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

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

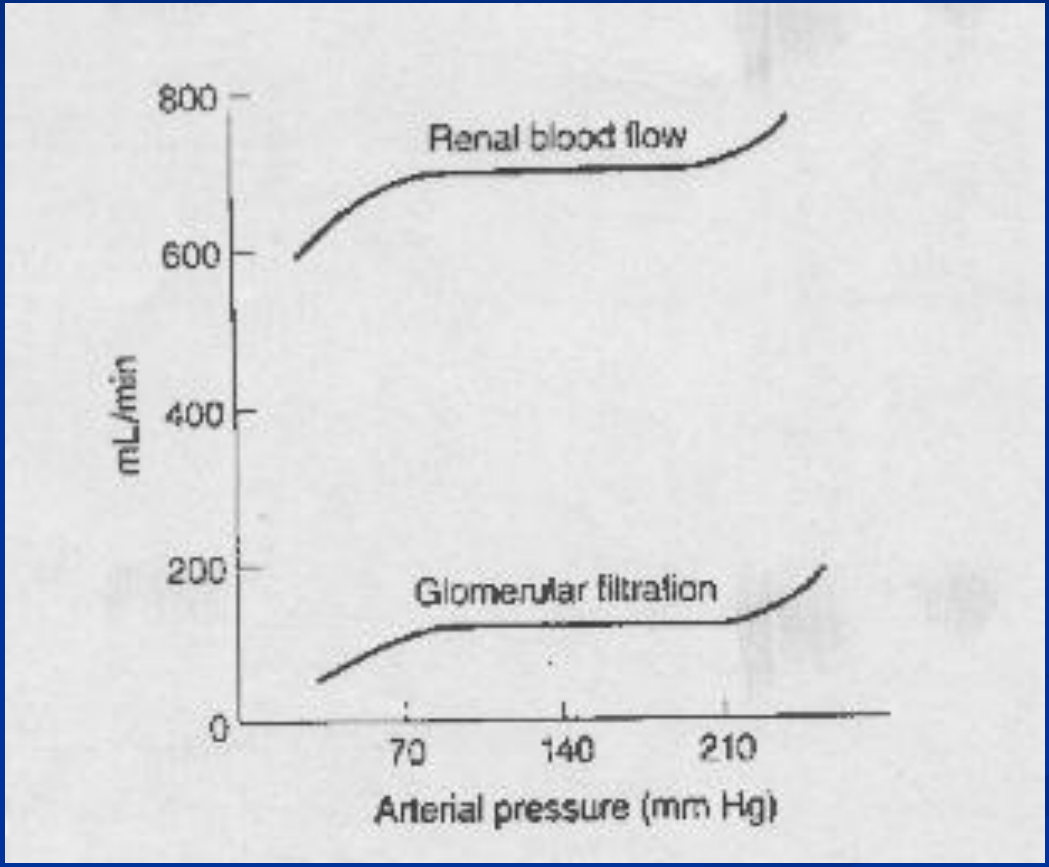
Autoregulation

- 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

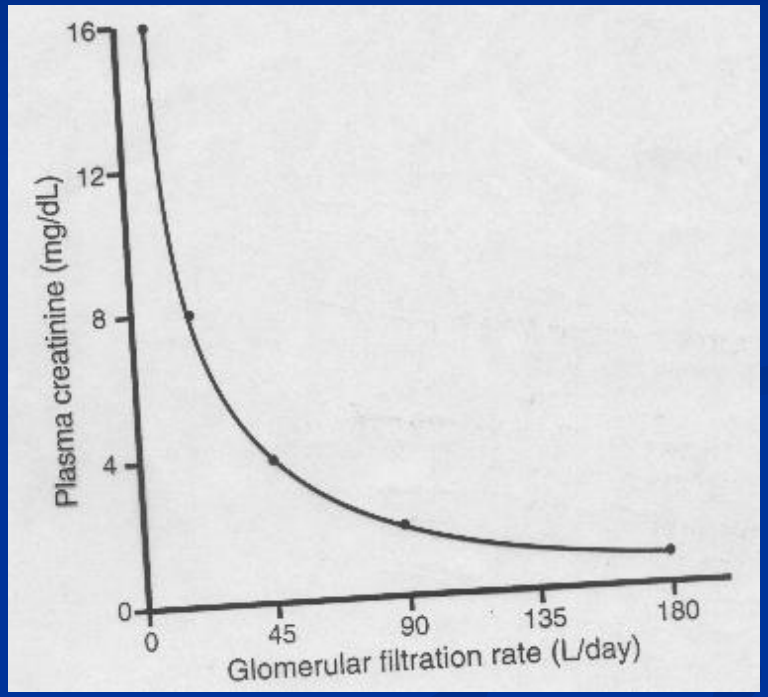
- volume of plasma completely cleared of a substance by both kidneys per unit time
- Clearance equation
  - $C = \frac{[U]_s \times V/min}{[P]_s} = ml/min$
- Renal clearance for different substances various between 0-600ml/min

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
- $[U]_g \times V_{min} = zero$
- 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