ADRENAL GLAND
Cortex and Medulla

- ANATOMY
- Embryology

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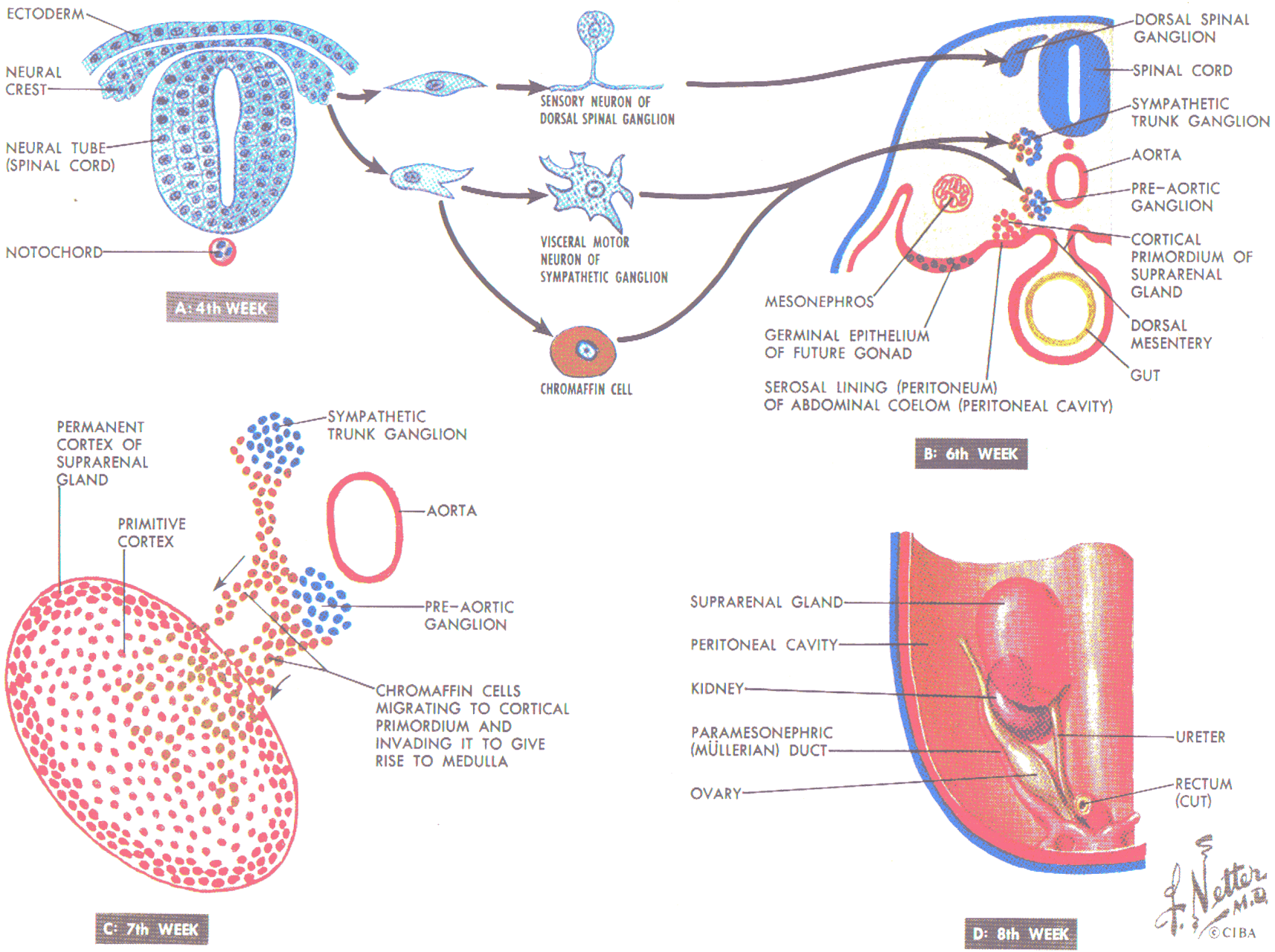
Embryology

- Adrenal Cortex:
- Coelomic mesoderm
- Cluster of cells between root of mesentery and genital ridge
- Androgenic and Estrogenic Tumor

- Adrenal Medulla:
- Develops as special portion chromafin system
- from neuro ectoderm
- Sympathoblast
- Sympathogonia
- Mature Ganglion cells


ECTODERM
NEURAL CREST
NEURAL TUBE (SPINAL CORD)
NOTOCHORD
A: 4th WEEK
SENSORY NEURON OF DORSAL SPINAL GANGLION
VISCERAL MOTOR NEURON OF SYMPATHETIC GANGLION
CHROMAFFIN CELL
DORSAL SPINAL GANGLION
SPINAL CORD
SYMPATHETIC TRUNK GANGLION
AORTA
PRE-AORTIC GANGLION
CORTICAL PRIMORDIUM OF SUPRARENAL GLAND
DORSAL MESENTERY
GUT
MESONEPHROS
GERMINAL EPITHELIUM OF FUTURE GONAD
SEROSAL LINING (PERITONEUM) OF ABDOMINAL COELOM (PERITONEAL CAVITY)
B: 6th WEEK
PERMANENT CORTEX OF SUPRARENAL GLAND
PRIMITIVE CORTEX
SYMPATHETIC TRUNK GANGLION
AORTA
PRE-AORTIC GANGLION
CHROMAFFIN CELLS MIGRATING TO CORTICAL PRIMORDIUM AND INVADING IT TO GIVE RISE TO MEDULLA
C: 7th WEEK
SUPRARENAL GLAND
PERITONEAL CAVITY
KIDNEY
PARAMESONEPHRIC (MÜLLERIAN) DUCT
OVARY
URETER
RECTUM (CUT)
D: 8th WEEK
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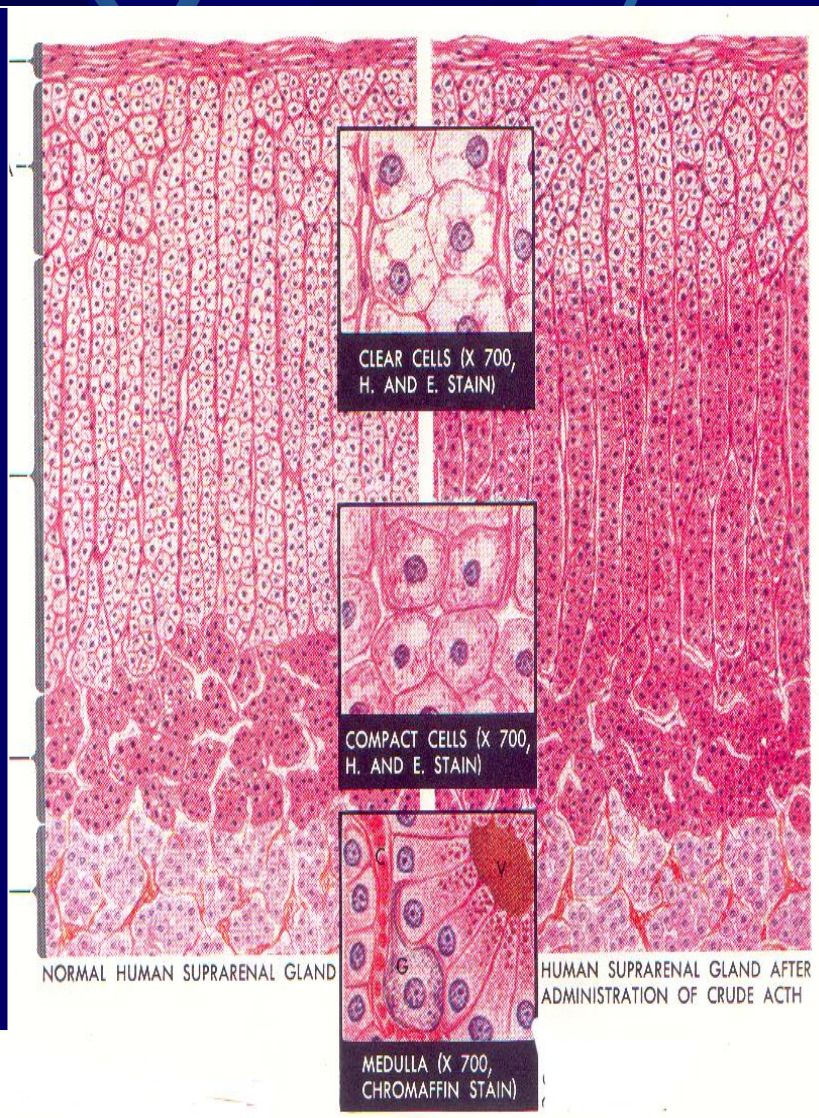
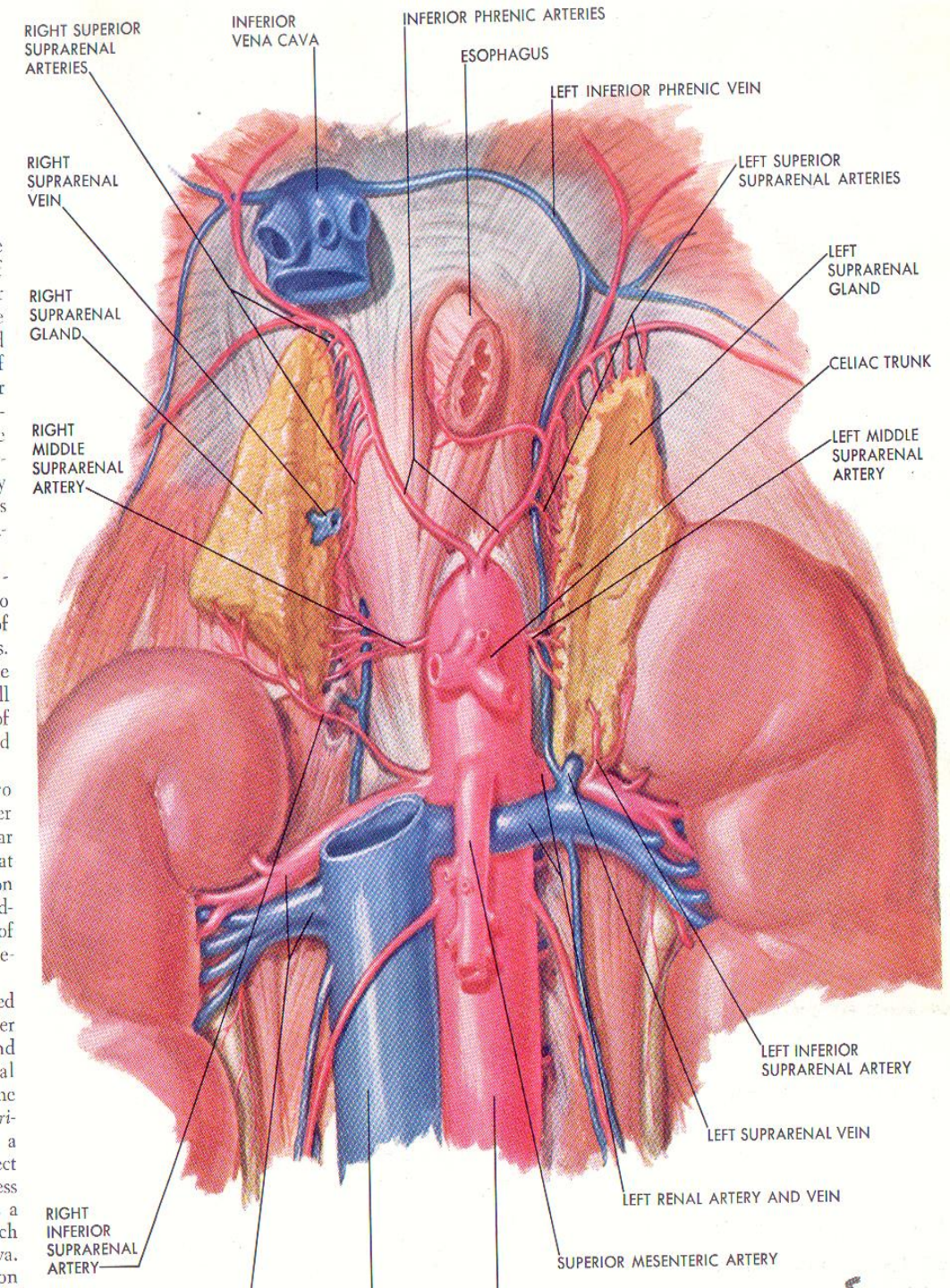
Histology:

- Adrenal Cortex:
  - Zona Glomerulosa
    - Aldosterone
  - Zona fasciculate
    - Store house for cholesterol
  - Zona reticularis
    - Rest of hormones.
- Adrenal Medulla
  - Adrenaline, Noradrenaline

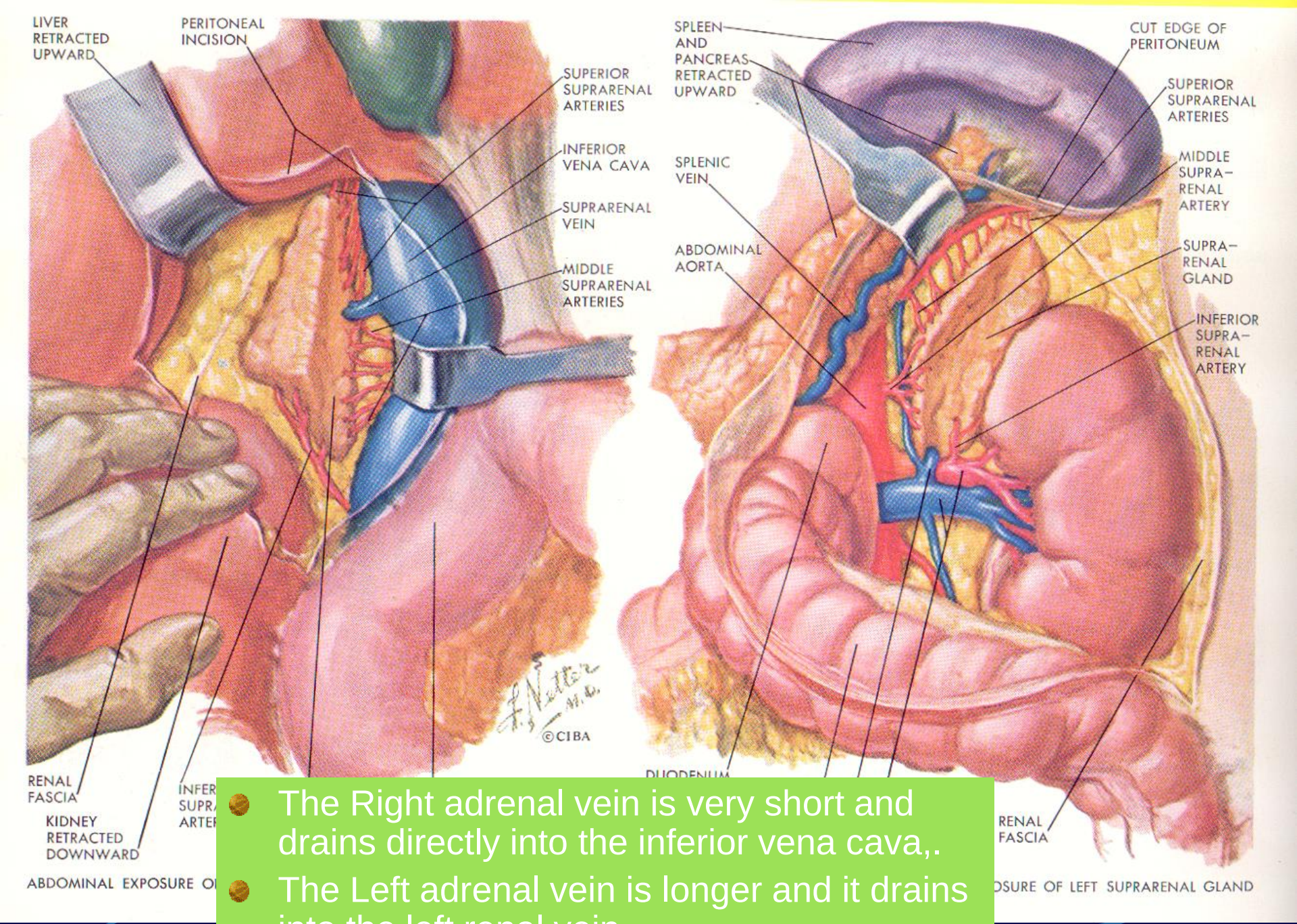




- The superior adrenal artery, branch of inferior phrenic Artery
- The middle adrenal artery, branch of abdominal aorta direct.
- The inferior adrenal artery, branch of renal artery

The Adrenal gland,

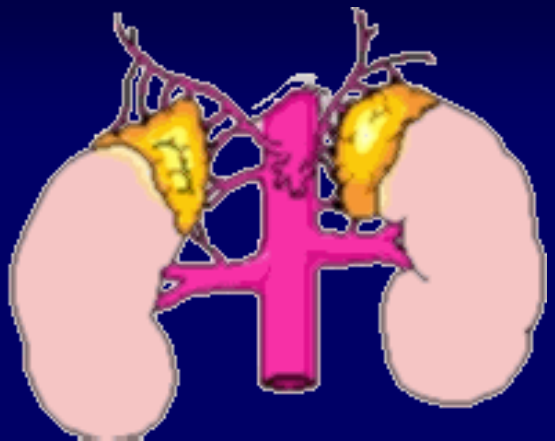
- Suprarenal gland
- Enclosed, together with the kidney, within the renal fascia but a lamina of fibroareolar tissue separates the two structures, so that they occupy separate compartments.
- Right adrenal is triangular in shape and the left is semilunar



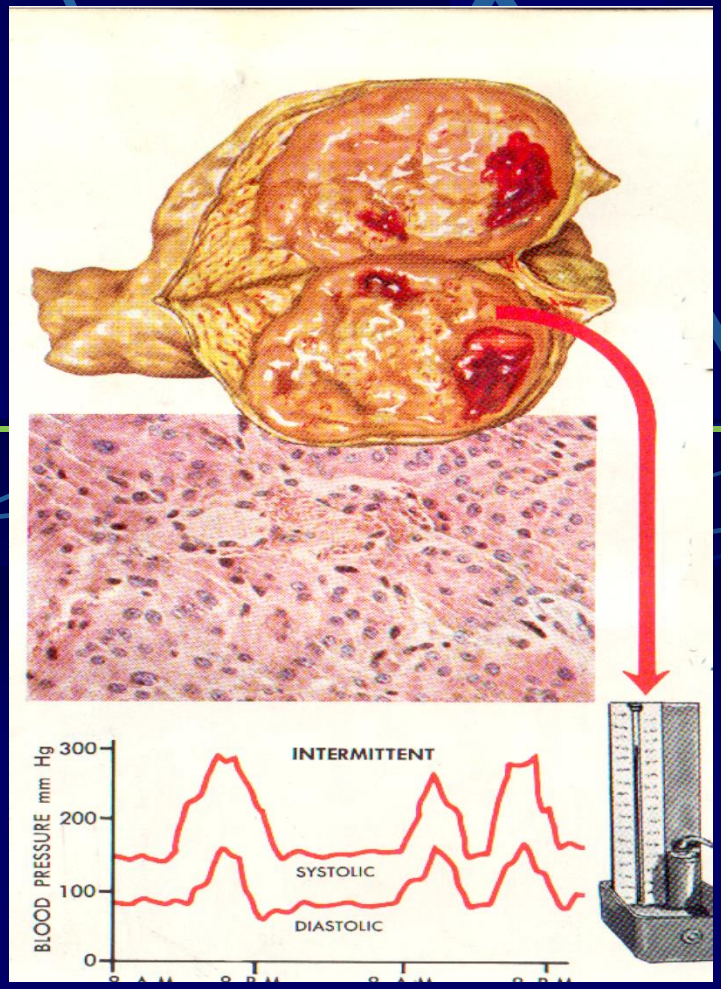
- The Right adrenal vein is very short and drains directly into the inferior vena cava,.
- The Left adrenal vein is longer and it drains into the left renal vein.

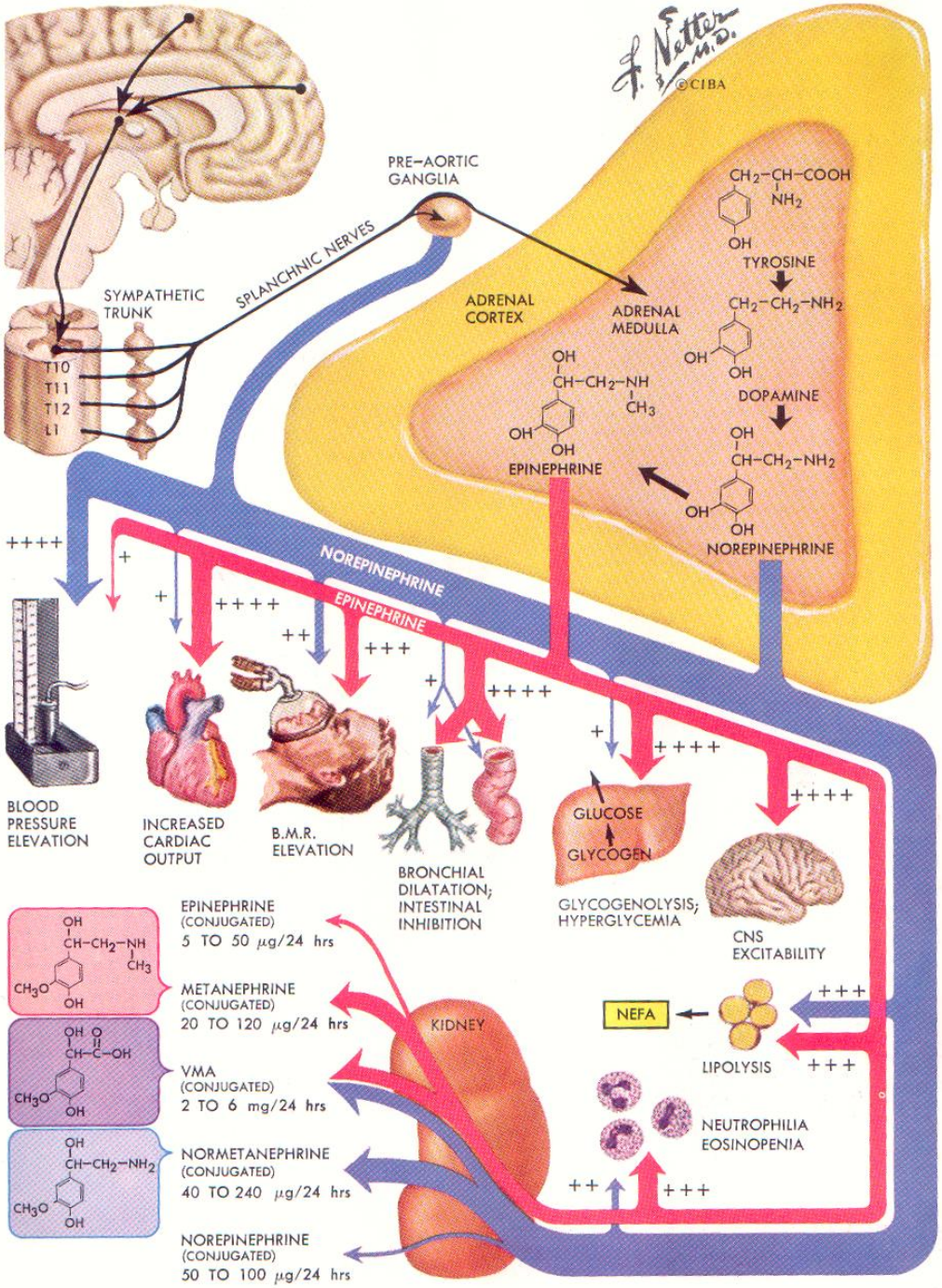
Adrenal Medulla

Tumours of Adrenal medulla



Phaeochromocytoma

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PRE-AORTIC GANGLIA
SPLANCHNIC NERVES
SYMPATHETIC TRUNK
T10
T11
T12
L1
ADRENAL CORTEX
ADRENAL MEDULLA
TYROSINE
DOPAMINE
EPINEPHRINE
NOREPINEPHRINE
NOREPINEPHRINE
EPINEPHRINE
BLOOD PRESSURE ELEVATION
INCREASED CARDIAC OUTPUT
B.M.R. ELEVATION
BRONCHIAL DILATATION; INTESTINAL INHIBITION
GLUCOSE
GLYCOGEN
GLYCOGENOLYSIS; HYPERGLYCEMIA
CNS EXCITABILITY
NEFA
LIPOLYSIS
NEUTROPHILIA
EOSINOPENIA
KIDNEY
EPINEPHRINE (CONJUGATED) 5 TO 50 μg/24 hrs
METANEPHRINE (CONJUGATED) 20 TO 120 μg/24 hrs
VMA (CONJUGATED) 2 TO 6 mg/24 hrs
NORMETANEPHRINE (CONJUGATED) 40 TO 240 μg/24 hrs
NOREPINEPHRINE (CONJUGATED) 50 TO 100 μg/24 hrs

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

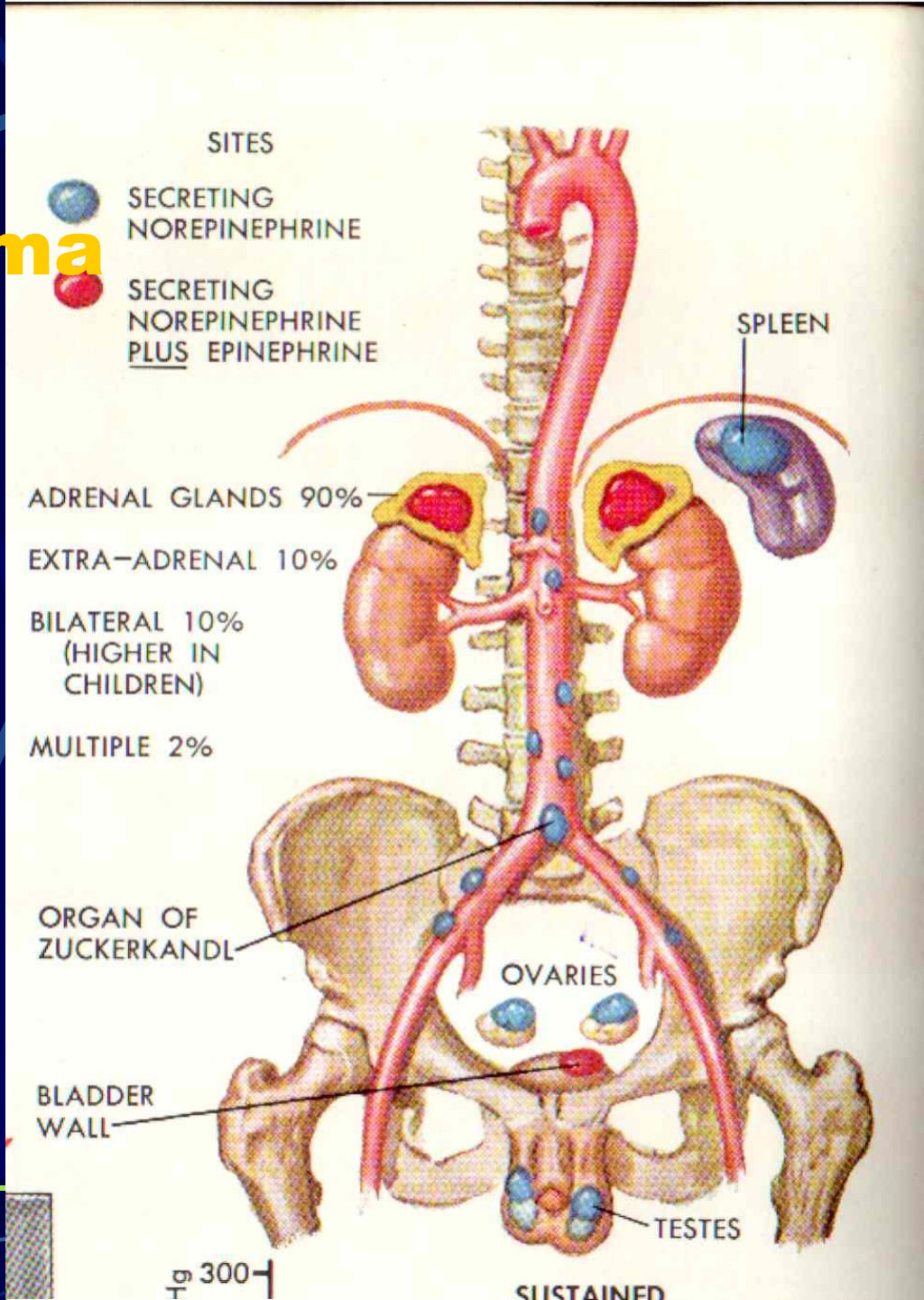
- Phaeochromocytomas are tumours composed of chromafin tissue derived from nervous system
- It is a functionally active catecholamine secreting tumor.
- It produces an excess of adranaline especially noradranaline 20:1 ratio
- Occurs in 4^{th} and 5^{th} decade of life, higher preponderance in the female
- Only0.5 % of All Hypertensives are due to pheochromocytoma
- All Patients under 60 years with sustained hpertension 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

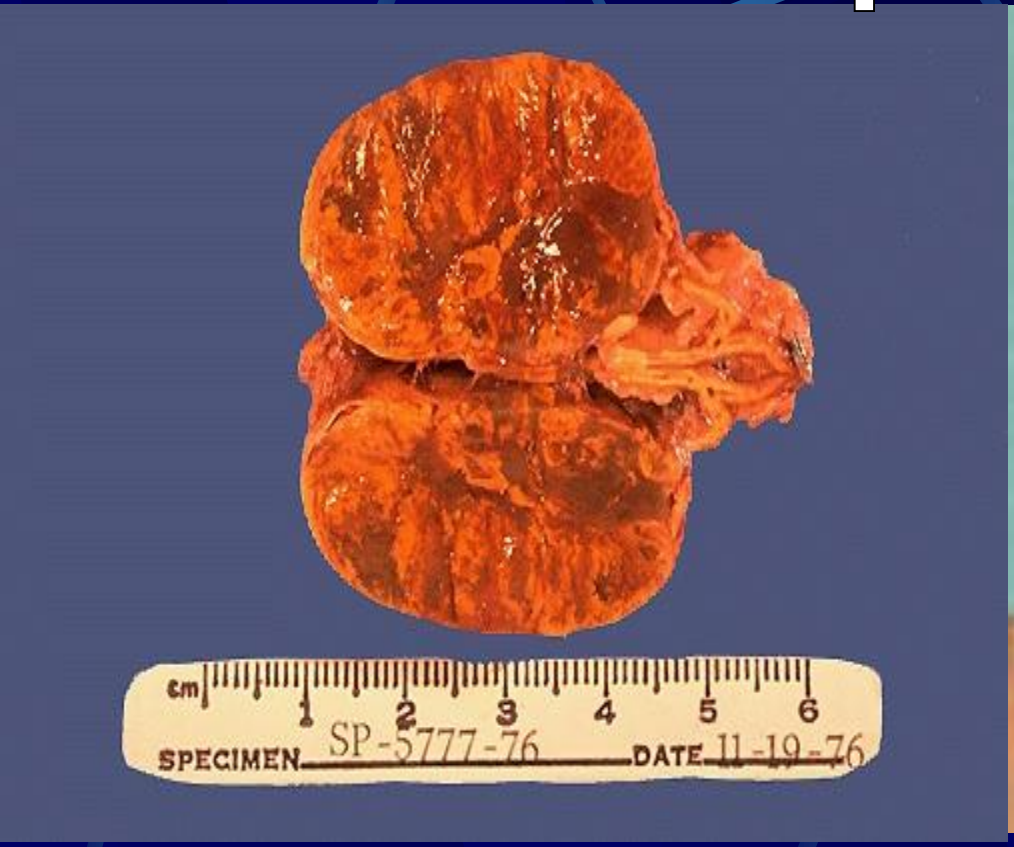
- 90% arises from chromafin cells in adrenal medula.
- 10% arise from Para ganglia of sympathetic nervous system- coeliac, mesenteric, renal, hypogastric, testicular
- Most common extra adrenal site is Oragn of Zuckerkandle,
- A tumour in an ectopic site and one in a child is more likely to produce nor-adrenaline



Phaeo. Can be a part of autosomal dominant multiple endocrine neoplastic syndrome

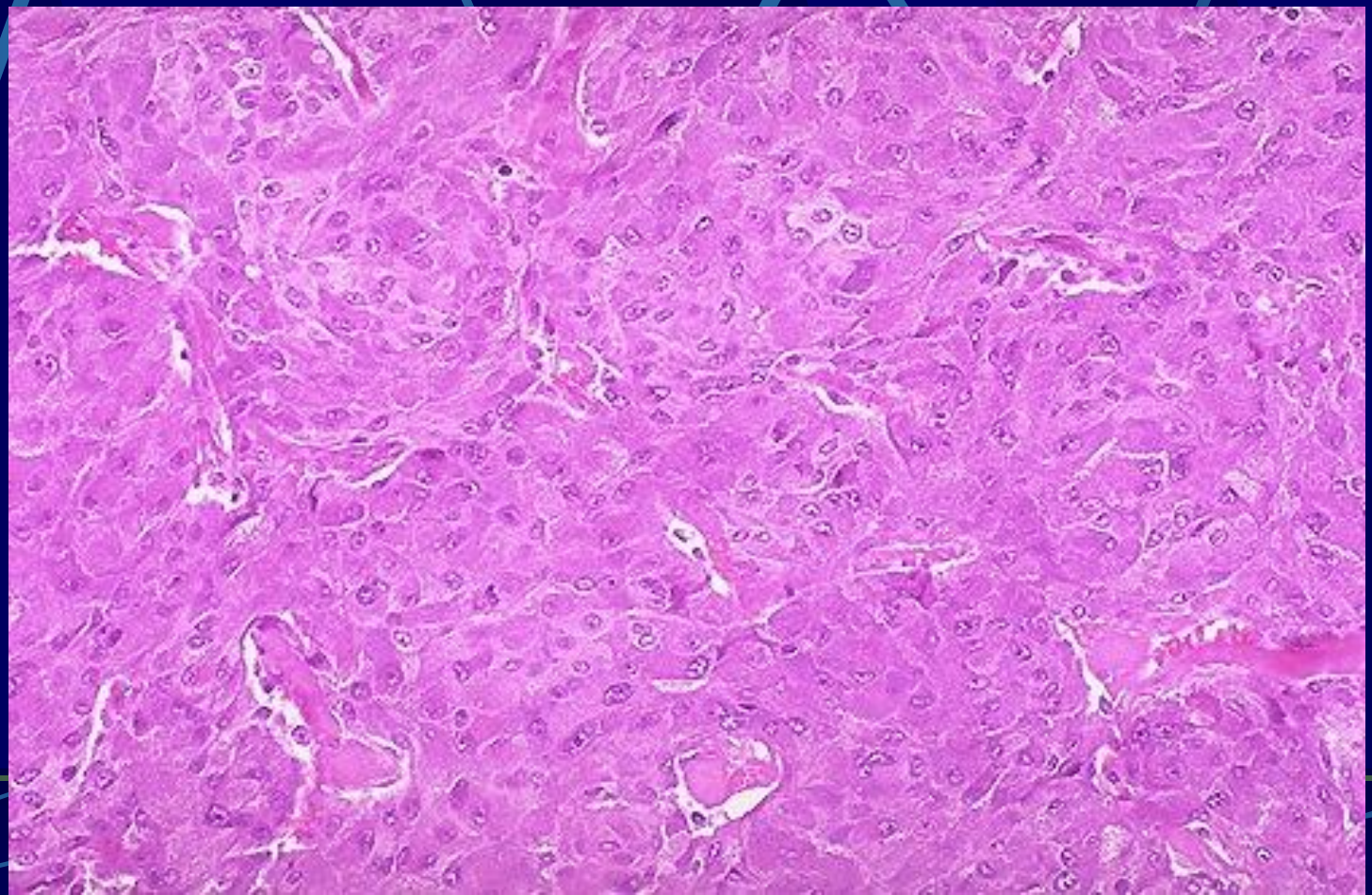
- Multilple endocrine adenomatosis type IIB
  - Parathyroid adenoma/hyperplasia, Medulary carcinoma of thyroid,Phaeo.
- Multiple endocrine adenomatosis type IIA (Sippel's syndrome)
  - Medularry carcinoma of thyroid,mucosal adenoma,Marfanoid app., Phaeo.
- Von Hippel- Lindau syndrome
  - Haemangioplastoma of cerebellum,retina or brain and Phaeo.

Pheo- pathology



- 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,wtloss,anorexia
- Nausea, vomiting

Attacks pre-disposed by

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

Hyper Tensive Attacks

Feeling of Doom, Fear

I am going to Die

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

Alpha Adrenergic Effect

Increased Catecholamines in Circulation

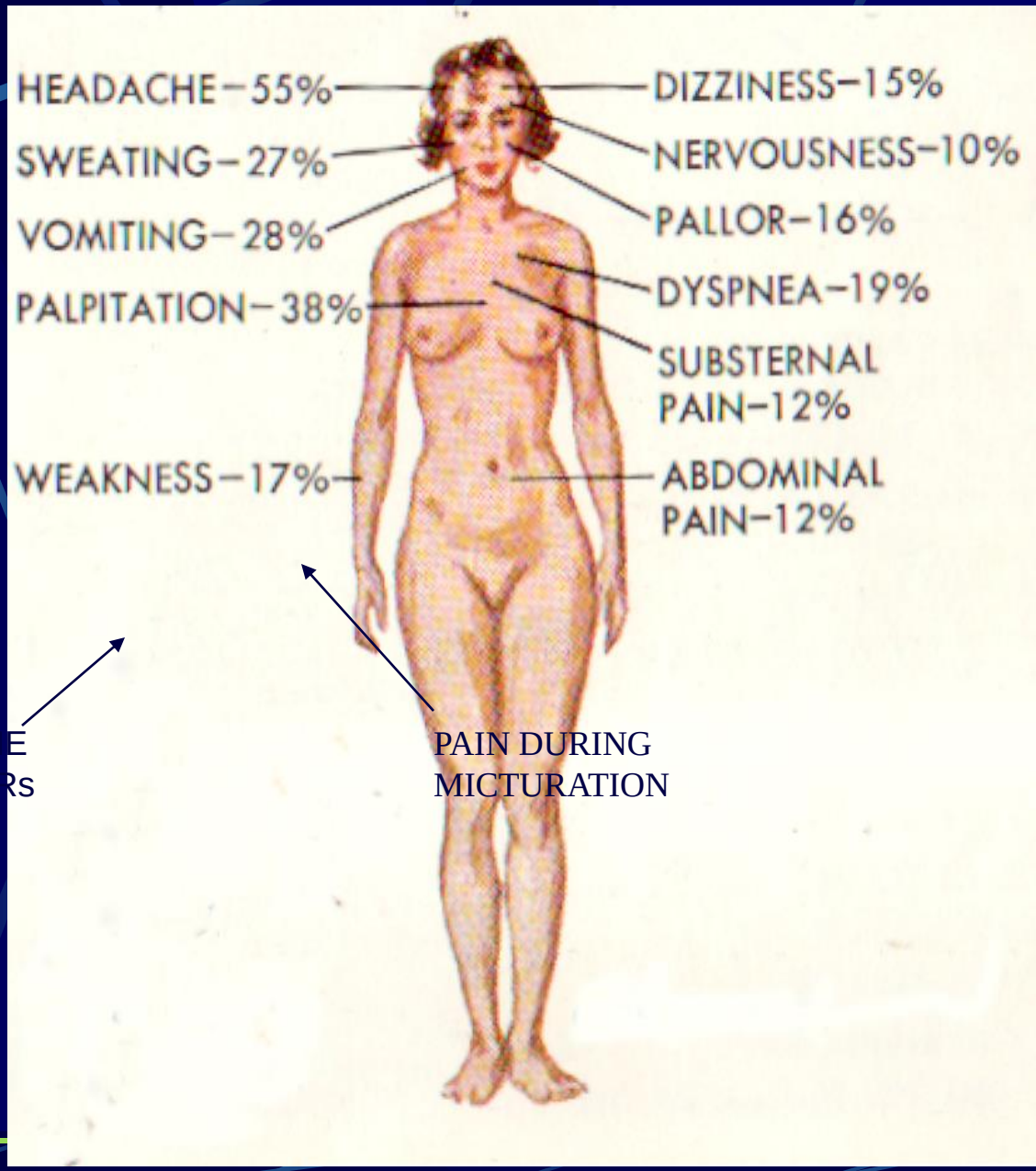
Beta Adrenergic

Diastolic hypertension Bradycardia

Weakness, hypotension follows the attack

Severe enough to produce gangrene – Toes, fingers.

Clinical Picture



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,

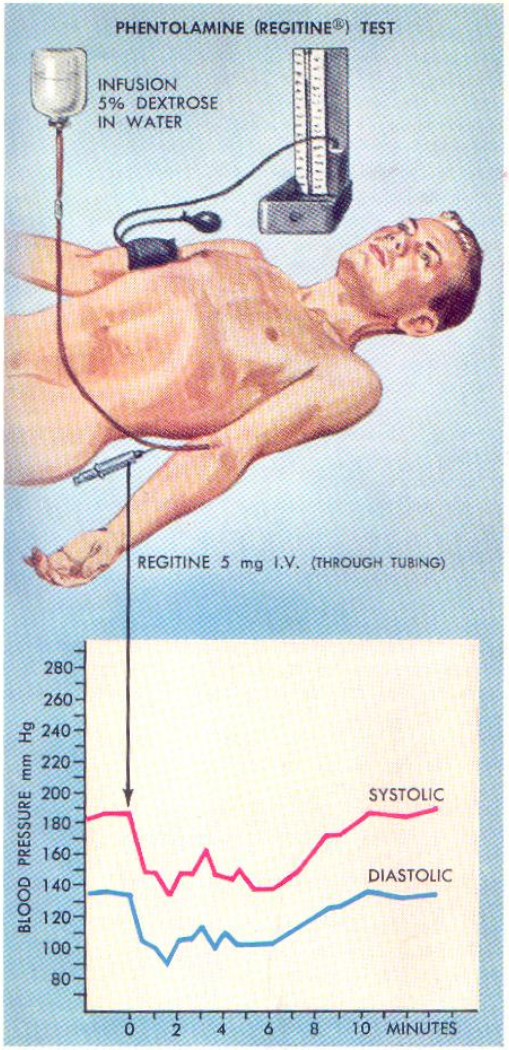
Cardiomyopathy, Eclampsia of pregnancy

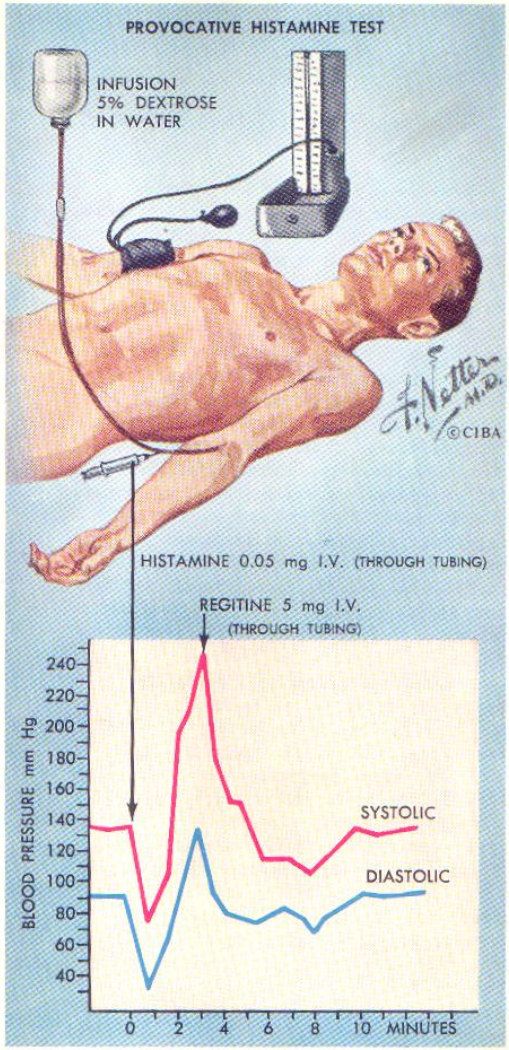
Diagnostic Pointers

Tests	Normal Values	Range
Urinary Metanephrine	<1.3mgs/24 hrs	0.3 –1.3 mgs/24 hrs
Urinary HMMA/ VMA	<9mgs/24 hrs	3-9 mgs/24 hrs
Plasma catecholamine Adri+Noradri	<1 ng/ml	0.8-1 ng/ml

One single test done on one occasion cannot be considered diagnostic,

It should be done on 2-3 occasions


PHENTOLAMINE (REGITINE®) TEST
INFUSION
5% DEXTROSE
IN WATER
REGITINE 5 mg I.V. (THROUGH TUBING)
BLOOD PRESSURE mm Hg
280
260
240
220
200
180
160
140
120
100
80
SYSTOLIC
DIASTOLIC
0
2
4
6
8
10 MINUTES


PROVOCATIVE HISTAMINE TEST
INFUSION
5% DEXTROSE
IN WATER
F. Netter M.D.
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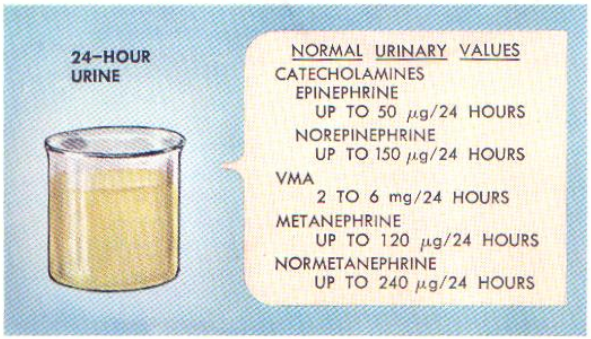
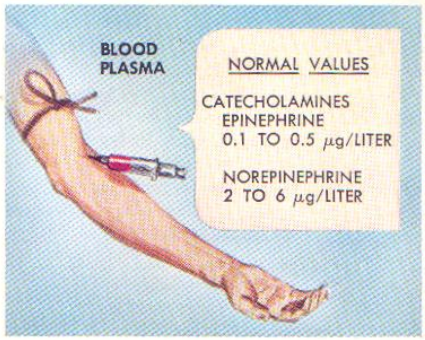
HISTAMINE 0.05 mg I.V. (THROUGH TUBING)
REGITINE 5 mg I.V.
(THROUGH TUBING)
BLOOD PRESSURE mm Hg
240
220
200
180
160
140
120
100
80
60
40
SYSTOLIC
DIASTOLIC
0
2
4
6
8
10 MINUTES


24-HOUR
URINE
NORMAL URINARY VALUES
CATECHOLAMINES
EPINEPHRINE
UP TO 50 μg/24 HOURS
NOREPINEPHRINE
UP TO 150 μg/24 HOURS
VMA
2 TO 6 mg/24 HOURS
METANEPHRINE
UP TO 120 μg/24 HOURS
NORMETANEPHRINE
UP TO 240 μg/24 HOURS


BLOOD
PLASMA
NORMAL VALUES
CATECHOLAMINES
EPINEPHRINE
0.1 TO 0.5 μg/LITER
NOREPINEPHRINE
2 TO 6 μg/LITER

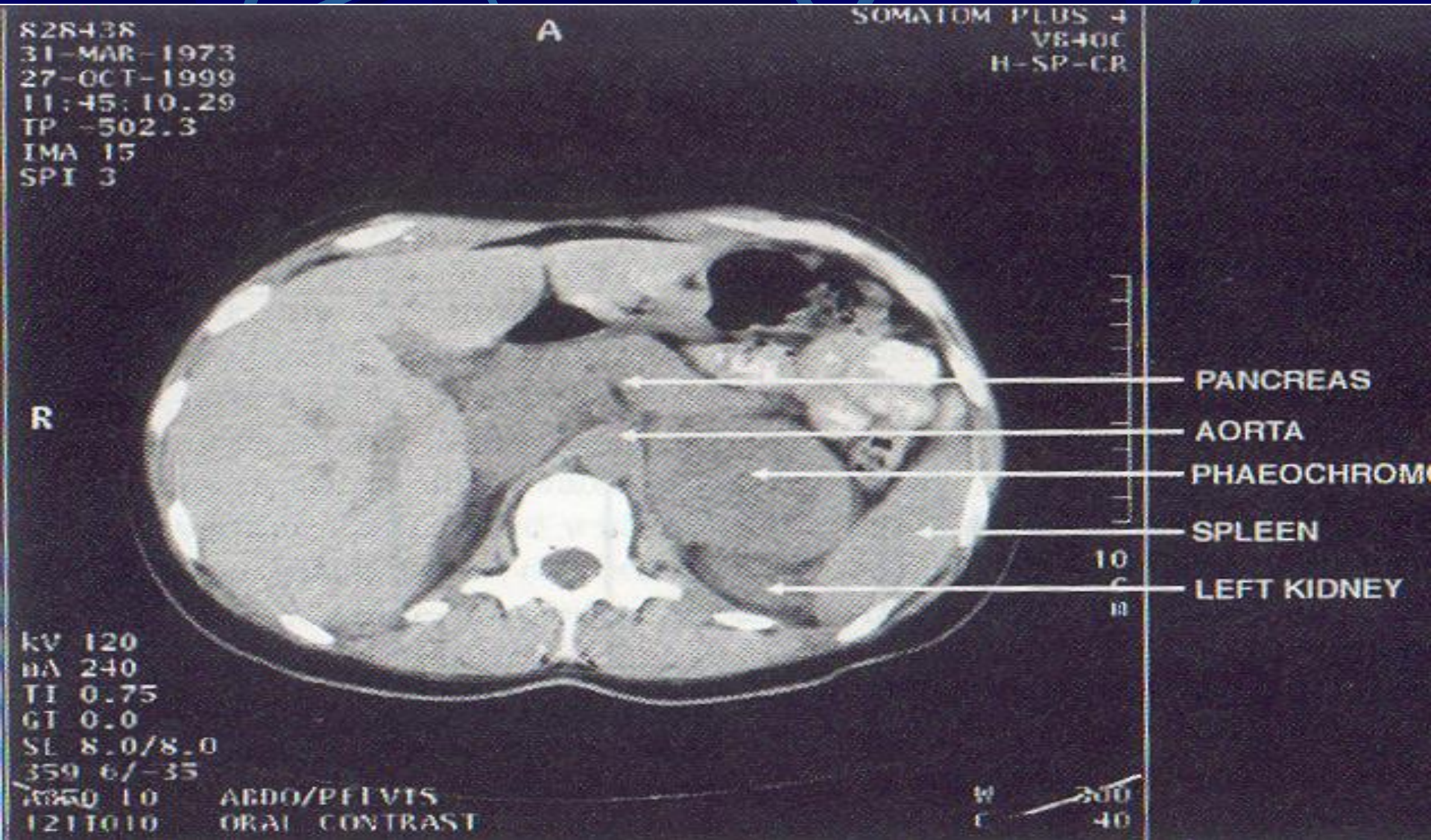
Localisation

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

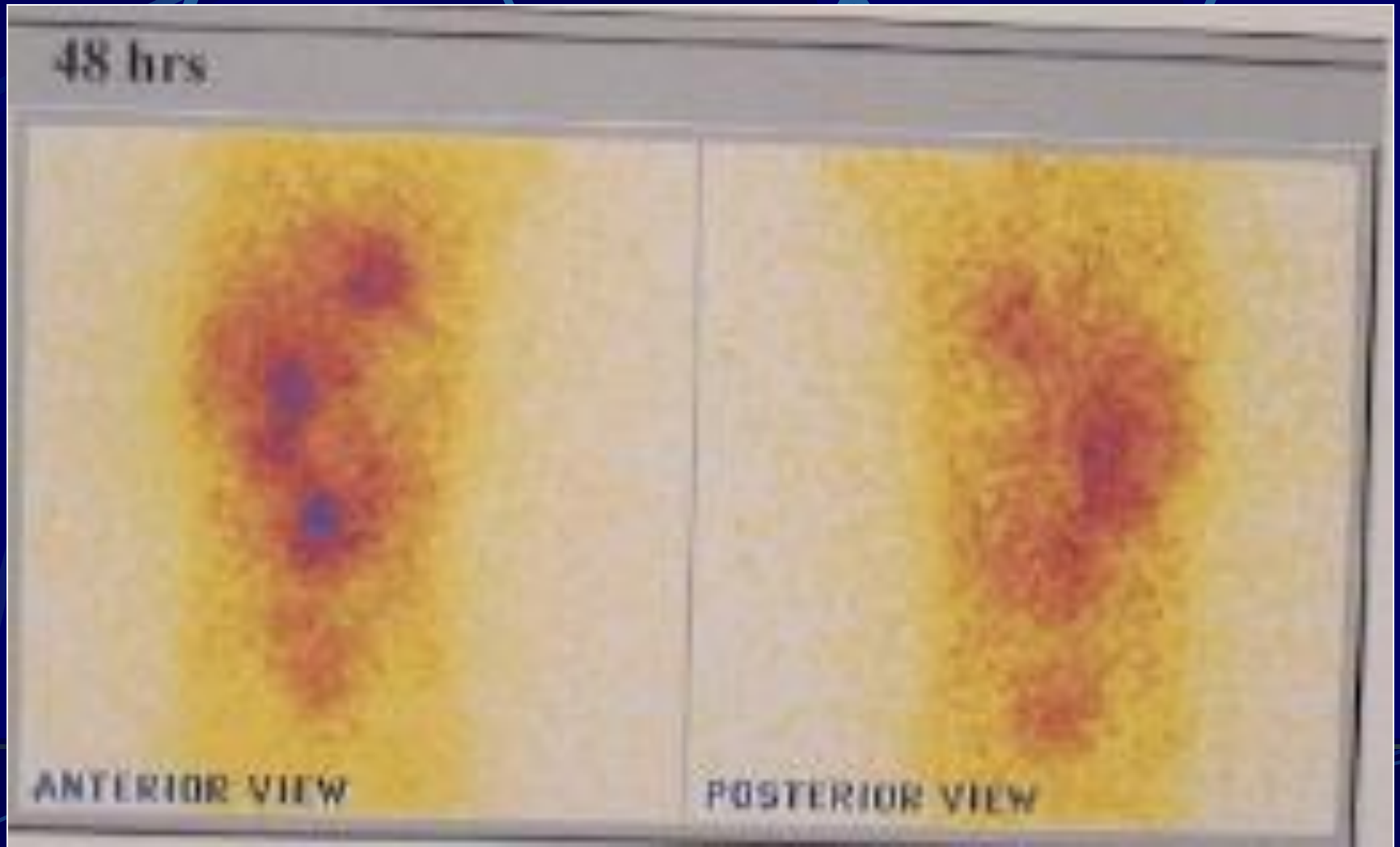
The last three tests on are no longer required.

False reports may be found if strict dietary and drug restrictions is not followed

MRI for Pheochromocytoma

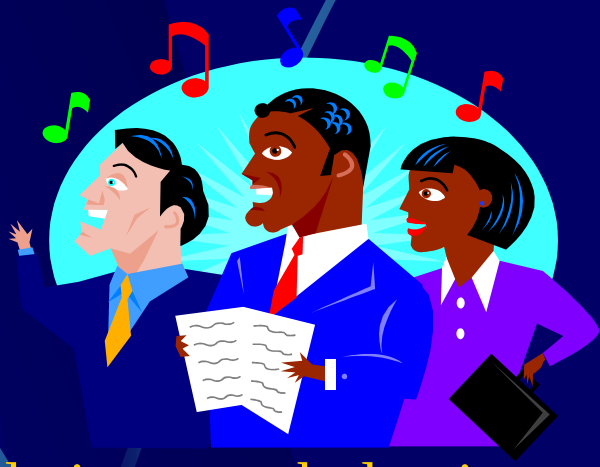


MIBG scintiscan for Pheochromocytoma



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 catacholamine surge

  Dis Advt: Being non selective: Tachycardia, arrhythmias , somnolence

- **Prazocin Doxazocin Terazocin - Selective**

Beta adrenergic antagonists

- Propranalol
- Atenolol
- Metoprolol

1.To control the effects of adrenaline

2. To block excessive cardiac sympathatic 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
- Day of surgery – Inj. Midazolam IV,

  Inj. Fentanyl, Inj. Reglan and inj. Ranitidine.
- Anaesthesia – almost every anaesthetic technique is tried. We used either balanced general anaesthesia or epidural anaesthesia + general anaesthesia.

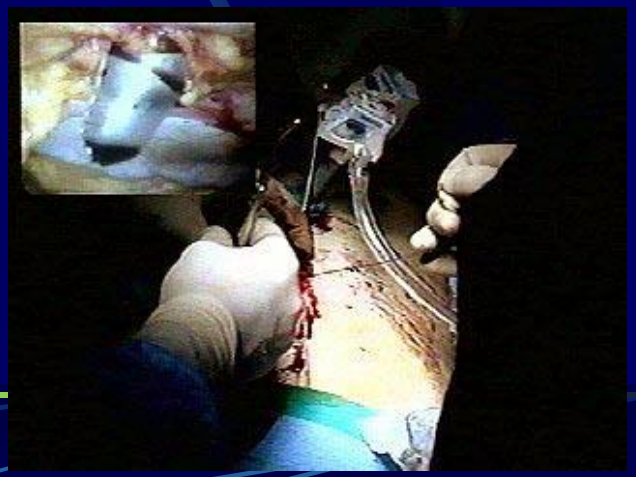
Surgery for Pheochromocytoma

Open adrenalectomy

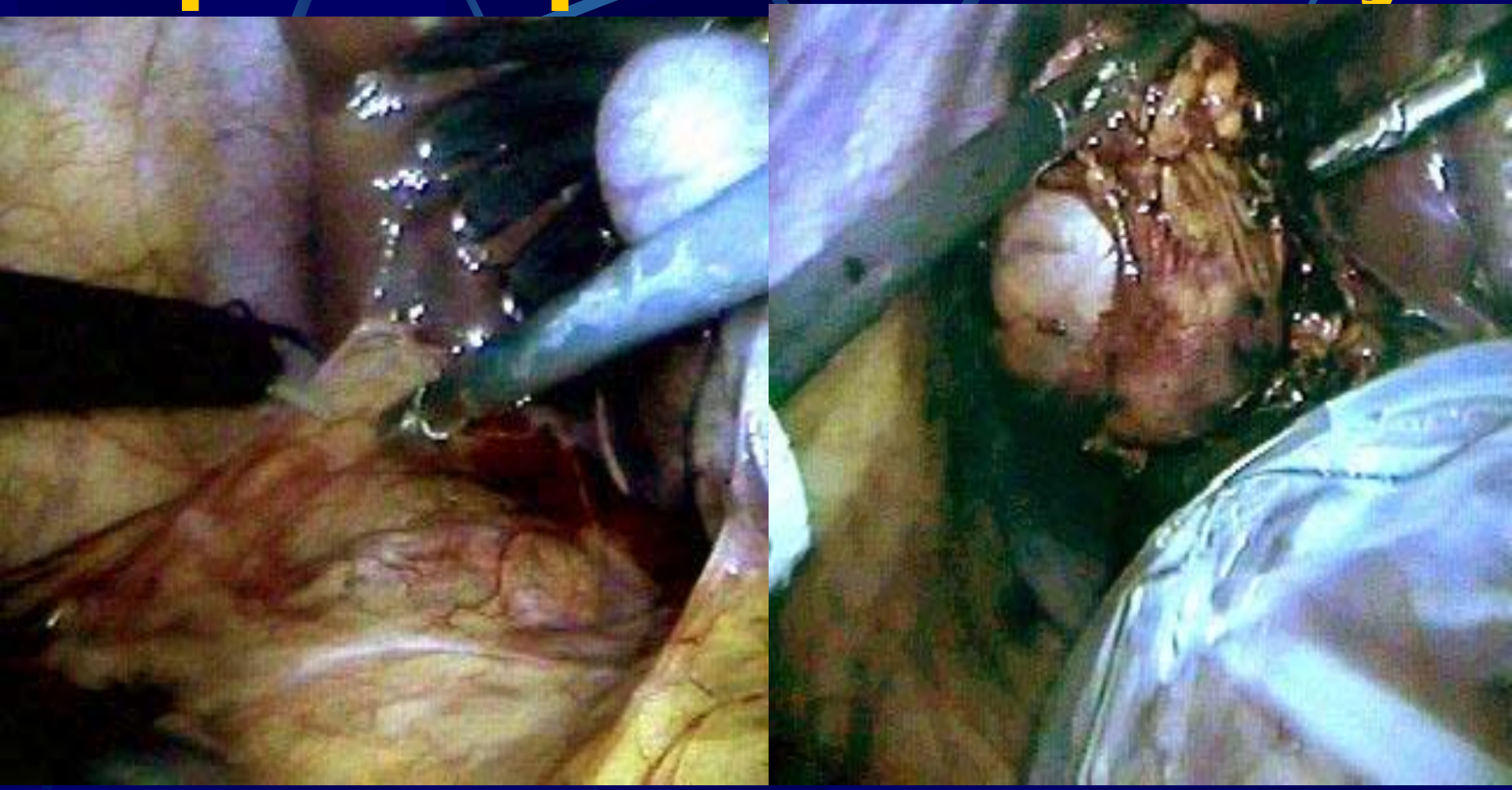
1. **Lateral Retroperitoneal**
2. **Transabdominal**

Laparoscopic surgery

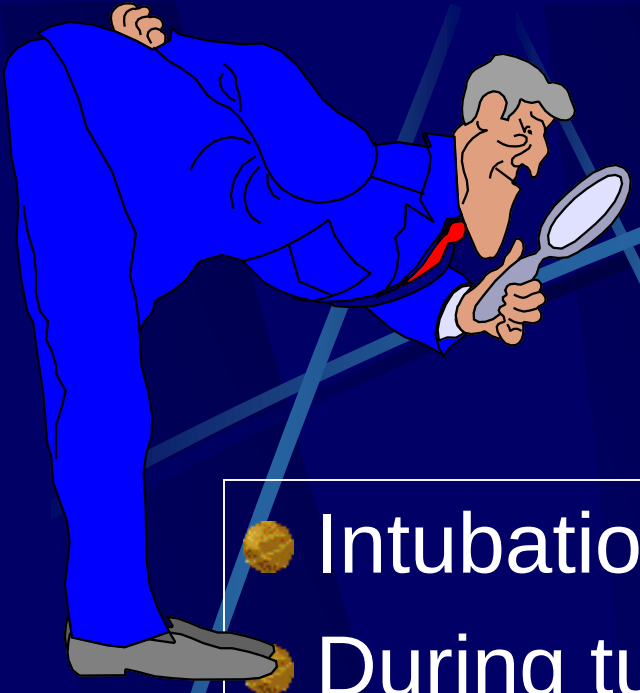
1. **Retroperitoneal**
2. **Transpertitoneal**



Laperoscopic Adrenalectomy



- Sustained hemodynamic changes of same severity as open surgery



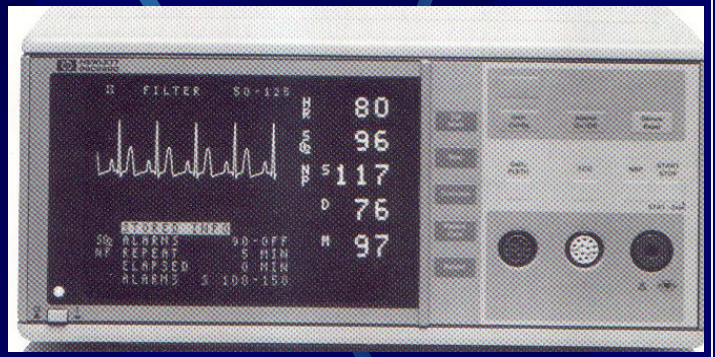
Critical Steps in Perioperative period

- 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

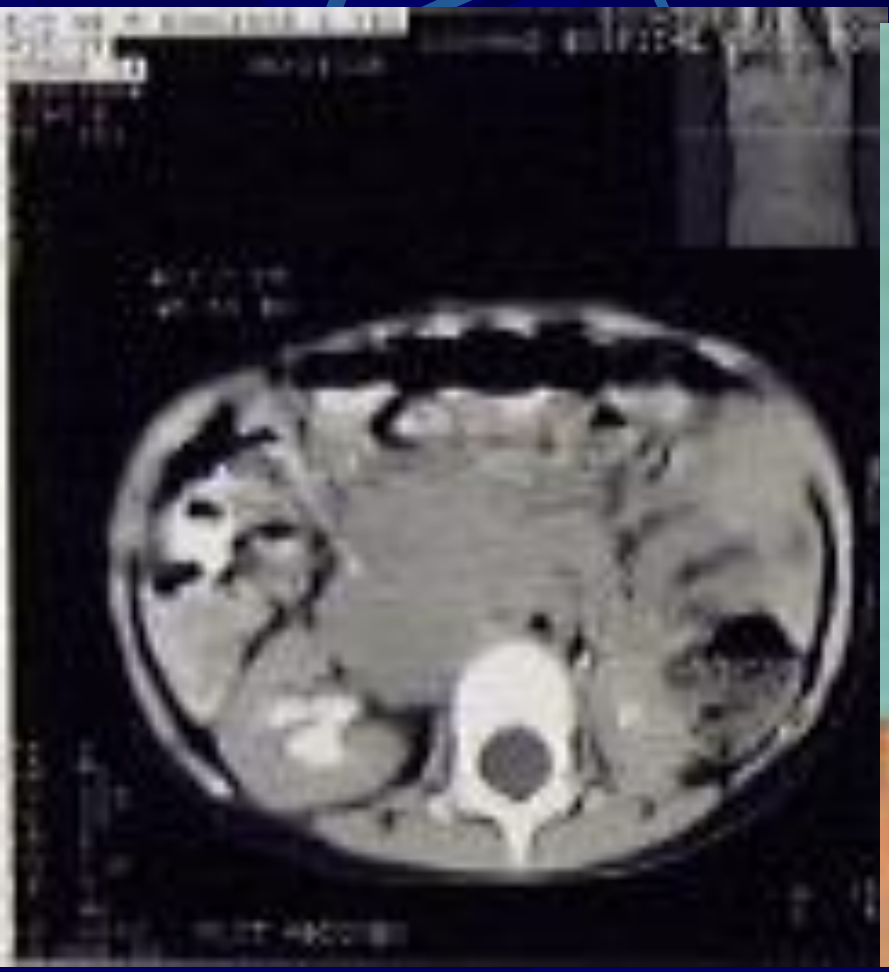
After tumour excision

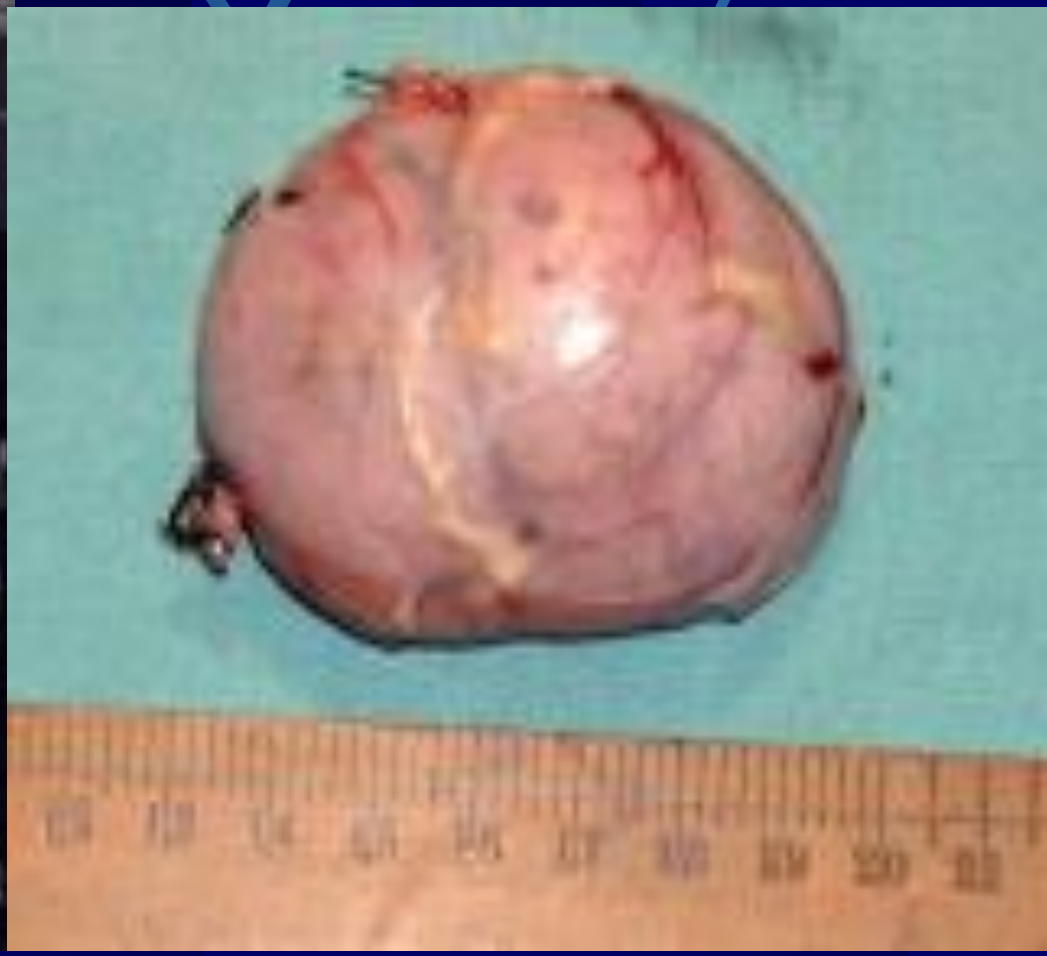
- After ligation of last major vein: exponential decrease of BP.
- Fill the circulation with colloid solution either haemaccel or hysteril to bring CVP upto 9 and 10.
- Dopamine infusion
- Hypotension may be because of removal of active adrenal gland – opposite adrenal suppressed.

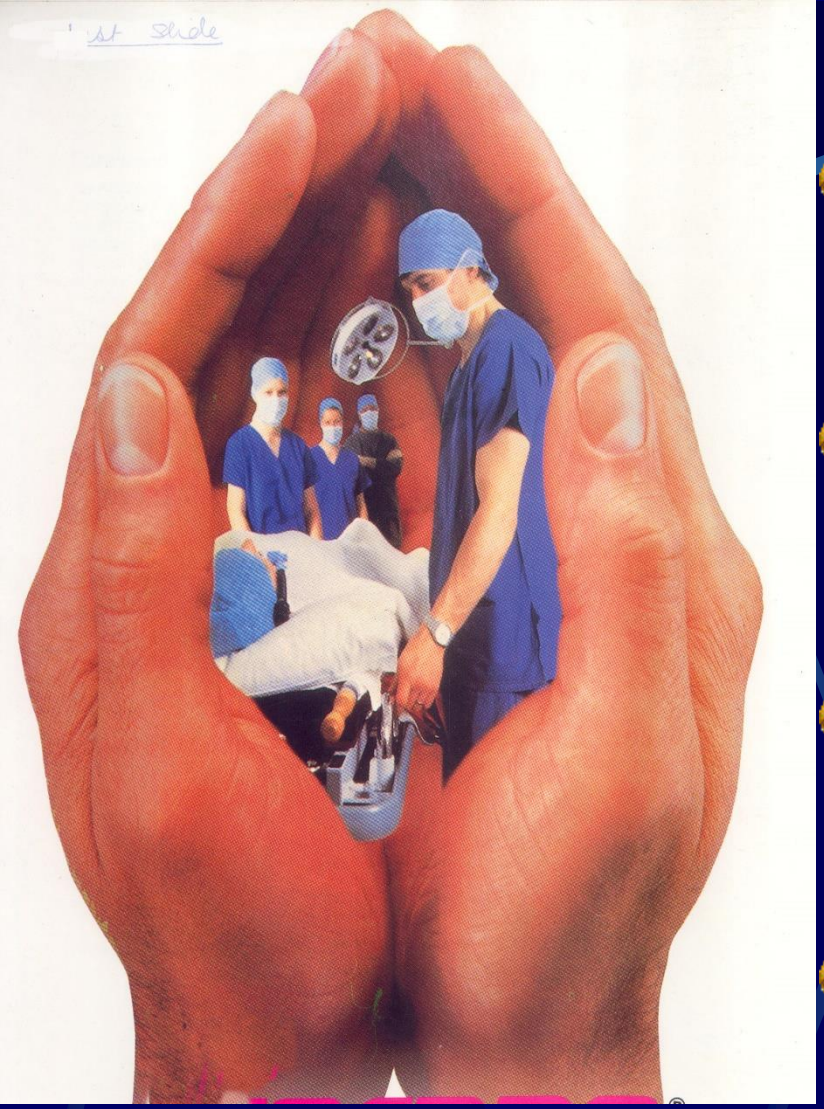
POSTOPERATIVE PERIOD

- 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