database confirms the findings within our own institution.

Evaluation of new surgical procedures in comparison with standard operative therapies can be fraught with potential for bias. Ideally, new procedures should be prospectively analyzed with randomized studies. However, in the case of laparoscopic adrenalectomy, outcomes observed as we first mastered the procedure were so profoundly improved over those with open adrenalectomy that we could not ethically propose randomized treatment for patients with benign adrenal neoplasms.

Historically, open adrenalectomy for pheochromocytoma has been associated with higher morbidity and length of stay. In our study, more patients with pheochromocytomas had been treated with open than with laparoscopic adrenalectomy. However, reanalysis of our data excluding patients with pheochromocytomas had no significant impact on in differences in length of stay, resumption of activity, or total patient charges. Likewise, because most authors agree that laparoscopic adrenalectomy should be reserved for benign adrenal neoplasms, reanalysis of our data to exclude the four patients treated for cancer in the open group had no significant impact on the differences in all categories examined.

Laparoscopic adrenalectomy is a technically challenging procedure that should be undertaken only by surgeons whose sufficient experience with retroperitoneal anatomy allows them to convert to open procedures when required. In addition, it is essential that surgeons managing these patients have a sound grounding in the management of endocrine disease. Laparoscopic adrenalectomy should now be considered for removal of all benign neoplasms of the adrenal gland.

References

1. Brunt LM, Doherty GM, Norton JA (1996) Laparoscopic adrenalectomy compared to open adrenalectomy for benign adrenal neoplasms. [see comments] J Am Coll Surg 183: 1–10
2. Duh QY, Siperstein AE, Clark OH, Schecter WP, Horn JK, Harrison MR, Hunt TK, Way LW (1996) Laparoscopic adrenalectomy: comparison of the lateral and posterior approaches. Arch Surg 131: 870–876
3. Fletcher DR, Beiles CB, Hardy KJ (1994) Laparoscopic adrenalectomy. Aust N Z J Surg 64: 427–430
4. Gagner M (1995) Adrenalectomy by laparoscopy. Ann Endocrinol (Paris) 56: 630–631
5. Gagner M (1995) Laparoscopic adrenalectomy. Surg Clin North Am 76: 523–537
6. Gagner M, Lacroix A, Bolte E (1992) Laparoscopic adrenalectomy in Cushing's syndrome and pheochromocytoma. [letter] N Engl J Med 327: 1033
7. Gagner M, Lacroix A, Bolte E, Pomp A (1994) Laparoscopic adrenalectomy: the importance of a flank approach in the lateral decubitus position. Surg Endosc 8: 135–138
8. Gagner M, Lacroix A, Prinz RA, Bolté E, Albala D, Potvin C, Hamet P, Kuchel O, Quérin S, Pomp A (1993) Early experience with laparoscopic approach for adrenalectomy. Surgery 114: 1120–1125
9. Go H, Takeda M, Imai T, Komeyama T, Nishiyama T, Morishita H (1995) Laparoscopic adrenalectomy for Cushing's syndrome: comparison with primary aldosteronism. Surgery 117: 11–17
10. Guazzoni G, Montorsi F, Bergamaschi F, Rigatti P, Cornaggia G, Lanzi R, Pontiroli AE (1994) Effectiveness and safety of laparoscopic adrenalectomy. J Urol 152(Pt 1): 1375–1378
11. Guazzoni G, Montorsi F, Bocciardi A, Pozzo LD, Rigatti P, Lanzi R, Pontiroli A (1995) Transperitoneal laparoscopic versus open adrenalectomy for benign hyperfunctioning adrenal tumors: a comparative study. [see comments] J Urol 153: 1597–1600
12. Korman JE, Ho T, Hiatt JR, Phillips EH (1997) Comparison of laparoscopic and open adrenalectomy. [in process citation] Am Surg 63: 908–912
13. Mercan S, Seven R, Ozarmagan S, Tezelman S (1995) Endoscopic retroperitoneal adrenalectomy. Surgery 118: 1071–1076
14. Meurisse M, Joris J, Hamoir E, Hubert B, Charlier C (1994) Laparoscopic adrenalectomy in pheochromocytoma and Cushing's syndrome: reflections about two case reports. Acta Chir Belg 94: 301–306
15. Miccoli P, Iacconi P, Conte M, Goletti O, Buccianti P (1995) Laparoscopic adrenalectomy. J Laparoendosc Surg 5: 221–226
16. Prinz RA (1995) A comparison of laparoscopic and open adrenalectomies. Arch Surg 130: 489–494
17. Proye CA, Huart JY, Cuvillier XD, Assez ML, Gambardella B, Carnaille BML (1993) Safety of the posterior approach in adrenal surgery: experience in 105 cases. Surgery 114: 1126–1131
18. Rutherford JC, Gordon RD, Stowasser M, Tunny TJ, Klemm SA (1995) Laparoscopic adrenalectomy for adrenal tumours causing hypertension and for ''incidentalomas'' of the adrenal on computerized tomography scanning. Clin Exp Pharmacol Physiol 22: 490–492
19. Rutherford JC, Stowasser M, Tunny TJ, Klemm SA, Gordon RD (1996) Laparoscopic adrenalectomy. World J Surg 20: 758–761
20. Stoker ME, Patwardhan N, Maini BS (1995) Laparoscopic adrenal surgery. Surg Endosc 9: 387–391
21. Stuart RC, Chung SC, Lau JY, Chan CS, Cockram CS, Yeung VTF, Li AKC (1995) Laparoscopic adrenalectomy. Br J Surg 82: 1498–1499
22. Suzuki K, Kageyama S, Ueda D, Ushiyama T, Kawabe K, Tajima A, Yoshio A (1993) Laparoscopic adrenalectomy: clinical experience with 12 cases. [see comments] J Urol 150: 1099–1102
23. Takeda M, Go H, Imai T, Komeyama T (1994) Experience with 17 cases of laparoscopic adrenalectomy: use of ultrasonic aspirator and argon beam coagulator. J Urol 152: 902–905
24. Udelsman R, Mersey JH (1995) A clinical moment with endocrinology and metabolism: laparoscopic adrenalectomy. Maryland Med J 44: 611–612