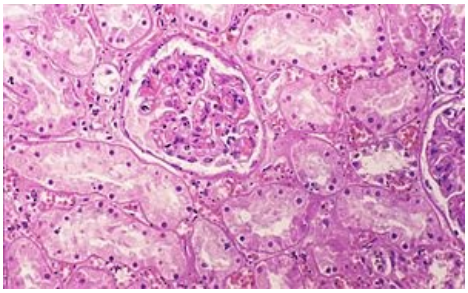
Acute Tubular Necrosis

Phases of ATN:

Acute parenchymatous renal failure (acute tubular necrosis, ATN, ARF) means direct damage to the renal parenchyma, most commonly **ischemic** or **toxic**. ATN is usually associated with oliguria (diuresis < 500 ml/day), and brownish cylinders tend to be present in urinary sediment. [1]

ATN can develop from **prerenal failure** because of vasoconstriction with subsequent development of tubular necrosis, it can arise from **hypoxic-ischemic damage**, **toxic damage** to tubular cells by drugs, contrast agents, exogenous and endogenous toxins.[2]

Prognosis of ATN is good, except for severe damage with formation ofthrombus in the microcirculation leading to cortical necrosis. The mortality and morbidity of children with ARF is worse in neonates and children with multiorgan involvement. Renal function in children with ATN who recover normalizes. In some children, renal function may take several days to recover, and in others several weeks. The recovery of renal function may be accompanied by a **polyuric phase**, which is less common in children than in adults.[2]



Acute tubular necrosis - histological slide

Etiopathogenesis

Ischemic ARS

A decrease in renal function due to ischemic tubular damage as a consequence of renal hypoperfusion (most commonly shock) is manifested:

1. decrease in blood flow (mainly through the cortex),
2. decrease in capillary wall permeability,
3. reflux of filtrate through the damaged tubule wall into the interstitium,
4. blockage of the tubules.

Prolonged ischaemia reduces production of vasodilator agents and stimulates production of vasoconstrictors → deepening the ischaemia → tubular necrosis. This allows the filtrate to reflux through the necrotic epithelium back into the interstitium, rendering filtration ineffective; moreover, sloughed tubular cells can occlude the tubule lumen → ↑ tubular pressure and stop glomerular filtration.

Nephrotoxic ARS (nephrotoxic damage or severe TIN) =

Nephrotoxic ARS can be caused by internal (endogenous) or external (exogenous) influences.

Exogenous influences include:

1. **antibiotics** - aminoglycosides depositing in the proximal tubule and ensuring release of lysosomes → destruction; sulfonamides causing tubule obstruction by crystals; tetracyclines and amphotericin B,
2. **contrast agents**,
3. **heavy metals** (Hg, Pb, etc.),
4. **cytostatics** - methotrexate; cisplatin - damages mitochondria, blocks ATPase; mitomycin

5. **immunosuppressants** - cyclosporine - intrarenal constriction of afferent arteriole,
6. **organic solvents** - ethylene glycol.

The endogenous influences include:

Intratubular precipitation of hemoglobinu or myoglobinu - rhabdomyolysis: crush syndrome, ischemic muscle damage, ketoacidosis, infection, cocaine.

Laboratory findings

Excretion fraction of Na^+ >3%, osmolarity approaches plasma.

Clinical picture and course

ARS persists after renal perfusion is restored; prerenal ARS may correct immediately. The course can be divided into three phases. The first is the **initiation phase** when insult occurs and oliguria can still be prevented. The second phase is the **advanced ARS phase**, when **oliguria** occurs, which lasts 7-14 days; in this phase there is a risk of: hyperhydration, ion imbalance (mainly hyperkalemia), acidosis, uremic syndrome. The last phase is the **reparation phase**, when function is gradually restored, tubular flow is restored; first diuresis → inability to concentrate - **polyuric phase**, when concentration impairment persists for many months.

Therapy

Acute renal failure treatment takes place on nephrology ward / ICU. It´s important to insure and monitor basic life functions, liquid bilance by precise collecting of urine and observing the state of hydratation.

Postrenal ARF: resumption of drainage of urine mechanically can take place the natural path (stent, urinary catheter) or outside of the natural path (percutaneous epicystostomy, puncture nephrostomy), then remove the obstruction in right time.

Prerenal ARF: resumption of renal perfusion pressure → **mean arterial pressure (MAP) 75–80 mm Hg:** - renewal of circulating volume in real hypovelmia according to the character of the loss (elektrolytes, plasma, blood), improvement of effective plasma volume in false hypovolaemia (plasmaexpanders, albumin, plasma or blood); **MAP < 70 mm Hg:** adjustment of volume, vassopresor drugs.

Other cases + renal ARF: therapy by cause

restoration diuresis in oligouria:

- ensuring normovolemia – furosemide in max. dosage up to 500 mg i.v. in 30 min,
- 20% mannitol 100–250 ml in crush syndromein + myoglobinuria,
- continuous administration of dopamineu 1,5–2,5 μg/kg/min → vasodilation in kidneys.

Hyperkalemia: restriction of potassiumu intake → in acute threat:

- acute hemodialysis (most effective),
- 10% calcium gluconicum 10–30 ml i.v. / NaCl 10–30 ml i.v. (inhibition of the membrane effect of K),
- 40% Glc 250 ml + 24 IU Ins / 8,4% $NaHCO_3$> 100 ml in 30 min infusion (supporst of utilisation K in the cell),
- ion exchanger Resonium A / Calcium Resonium 1–2 measuring cup after 2–4 p.o. with lactulose / in rectal enema.

Hypokalemia (threatens in poluuric phase of ARF, onset of anabolism and treatment MAC): supplementation of K (kalium chlorid).

Medical nutrition: daily energy intake 160–200 kJ/kg; proteins 0,8–1,2 g/kg, carbohydrates 6–8 g/kg, fats to 1 g/kg.

Compensation of renal function **extracorporeal cleaning methods**, among which we include hemodialysis + hemodiafiltraation / continuous hemofiltration + hemodiafiltration).

References

Related articles

- Acute renal failure - Acute Renal Failure
- Acute renal failure treatment
- Chronic Renal Failure

References

1. ŠTEFÁNEK, Jiří. *Medicine, Diseases, study at the 1st Faculty of Medicine, Charles University* [online]. [cit. 22 April 2010]. <https://www.stefajir.cz/>.
2. MUDr. HAVRÁNEK, Jiří: Acute renal failure

Source

- ŠTEFÁNEK, Jiří. *Medicína, nemoci, studium na 1. LF UK* [online]. [cit. 22. 4. 2010]. <https://www.stefajir.cz/>.