Minimally Invasive Surgery Approaches to Adrenal Gland Disorders
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Nothing to Declare

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Adrenal Glands
Anatomy & Physiology

- Located in the retroperitoneum superior to the kidneys bilaterally at the level of the 12th thoracic vertebra
- Surrounded by an adipose capsule and renal fascia.
- Third most highly perfused organ behind kidney and thyroid, 2000mL/kg/min

Adrenal Glands
Anatomy & Physiology

- Each separated into two distinct structures both of which produce hormones
  - Cortex - cortisol, aldosterone, and androgens
  - Medulla - chiefly produces epinephrine and norepinephrine
- Cortex
  - Mesodermal
  - 4th to 5th week
  - Glucocorticoids, mineralocorticoids, sex steroids
  - Hyperaldosteronism, Cushing's, virilization
- Medulla
  - Ectodermal
  - 5th to 6th week
  - Catecholamines
  - Pheochromocytoma
Indications for Adrenalectomy

- Hypersecretion of hormones
  - Pheo, Aldo, Cushing
- Cancers or potential cancers
- Local symptoms
- Uncertain diagnosis (diagnostic)

Indications for Adrenalectomy

- Metastases
  - Most common malignant tumor or the adrenal gland
- Primaries:
  - Lung
  - Breast
  - Melanoma
  - RCC
  - Extra-adrenal lymphoma
  - Leukemia
  - Pancreatic CA
  - Colon CA
  - Ovarian CA

“Incidentaloma”

- 0.5-5% of non-adrenal related CT scans
- Autopsy suggest a prevalence 2.1%
  - Nonsecretory adrenal adenomas (74.0%),
  - Hypersecretory adenomas (14.8%)
  - Carcinomas (4.0%)

Incidentaloma Workup

- Cushing’s syndrome
- If hypertensive or hypokalemic
  - tested for hyperaldosteronism
    - plasma aldosterone and renin levels
- Plasma-fractionated metanephrines
CUSHING’S SYNDROME

- Excessive circulating glucocorticoids
- Includes pituitary hypersecretion of ACTH
  - Cushing’s disease (75-80% of endogenous)
- Adrenal adenoma/carcinoma
- Ectopic ACTH/CRH secretion
- Always consider exogenous steroids
  - Creams and lotions

Adrenal Cushing’s Imaging

- Adrenal adenomas usually larger than 2cm
  - Solitary
  - Associated atrophy of the opposite gland
  - Density is low because of high lipid
- Carcinomas often indistinguishable from adenoma
  - Larger size (>6cm)
  - Necrosis and calcification (non-specific)
  - Large, irregular with invasion
  - mets can mimic

Subclinical Cushing’s

- Increasingly recognized w/ incidentaloma
- Biochemical evidence
  - Nonsuppressed w/ dexamethasone
  - Loss of diurnal variation in cortisol
  - Low plasma ACTH
- Lack the features of Cushing’s syndrome
- May have:
  - Hypertension
  - Diabetes
  - Obesity
  - osteoporosis
- REQUIRE STEROIDS PERIOPERATIVELY!!!!!
**Indications for Adrenalectomy**

- Lateralization is indicated:
  - All patients > 40 years
  - Bilateral adrenal nodularity
  - Normal adrenals
  - Unilateral nodule smaller than 1 cm

**Aldosteronomia Preop**

- Hypertension control
- Hypokalemia corrected
- Spironolactone (aldosterone antagonist)
  - Preop hypertension tx
  - Complete biochemical workup prior
  - Discontinued postop

**Adrenal vein sampling**

- Lateralization is indicated:
  - All patients > 40 years
  - Bilateral adrenal nodularity
  - Normal adrenals
  - Unilateral nodule smaller than 1 cm

**(Relative) Contraindications for Laparoscopic Adrenalectomy**

- Large adrenal tumors
  - What is “large”? > 6-15 cm?
  - > 8 cm for right
  - > 10 cm for left
- Adrenocortical carcinomas
  - Not for obviously invasive cancers (ie. when en bloc resection necessary).
  - Right sided tumors > 9 cm have high chance of invading into IVC and right heart - may need CPB
  - Start laparoscopic then convert as needed?
- Technical limitations – tumor fracture
- Risks of inadequate / inappropriate resection (cancer) - en bloc resection of adjacent organs and regional LAD
Tumors > 5cm

- 39 patients
  - No perioperative mortality
  - No conversion to open surgery
  - No capsular disruption
- Mean size 6.2 cm (5-12 cm)
- Operative time 207 (115-315 min)
- Blood loss 75 ml (minimal-1400 ml)
- Complications:
  - Intraoperative diaphragmatic perforation (1)
  - Wound infections (3)
  - Pneumonia (1)


Open Adrenalectomy – Prior Generation

J-incision (Makuuchi)  Thoraco-abdominal  Posterior (Hugh-Young)

Laparoscopic Adrenalectomy

Lateral Transabdominal Approach


Posterior Retroperitoneal Approach


Approaches for Adrenalectomy

Traditional
- Anterior
- Lateral
- Posterior
- Thoraco-abdominal

Minimally Invasive
- Anterior Transabdominal
- Lateral Transabdominal
- Lateral Retroperitoneal
- Posterior Retroperitoneal

Newer Minimally Invasive
- Robot-assisted
- Single Port Access
- NOTES
Laparoscopic Adrenalectomy: Lateral Transabdominal (Gagner) Approach

- “Open it like a book”
  - Medial visceral rotation
  - Front page: liver (R) pancreas-spleen (L)
  - Back page: adrenal-kidney
- “Read from the top down”
  - Start mediosuperior corner
  - Create a “V”, open top
  - Dissect adrenal medially
    - clockwise (R)
      - Until encounter renal v
    - counter-clockwise (L)
      - Until phrenic v

Variation of Adrenal Vein Anatomy

- Right vein
  - 5-10% multiple
  - 10% not into IVC (R renal, R hepatic, Confluences)
- Left
  - Inferior phrenic vein joining adrenal vein before draining into L renal vein.

Laparoscopic Adrenalectomy: Anatomy

- Venous drainage is solitary
  - Left vein ~2 cm into renal
  - Right ~0.5 cm into IVC
  - 20% variable / anomalous
  - 5-10% double
- Arterial supply is diffuse
  - Inferior phrenic artery
  - Juxtaceliac aorta
  - Renal artery

LA: Anatomy on Left
Left Adrenal Vein

- Lateral position
- 4 subcostal ports
- Dissect splenic flexure down and spleen & tail of pancreas anteriorly
- Follow the inferior phrenic vein draining into the left adrenal vein

Right Adrenal Vein

- Lateral position
- 4 subcostal ports
- Retract liver anteriorly, dissect triangular ligament
- Follow the lateral border of IVC to find the right adrenal vein

LA: Anatomy on Right

Laparoscopic Adrenalectomy
Alternate Approaches

- Walz Technique
- Hand assist
- Microlaparoscopy
- Robot
- SILS
- NOTES
Hand Assisted Laparoscopic Adrenalectomy

- Large tumor (>8-12 cm)
- Difficult to control vessels
- Need to remove specimen intact through a incision anyway
- “Elective” conversion in a difficult case

Needlescopic Adrenalectomy

- 12 mm umbilical, 2/2/5 mm subcostal
- 15 compared with 21 lap adrenals
- Op time 169 vs 220 min
- Blood loss 61 vs 183 ml
- Hospital stay 1.1 vs 2.7 days
- Convalencesce 2.1 vs 3.1 weeks

Robot-Assisted Laparoscopic Adrenalectomy

- Prospective, non-randomized 100 patients
- Op time 95 minutes
  - Depends on surgeon experience, assistant level and tumor size
- Conversion 5%, complications 10%
- Cost higher
  - €4102 vs € 1799 (2.3 x)


Single Access Retroperitoneoscopic Adrenalectomy (SARA)

- 47 patients, 50 adrenals
  - 2 cm incision
  - 20 aldo, 15 pheo, 6 Cushing
  - Completed in 41
  - Op time 56 min
  - 47% had pain medication
  - Stayed 2.4 days in hospital
  - Compared favorably with other LA


Laparoscopic Adrenalectomy: NOTES

- Transvaginal retroperitoneal approach
- Natural orifice transluminal endoscopic surgery (NOTES)
- Successful in 2 pigs and 2 cadavers


Survey of Residency Training in Laparoscopic and Robotic Surgery

David A. Duchene, Alireza Motamedeh, Isheer S. Gill, Ralph V. Clayman and Howard N. Winfield*
LA survey

- In the last 12 months:
  - 32% performed LA 1 to 5 times
  - 3% had performed it 6 to 10 times
  - 1 resident had performed it greater than 10 times
- 56% had not performed the procedure but it was done at their institution
- 8% did not perform LA at their institution
- 54% believe goldstandard, 36% believe it looks promising


500 Laparoscopic Adrenalectomies
UCSF, 1993 to 2009: Diagnoses

- Hyperaldosteronism N=161 32%
- Pheochromocytoma N=117 23%
- Cushing N=82 16%
- Cortical tumors N=41 8%
- Metastases N=42 8%
- Others N=57 11%

Laparoscopic Adrenalectomy:
Converted (UCSF, 4/93-12/09)

- 3 converted to hand-assisted
  - 15 cm L pheo (#111, 4 yr later distant mets)
  - 16 cm L metastatic hepatoma (#196, 6 m later rec hepatoma)
  - 5 cm R myelolipoma/hemorrhage (#226, adhesions, benign)
- 5 converted to open
  - 8 cm R pheo (#202, crisis, adhesions, 18 m later distant mets)
  - 8 cm R cort tu/hemorrhage (#225, adhesions, adenoma)
  - 8 cm R pheo (#240, adhesions, 6 m later distant/local mets)
  - 5 cm L renal cell met (prior op, locally invasive)
  - 3 cm L pheo (splenic capsule tear)

Laparoscopic Adrenalectomy:
Hospital days (UCSF, 4/93-1/05)

- 0 10 20 30 40 50 60 70 80
- 23 hrs 2 days 3 days 4+ days
- Length of Hospitalization
- Aldo
- Pheo
- Cushing
- Others
Laparoscopy for Adrenal Tumors: UCSF Experience

- Primary Hyperaldosteronism
  - Under diagnosed
  - Venous sampling is necessary in SOME
- Pheochromocytoma/Paraganglioma
  - Common familial syndromes – MEN 2, VHL, SDHB/D
- Cushing’s
  - High periop morbidity, but excellent long term outcome
    - Subclinical Cushing’s benefit from resection
- Metastasis to Adrenal
  - Resectable/curable, low risk for local recurrence
- Incidentaloma
  - A few need resection
  - Work up emphasize pheo & Cushing, no FNA

Minimally Invasive Adrenalectomy

- Laparoscopic adrenalectomy is the standard
  - except large tumors and invasive cancers
- Approach depends on surgeon’s preference
  - lateral transabdominal or posterior retroperitoneal
- Techniques continue to evolve

Thank You
Cortical Hypersecretory

- Cushing’s syndrome (Cortisol secreting)
- Aldosteronoma
- Virilization
- Combined hormone excess syndromes
- Adrenocortical carcinomas (50%)
Adrenomedullary tumors

- Pheochromocytoma
- Ganglioneuroblastoma
- Neuroblastoma
- Neuroendocrine carcinoma

Miscellaneous

- Primary adrenal lymphoma - Unilateral or bilateral
- Composite or mixed tumors
- Massive macronodular adrenal hyperplasia
- Hamartoma
- Teratoma
- Myelolipoma
- Angiomyolipomas
- Amyloidosis
- Plexiform neurofibromas

Stromal malignancies

- Neurofibrosarcoma
- Angiosarcoma
- Liposarcoma
- Fibrosarcoma
- Leiomyosarcoma
- Myxosarcoma
- Malignant teratoma

HA Screening

- Plasma aldosterone concentration (PAC) to plasma renin activity (PRA) ratio
- 24-h urine aldosterone > 12 lg/24 h while the patient is on a high sodium diet

Principles

- Divide the superior and lateral blood supplies first
- Leave attached to kidney to retract inferiorly and anteriorly
- Left side adrenal vein enters renal vein
- Phrenic branch medial = bleeding
- Beware ligation of upper pole apical branch to kidney

Size & Type of Tumor Change the Approach
(IRCAD-EITS, Strasbourg, May 14, 2005)