Renal Blood flow; Renal Clearance

Dr Sitelbanat

Objectives

At the end of this lecture student should be able to describe:

- **Renal blood flow**
- **Autoregulation of GFR and RBF**
- **Regulation of GFR**
- **The Calcuation of Clearance**

Renal Blood flow

- **In average adult RBF = 1.1l/min**
- **PAH an organic acid used for measurement of RBF**
- **In one renal circulation/min PAH is almost completely removed from the plasma & excreted in urine**
- **PAH clearance = volume of plasma cleared from PHA/min = RPF/min**

Calculation of renal blood flow

- **RPF= the amount of a PAH excreted per unit time**
- **~ 90% of PAH in arterial blood is removed by the kidney**
- **Clearance of PAH = $\frac{[U]_{PAH} \times V_{min}}{[P]_{PAH}}$ = 630ml/min**
- **=effective renal plasma flow (ERPF)**

Calculation of renal blood flow *cont.*

- **Actual renal <u>plasma</u> flow (RPF) = ERPF/ extraction ratio = 630 / 90 * 100 = 700ml/min**
- **Calculate the renal <u>blood</u> flow (RPF)**

  = 700/55 * 100 = 1.2 l/min
- **OR**
- **RBF = $\frac{\text{RAP – RVP}}{\text{Total Renal vascular pressure}}$**

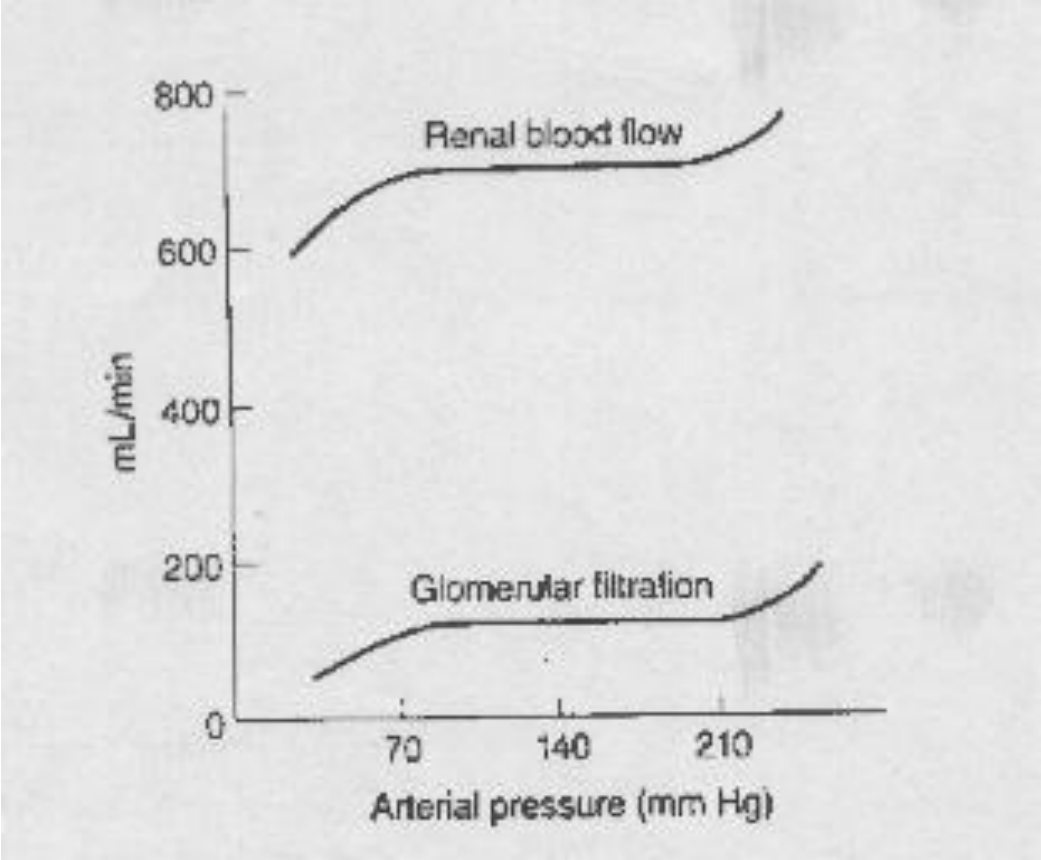
Autoregulation

- **Feed back mechanism to keep RBF and GFR relatively constant despite marked changes in ABP**
- **Range of autoregulation is between 75-160 mmHg ABP**
- **< 60 mmHg → ↓ GFR → Kidney shut down**

Autoregulation of GFR

- Changes diameters of afferent, efferent arteriole, and glomerular capillaries
  - drop pressure results in dilation of afferent arteriole, dilation of glomerular capillaries and constriction of efferent arteriole.
  - Rises in pressure results in constriction of afferent arteriole.

Autoregulation of GFR & RBF



Three processes controlling GFR

1. **Myogenic autoregulation**
2. **Hormonal regulation (tubuloglomerular & renin-angiotensin)**
3. **Autonomic regulation (extrinsic)**

1. Myogenic autoregulation

- **The ability of blood vessels to resist stretching**

- **↑ hydrostatic Pressure → stretching vessels wall → reflex contraction**

2. Hormonal Regulation

- **Tubuloglomerular feedback**
- **Renin-angiotensin Aldsterone**
- **Other Hormones**

Tubuloglomerular feedback

- **↓ GFR → slow flow → ↑ Nacl reabsoption → ↓ Nacl at macula densa:**
  1. **↑ renin → ↑ angiotensin II → efferent vasoconstriction → ↑ GFR**
  2. **Afferent dilation → ↑ GFR ?**

Renin-angiotensin Aldsterone

- **Renin is released into plasma**
  - **low ECF Na or low ECV**
  - **↑ sympathetic (hypotension)**
  - **↓ afferent pressure**
- **Renin acts on angiotensinogen → Angiotensin I**
- **Angiotensin converting enzyme (ACE): Angiotensin I → angiotensin II**
- **angiotensin II act on adrenal cortex → aldosterone secretion→ ↑ Na reabsorption in distal & collecting duct of nephron**
- **↑ H and K secretion in exchange for Na**

Other Hormonal Regulator of GFR

1. **Adrenaline, noradrenaline → affarent vasoconstriction → ↓ GFR**
2. **Angiotensin II→ Vasoconstriction of efferent → ↑ GFR**
3. **Prostaglandins, bradykinin affarent vasodilator → ↑ GFR**

Autonomic Regulation of GFR

- In normal condition Sympathetic NS has little influence on GFR
- ↓ BP (hemorrhage) → ↑ sympathetic → vasoconstriction of renal artery → ↓ RBF → vasoconstriction of afferent → ↓ GFR TO DIVERT BLOOD TO VITAL ORGANS

Clearance

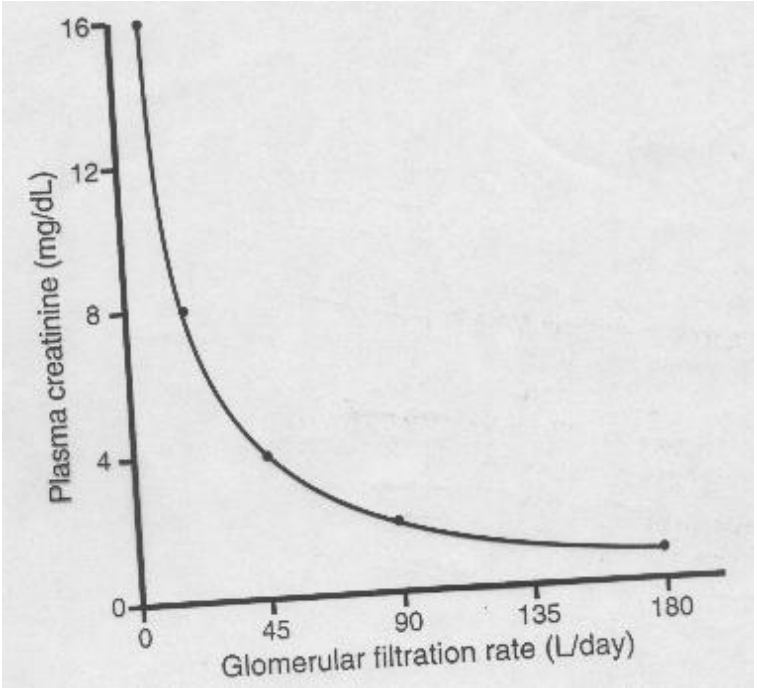
- **volume of plasma completely cleared of a substance by both kidneys per unit time**
- **Clearance equation**
  - **$C = \frac{[U]_s \times V/min}{[P]_s}$ = ml/min**
- **Renal clearance for different substances various between 0-600ml/min**

Inulin clearance & GFR

- **120 ml/min**
- **As inulin is**
  - **freely filtered**
  - **not reabsorbed or secreted**
- **Inulin clearance = GFR**

Creatinine clearance &GFR

- **Creatinine is an endogenous substance used routinely to measure GFR**
- **Completely filtered, but secreted in small quantity**
- **Inverse relationship between GFR & plasma creatinine**



Glucose & urea clearance

- **Renal clearance of glucose=zero**
- **Filtered, completely absorbed, no glucose in urine**
- **$[U]_g$ x V_{min} = zero**
- **Urea clearance = 60 ml/min, urea filtered, partially reabsorbed**

Inulin clearance vs. clearance of other substance (S)

- **C_x = inulin clearance → Substance x is filtered but not absorbed or secreted**
- **C_y < inulin clearance → Substance y is filtered and partially absorbed**
- **C_z > inulin clearance → Substance z is filtered and secreted**

Summary

1. **Renal blood flow**
2. **Calculation of renal blood flow**
3. **Autoregulation**
   - **Myogenic**
   - **Hormonal regulation (tubuloglomerular & renin-angiotensin)**
   - **Autonomic regulation**
4. **Clearance**
   1. **Inulin**
   2. **Creatinine**
   3. **Glucose $ urea**