ADRENAL GLAND
Cortex and Medulla

- ANATOMY
- Embryology
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## Embryology

<table>
<thead>
<tr>
<th><strong>Adrenal Cortex:</strong></th>
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<tr>
<td>Coelomic mesoderm</td>
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<tr>
<td>Cluster of cells between root of mesentery and genital ridge</td>
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<tr>
<td>Androgenic and Estrogenic Tumor</td>
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<table>
<thead>
<tr>
<th><strong>Adrenal Medulla:</strong></th>
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<tr>
<td>Develops as special portion chromafin system from neuro ectoderm</td>
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<tr>
<td>Sympathoblast</td>
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<td>Sympathogonia</td>
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<td>Mature Ganglion cells</td>
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Histology:

- **Adrenal Cortex:**
  - Zona Glomerulosa
    - Aldosterone
  - Zona fasciculate
    - Store house for cholesterol
  - Zona reticularis
    - Rest of hormones.

- **Adrenal Medulla**
  - Adrenaline, Noradrenaline
The superior adrenal artery, branch of inferior phrenic Artery
The middle adrenal artery, branch of abdominal aorta direct.
The inferior adrenal artery, branch of renal artery
The Adrenal gland,

- Suprarenal gland
- Enclosed, together with the kidney, within the renal fascia but a lamina of fibroareolar tissue separates the two structures, so that they occupy separate compartments.
- Right adrenal is triangular in shape and the left is semilunar
The Right adrenal vein is very short and drains directly into the inferior vena cava.

The Left adrenal vein is longer and it drains into the left renal vein.
Adrenal Medulla

Tumours of Adrenal medulla
Phaeochromocytoma
Classification of Tumours of Adrenal Medulla

1. Benign:
   - a. Ganglioneuroma
   - b. Phaeochromocytoma (90%)

2. Malignant
   - Neuroblastoma
   - Phaeochromocytoma (10%)
Classification on Origin:

- Arising from the chromaffin cells - Phaeochromocytoma.
- Arising from the nerve cells (mature or immature) of the sympathetic nervous system:
  - Arising from and reproducing nerve cells of very immature type - Neuroblastoma.
  - Arising from and reproducing ganglion nerve cells of adult type - Ganglioneuroma
Phaeochromocytoma

- Phaeochromocytomas are tumours composed of chromafin tissue derived from nervous system.
- It is a functionally active catecholamine-secreting tumour.
- It produces an excess of adrenaline especially noradrenaline 20:1 ratio.
- Occurs in 4th and 5th decade of life, higher preponderance in the female.
- Only 0.5% of all hypertensives are due to pheochromocytoma.
- All patients under 60 years with sustained hypertension should be evaluated for Pheo.
Phaeochromocytoma

- Ten percent tumour
- 10% are extra adrenergic
- 10% are Multiple
- 10% are malignant
- 10% are in Children
- 10% are Bilateral
Sites of Phaeochromocytoma

- 90% arises from chromafin cells in adrenal medula.
- 10% arise from Para ganglia of sympathetic nervous system - coeliac, mesenteric, renal, hypogastric, testicular.
- Most common extra adrenal site is Organ of Zuckerkandl.
- A tumour in an ectopic site and one in a child is more likely to produce nor-adrenaline.
Phaeo. Can be a part of autosomal dominant multiple endocrine neoplastic syndrome

- Multiple endocrine adenomatosis type IIB
- Multiple endocrine adenomatosis type IIA (Sippel’s syndrome)
- Von Hippel-Lindau syndrome
- Parathyroid adenoma/hyperplasia, medulillary carcinoma of thyroid, Phaeo.
- Medulillary carcinoma of thyroid, mucosal adenoma, Marfanoid app., Phaeo.
- Haemangioplastoma of cerebellum, retina or brain and Phaeo.
The tumour is usually small (less than 5 cm).
It has a thin but definite capsule.
It is soft and is brownish in colour.
Microscopically, it consists of phaeochromocytes in large numbers. These are large, well-differentiated round cells, which characteristically stain black with chromium salts.
Clinical presentation

- Hypertension
- Headache
- Palpitation
- Trembling
- Sweating
- Feeling of panic and doom
- Pallor, wt loss, anorexia
- Nausea, vomiting
Attacks pre-disposed by

- Bending,
- twisting
- Change of
- emotions
- Post-prandial
- hypoglycemia

Hyper Tensive Attacks

Increased Catecholamines in Circulation

Alpha Adrenergic Effect

- Tachycardia, Excessive head ache,
- sweating unrelated to Temperature
- Palpitation, Nervousness, Circumoral Pallor

Feeling of Doom, Fear
I am going to Die

Beta Adrenergic Bradycardia

Diastolic hypertension

Weakness, hypotension follows the attack
Severe enough to produce gangrene – Toes, fingers.
Clinical Picture

- Gangrene of fingers
- Pain during micturition

Symptoms:
- Headache - 55%
- Sweating - 27%
- Vomiting - 28%
- Palpitation - 38%
- Weakness - 17%
- Dizziness - 15%
- Nervousness - 10%
- Pallor - 16%
- Dyspnea - 19%
- Substernal pain - 12%
- Abdominal pain - 12%
Other clinical features

- Cholelithiasis
- Abnormal glucose tolerance test
- Bleeding
  - Epistaxis
  - Hematemesis
  - Haematuria
  - Stroke
- Clinically: Hypertension
Phaeochromocytoma-crisis

- Hypertensive encephalopathy
- Neurological deficit
- Corneal blindness
- Progressive metabolic acidosis and death
- Left Ventricular failure

D-D

Thyrotoxicosis, Diabetes mellitus, malignant hypertension, Carcinoid Syndrome,
Gram negative septicemia,
Cardiomyopathy, Eclampsia of pregnancy
# Diagnostic Pointers

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<tr>
<th>Tests</th>
<th>Normal Values</th>
<th>Range</th>
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<tr>
<td>Urinary Metanephrine</td>
<td>&lt;1.3mgs/24 hrs</td>
<td>0.3 – 1.3 mgs/24 hrs</td>
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<tr>
<td>Urinary HMMA/ VMA</td>
<td>&lt;9mgs/24 hrs</td>
<td>3-9 mgs/24 hrs</td>
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<tr>
<td>Plasma catecholamine Adri+Noradri</td>
<td>&lt;1 ng/ml</td>
<td>0.8-1 ng/ml</td>
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One single test done on one occasion cannot be considered diagnostic, it should be done on 2-3 occasions.
Localisation

- MRI
- CT Scan
- MIBG scan (Meta-iodobenzyl guanidine)
- Selective adrenal vein sampling for hormone
- Catecholamine suppression test
- Catecholamine provocation test

The last three tests on are no longer required.

False reports may be found if strict dietary and drug restrictions is not followed.
MRI for Pheochromocytoma
MIBG scintiscan for Pheochromocytoma
Preoperative Preparation

- Close communication between anesthetist, surgeon, and physician should be present.
- Once the diagnosis is made, surgery is the only curative procedure.

Pharmacological control of adverse effects of circulating catecholamine

- Control of Hypertension
- Tachycardia, arrhythmias,
- Restoration of blood volume
- Control of end organ damage

It is very important to diagnose and treat Pheo before surgery.

Mortality of untreated Pheo with any surgery is as high as 50%
**Alpha adrenergic antagonists**

- **Phenoxybenzamine** - non selective
  - **Adv:** long duration of action
  - Prevents intra op catecholamine surge
  - **Dis Adv:** Being non selective: Tachycardia, arrhythmias, somnolence

- **Prazocin**  **Doxazocin**  **Terazocin**  - Selective

**Beta adrenergic antagonists**

- **Propranolol**
- **Atenolol**
- **Metoprolol**

1. **To** control the effects of adrenaline
2. **To** block excessive cardiac sympathetic drive secondary to alpha blockade

Suppression of Beta rece. mediated cardiac sympathetic activity in absence of adequate arteriolar dilation may precipitate Ac. Pulmonary Oedema
Investigations

- ECG
- Echocardiography
- BSL profile
- Renal Function Tests
- Renal scan
- X-ray Chest
- Serial Hematocrit
- Serum Calcium
PHARMACOLOGICAL CONTROL OF CATECHOLAMINE SURGE DURING SURGERY

Many drugs have been used for this purpose.

- Phentolamine
- Sodium Nitroprusside
- Nicardipine
- Sodium nitro glycerin
- Magnesium sulphate
- Labetolol.
- SNP + Esmolol infusion commonly used
ANAESTHESIA TECHNIQUE

- Premedication – previous night. Diazepam, alpha blocker, beta blocker, H2 blocker
- Anaesthesia – almost every anaesthetic technique is tried. We used either balanced general anaesthesia or epidural anaesthesia + general anaesthesia.
Surgery for Pheochromocytoma

Open adrenalectomy
1. Lateral Retroperitoneal
2. Transabdominal

Laparoscopic surgery
1. Retroperitoneal
2. Transperitoneal
Sustained hemodynamic changes of same severity as open surgery
Critical Steps in Perioperative period

- Intubation
- During tumour manipulation
- Immediately following ligation of the venous drainage of the tumour

Preop. Steroids to be given if bilateral adrenalectomy is to be planned.
MONITORING

- NIBP
- Pulse oximetry
- ECG
- ETCO2
- Respiratory Gases
- CVP
- BSL
- Urine output
- Peripheral nerve stimulator
- Temperature
Intra operative Control of Catecholamine Release

- Combination of regional + G.A. provides satisfactory condition till tumour exposure
- During Manipulation of tumour – brisk

Presser response:
1. Control of hypertension
   with potent I V vasodilator eg SNP
2. Control of Tachycardia - with Beta blockers

Rise in BP is more pronounced in NORADR secreting tumour and Tachycardia more so in ADRI + DOPAMINE secreting tumour
After tumour excision

- After ligation of last major vein: exponential decrease of BP.
- Fill the circulation with colloid solution either haemaccel or hysteril to bring CVP upto 9 and 10.
- Dopamine infusion
- Hypotension may be because of removal of active adrenal gland – opposite adrenal suppressed.
POSTOPERATIVE PERIOD

- **Hypotension** may persist because of long acting alpha blockers.
- **Hypertension** – extra adrenal pheo contralateral adrenal pheo.
- **Somnolence** – sudden withdrawal of circulating catecholamines
- **Hypoglycemia** – may lead to loss of consciousness – blood glucose monitoring.
- **Malignant** – non receptive pheo – Residual as much as possible.
Pheochromocytoma:
Pheochromocytoma remains a great challenge to surgeons. Condition continues to demand great respect.

Development of techniques like laparoscopy only reduces the hospital stay. Successful outcome is a team work. Surgeons anaesthetist, and aftercare team.