Renal Block

Lecture One

# Acute Kidney injury

Important notes & MCQs


## Objectives:

- Introduction to the renal pathology
- Acute Kidney Injury
- Definition, Types, Clinical Overview, Causes
- Pathological findings
- Differential Diagnosis

This lecture doesn't focus on a single subject and it is mostly an introduction for renal pathology. Before studying, you should know the Anatomy, Histology and Physiology of the renal system.

## Introduction:

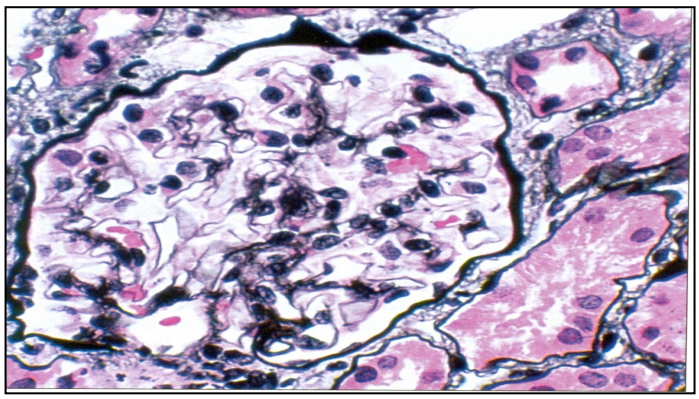
### Acute means:

Happens within hours to days.

So if we have a clinical scenario with 3 weeks history, we forget about it being acute.

### Acute Kidney Injury:

The kidneys can lose up to 70% of their function; and the creatinine will still be normal. Meaning only 15% of the nephrons of each kidney is working. Still, there won't be an increase in creatinine. But once it starts to increase it will elevate quickly.



### What are the four elements that we have to look for in a kidney?

1. Glomeruli.
2. Tubules. (Have to be back to back)
3. Blood Vessels.
4. Interstitium.

(If there's a lot that means fibrosis)

### On Routine what do we do?

We take a small biopsy and do immunofluorescence (we look for the antigen)

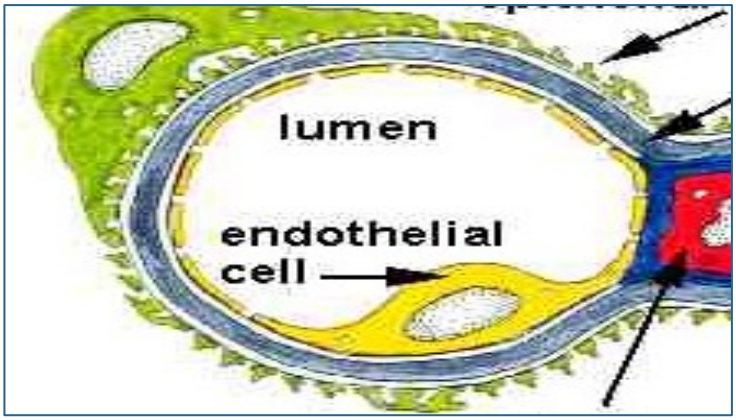
If I want to see if this patient has IgA in his glomeruli, I will bring Anti-IgA + A material that can fluoresce under the florescence microscopy. And finally, I watch the reaction happen between IgA (from the biopsy) + it's anti-IgA. Even when I wash the slide it won't go away.

### Why do we use immunofluorescence?

1. Specific. (I know what I'm looking for IgA, IgG, IgM, etc.)
2. I know exactly where it's located.
3. What kind of deposition we have.

### We can also use stains in histology

## Electron Microscopy:




Endothelial cell is close to the mesangium; cytoplasm in yellow is inside. Every molecule in the blood that has to go to the urinary space should pass through the endothelium fenestrae (Opening, pores).

1. Lamina rara interna (White)
2. Lamina densa (Blue)
3. Lamina rara externa (white on the outside)
4. Podocytes (Green)

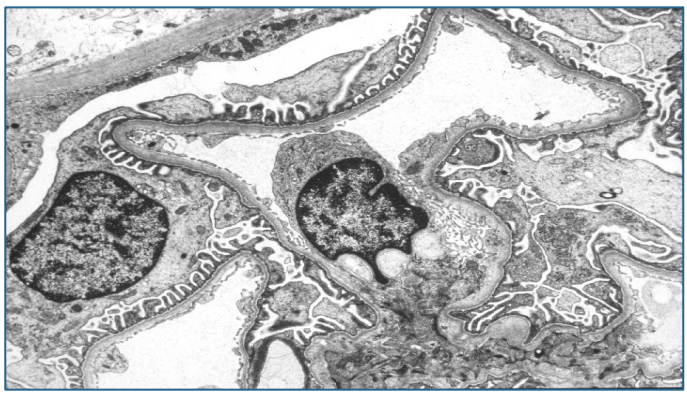
**Summary:**

Acute kidney injury:

Suddenly within few hours to few days.

Four elements that we see and have to study on biopsy:

- Glomeruli.
- Tubules
- Blood Vessels
- Interstitium



**Real picture under electron microscope**

- Endothelial Cell nucleus is always close to the mesangium.
- Every molecule should pass through fenestrae → Lamina rara interna → densa → externa → slit diaphragm of the podocyte → from bowman's space it goes to the proximal tubules.

**What will happen if the kidney is not functioning?**

- Serum creatinine will increase & creatinine clearance will decrease, urea also increases, what are the clinical features of uremia?
  - Lethargy
  - Anorexia
  - Dyspnea
  - Dysgeusia
  - Renal failure
  - Pruritis
  - Neuropathy
  - Nausea and vomiting
  - Pericarditis (accumulation of fluid leading to inflammation)

**Azotemia:**

Elevated blood urea nitrogen not from an intrinsic renal disease.

**Oliguria:**

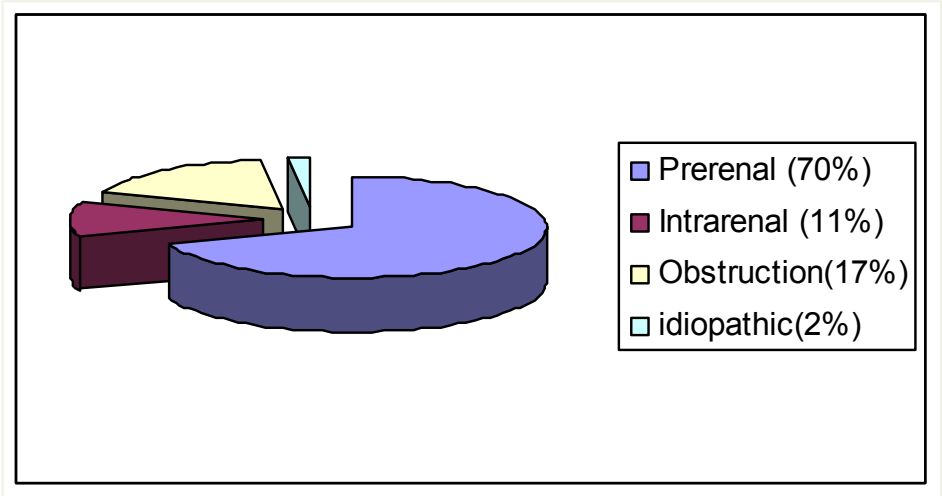
Urine output less than 500cc/24hr.

**Non-oliguria:**

Urine output greater than 500cc/24hr. (There could be an acute injury even though there isn't decreased urine output)

**Anuria:**

Urine output less than 50cc/24hr.




**Scenario:**

A patient is not urinating; he doesn't have any output of urine.

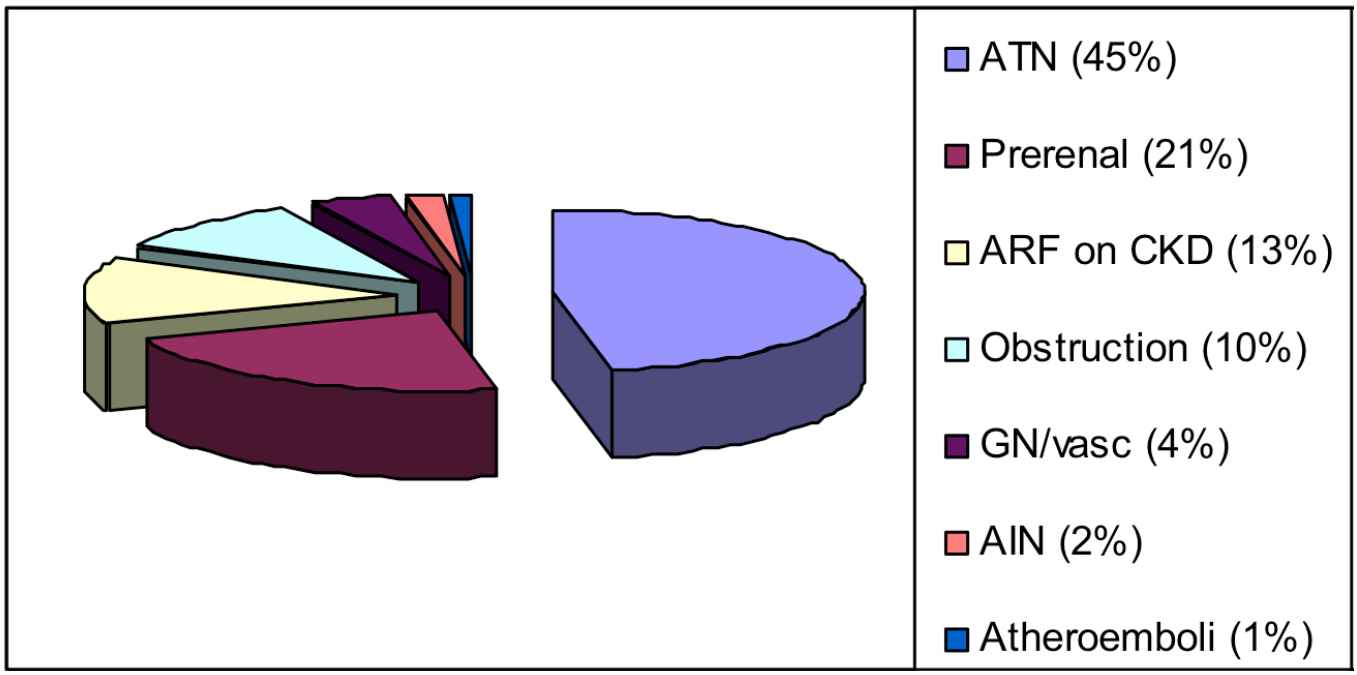
- Could be because of obstruction, what could initiate obstruction? (Post-renal)
  - Kidney stones.
  - Tumors.
  - Compression of ureters.
- Prerenal causes, like:
  - Hypovolemic shock, septic shock.
  - Something coming from outside the kidney.
- Intrarenal (inside the kidney, from the kidney).
- Idiopathic (we don't know the reason).
- If he was an elderly with diabetes he might develop atheroma.

**Summary:**

Causes of acute kidney injury:

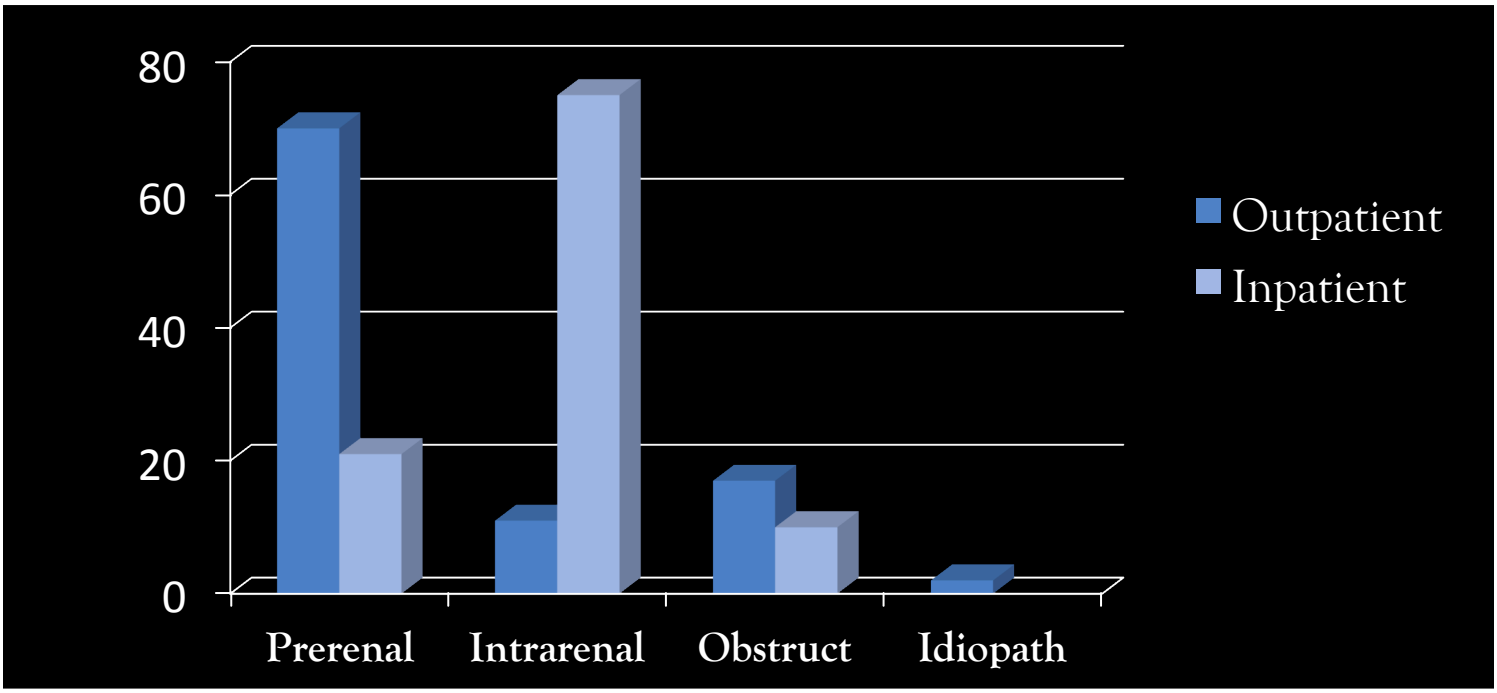
- Prerenal.
- Renal.
- Postrenal.

If he was an in-patient, what's the most common cause of his AKI?




- Acute tubular necrosis
- Prerenal (Hypovolemic shock due to not giving him enough fluids or blood or during surgery but not because of hemorrhage accident)
- Drugs that lead to acute tubular interstitial nephritis.

Patients in the ICU develop complications, but as long as the kidneys are functioning that means clinicians are doing well. When a patient reaches a stage where his kidneys stop working, the prognosis is not very good.




You have to know that the causes for inpatient are different from outpatient.

**Prerenal:**

It's more common in outpatients.

A lot more frequent than in inpatient, because it could be due to car accidents, hypovolemic shock in general.

Usually outpatients have normal kidneys so the injury is usually acute.

**Intrarenal:**

It's more common in inpatients.

The causes are from the kidney itself. Why?

Because inpatients already have different diseases like diabetes or hypertension so already their kidney function isn't that good.

**Obstruction** happens to both of them at approximately same percentage.

**Idiopathic** is in outpatients and we can't explain why it happened.

**Summary:**

- A patient walking down the street and gets into an accident → more chance of AKI due to prerenal causes.
- In hospitalized patients, they already have so many problems in the kidney so the problem it's intrarenal.
- Obstruction happens to both.

If a patient is prerenal → walking down the street and suddenly gets into an accident that causes hemorrhage → outpatient.

In the hospital → more risk of it being intrarenal, e.g. (Acute interstitial tubular nephritis, acute tubular injury due to some drugs, etc.)

## Mortality:

It remains unchanged. (High mortality rate)

## A patient with AKI, what should I do?

Should I take him to dialysis? Or not? Of course we can't leave him like this otherwise he will die.

There are certain features when present we MUST do dialysis, which are:

- Oliguria:
    - Less than 400cc/24hr will require dialysis immediately.
    - More than 400cc/24hr (Won't require dialysis as much as patients with less urine)
- Mechanical ventilation:

  If the patient has a respirator they develop many complications and might need dialysis immediately.
- Acute myocardial infarction
- Arrhythmia
- Hypoalbuminemia
- ICU stay:

  They have to do dialysis for longer times because they need to rest their bodies as they have multiple complications.
- Multi-system organ failure

**Summary:**

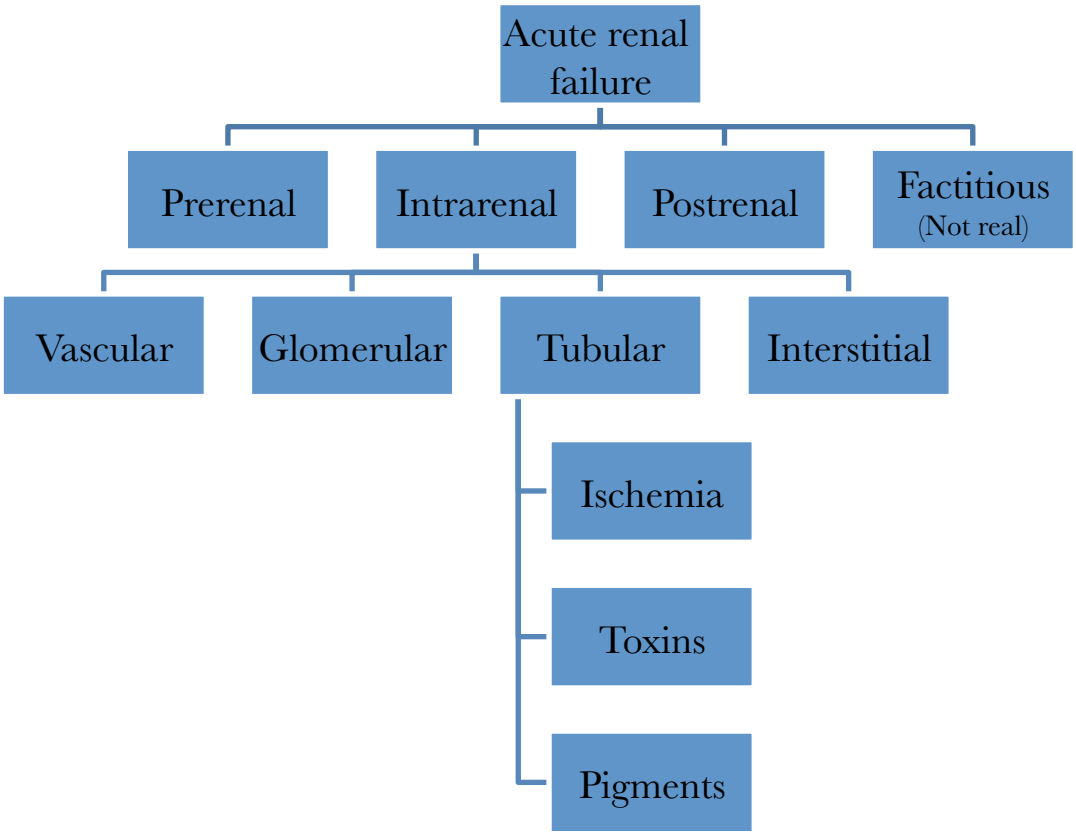
**Two acute kidney injury settings:**

- Patients with more urine output will need less dialysis. (Still urinating)
- Patients with less urine outcome will need dialysis immediately. (Not urinating at all)

Now let's say you have both patients in your clinic, who should you do dialysis for first?

The patient with less urine outcome.

**Pathogenesis:**




- When we say prerenal → blood not reaching the kidney. (Could be a patient in the hospital that wasn't given enough blood however when we talk about what's more common, it's in outpatients.)
- Intrarenal target the four elements we mentioned earlier and each one of them leads to AKI.
- Most important one of them is the tubules.
- **Interstitium can also lead to AKI, how?**

  If someone took drugs and those drugs caused an allergic reaction, it might lead to one of two things:
  - Acute tubular injury (due to toxins).
  - Acute interstitial nephritis.

**Summary:**

**We have four situations:**
Acute kidney injury can be prerenal, intrarenal or postrenal (forget about factitious)

Prerenal → Hypovolemic shock (no more blood reaching kidneys) → ischemia → Acute tubular injury → tubules are the most sensitive to ischemia.

**There is a continuum from prerenal physiology to ischemic pathology, what does it mean?**

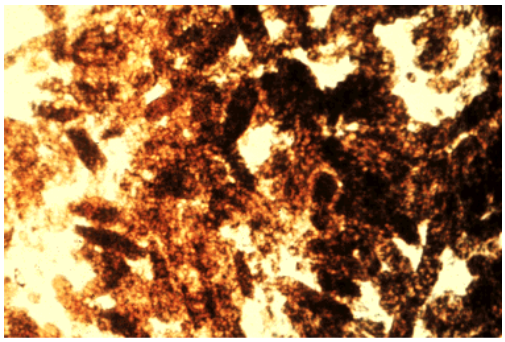
Starts when blood isn't reaching the kidneys → then first element that begins suffering is the tubules → then the rest follows → complications.

## Toxins that could lead to tubular injury:

Most important thing to know is that the tubules which are affected by ischemia are different from the tubules that are affected by toxins. So when they say for example the proximal tubules are affected or the distal, you must differentiate which injury it is related to.

## In acute tubular injury, what do we see?

Brown granular cast.



**Sediment in ATN** Urine sediment showing multiple, muddy brown granular casts. These findings are highly suggestive of acute tubular necrosis in a patient with acute renal failure. Courtesy of Harvard Medical School.

## Acute tubular injury is a clinicopathological entity defined by:

1. Acute renal failure.
2. Tubular injury/necrosis

## Now why do we talk about acute tubular injury specifically?

Because it is the most frequent.

What's the most important thing that leads to acute tubular injury?

- Ischemia
- Shock
- Sepsis
- Incompatible blood transfusions
- Thrombotic diseases
- Toxins:
  - → Endogenous:
    - Pigments, for example:
      - Hemolysis → too much hemoglobin → accumulate in the kidney → acute tubular injury.
      - Car accident → crushed a lot of muscles → myoglobin pigment → acute tubular injury
  - → Exogenous:
    - Drugs
    - Metals
    - Radiocontrast dye.

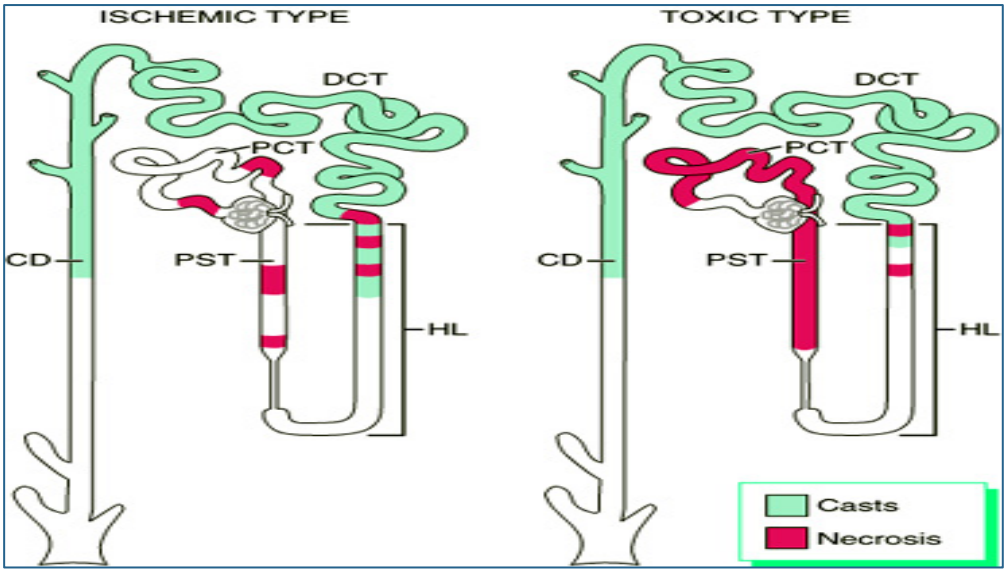
## Acute tubular necrosis (ATN):

Clinicopathological entity:

Pathologically: Destruction of tubular epithelial cell (Acute tubular necrosis)

Clinically: Acute suppression of renal function (no urine or below 400 ml/24h)

- ***Most common cause of renal failure***



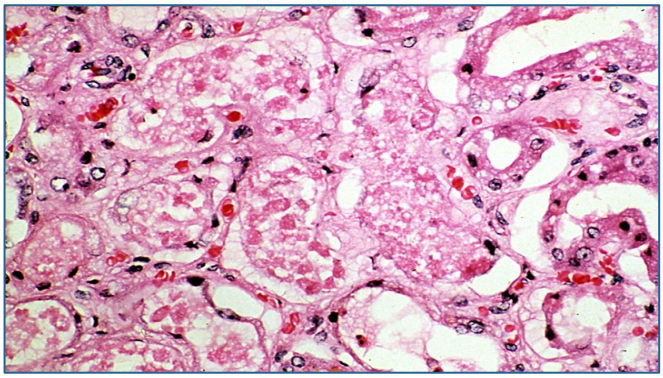

In the ischemic type:

Loop of Henle is necrotic.

In toxic type:

Proximal convoluted tubule.

Acute tubular necrosis:



- There are other causes that might block tubules.
- Those tubules are coagulated.
- This patient has multiple myeloma (plasma cell)
- It blocks all the tubules, and when we treat myeloma the kidney will regain its normal function.
- There are multiple giant cells they try to eat the cast that is blocking the tubules but they can't do anything.

**Summary:**

**Acute kidney injury:**

When the patient has high creatinine what happens? Lethargy, nausea, vomiting, etc.

**Etiology:**

- Prerenal.
  - Shock (Septic, hypovolemic, toxic)
- Intrarenal
  - Glomeruli → Crescentic
  - Tubules → ATN
  - Vascular → Acute vasculitis → Inflammation of blood vessels
  - Interstitium → Acute interstitial nephritis
- Postrenal
  - Obstruction (tumor, stones, etc.)

**Now Check Your Understanding:**

1. **Which of the following is NOT true regarding Acute Renal Injury**
    a) The most common cause in outpatients is Prerenal
    b) It is irreversible injury
    c) Although the medical technology have progressed the mortality rates remained the same
    d) It Causes Accumulation of nitrogenous waste products

2. **Which of the following is termed to urine output less than 500cc/24hr**
    a) Nonoliguria
    b) Oliguria
    c) Anuria
    d) Azotemia

3. **Which of the following is not included in the prerenal causes of ARI**
    a) Hypertension
    b) Reduction of blood volume
    c) NSAID
    d) Vasculitis

4. **Injury caused by obstruction of urine flow. (Urethral obstruction by enlarged prostate or tumor; ureteral or kidney pelvis obstruction by calculi)**
    a) Prerenal
    b) Intrarenal
    c) Post renal
    d) Perirenal

5. **The cause of _____ injury is impaired blood supply to the kidney (Fluid Volume Deficit , hemorrhage, heart failure, shock)**
    a) Prerenal
    b) Intrarenal
    c) Post renal
    d) Perirenal

6. **Which of your patients would be at highest risk for significant problems with the kidney**
    a) Hypertensive patient
    b) Diabetic patient
    c) Elderly
    d) All of above

7. **An elderly male patient produced only 25 ml of urine in the past 24 hours. The urologist discovers that prostatic hypertrophy is the cause. Which one of the following best describes this patient's acute renal failure**?
    a) Prerenal
    b) Intrarenal
    c) Post renal
    d) Perirenal

8. **A 34-year-old female experienced severe decline in urine output. She was then diagnosed with Acute Renal Failure. What is the most common cause?**
    a) Acute tubular necrosis
    b) Nephrotoxicity

**Answers:**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. B | 2. B | 3. A | 4. C | 5. A | 6. D | 7. C | 8. A |

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قال صلى الله عليه وسلم: (من سلك طريقًا يلتمس فيه علمًا سهّل الله له به طريقًا إلى الجنة).

دعواتنا لكم بالتوفيق.