Semmelweis Egyetem
Urológiai Klinika

Urolithiasis

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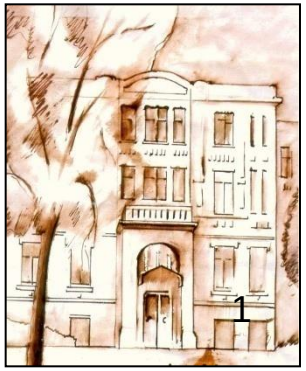
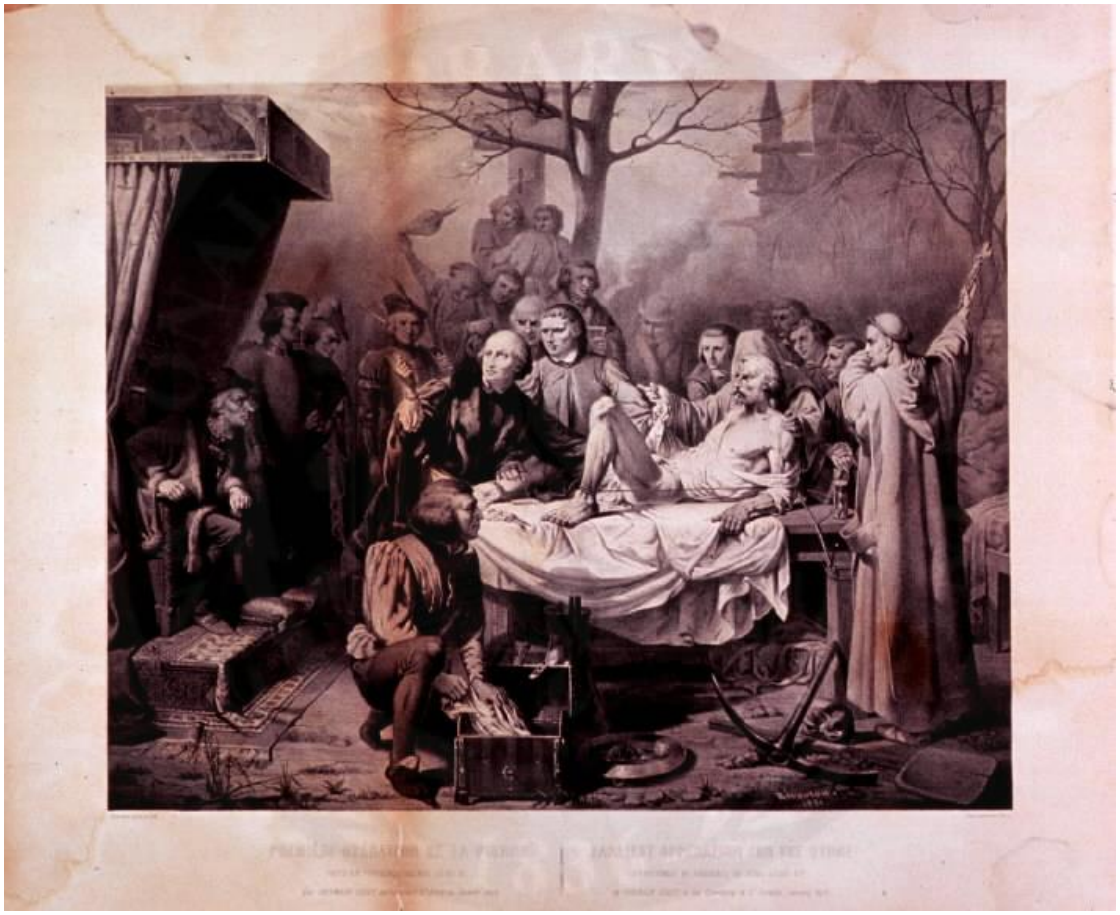
European Board of Urology certified Department

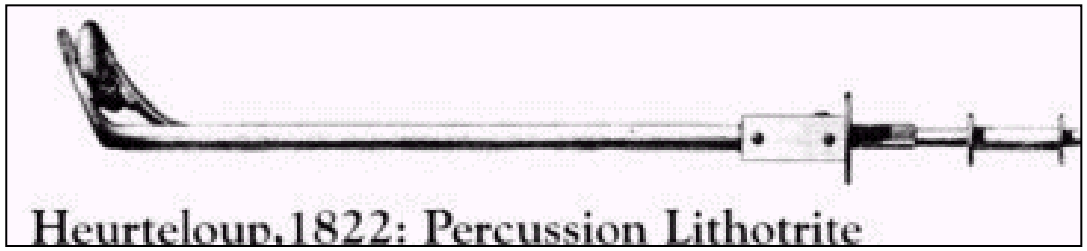


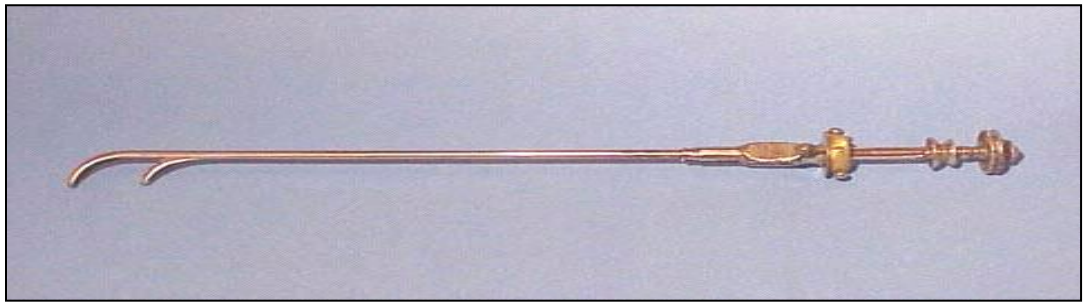
History



17. century - Frère Jaques

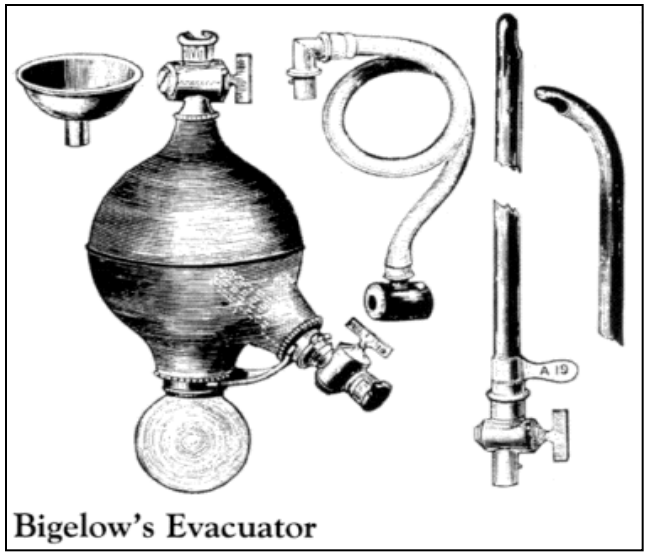
History





Heurteloup

To grab and fragment the stone



Henry Bigelow

Evacuate the fragments

History

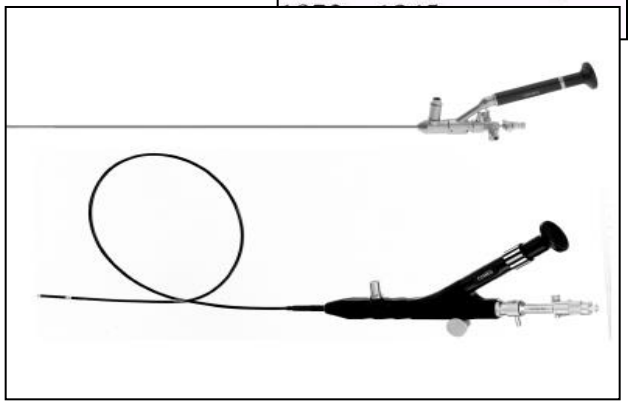
1869 - Percutan nephrostomy

Gustav Simon, Heidelberg –hydronephrosis


Hugh Hampton Young

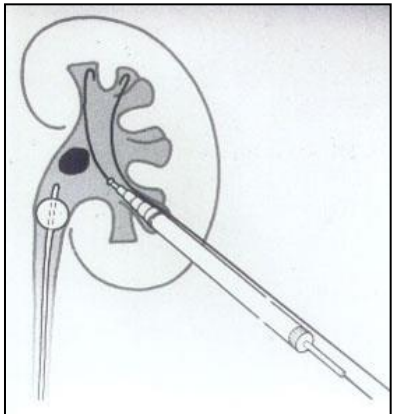
1912 – Ureteroscopy

Hugh Hampton: inserted a cystoscope in the ureter of a 2 month old child up to the kidney



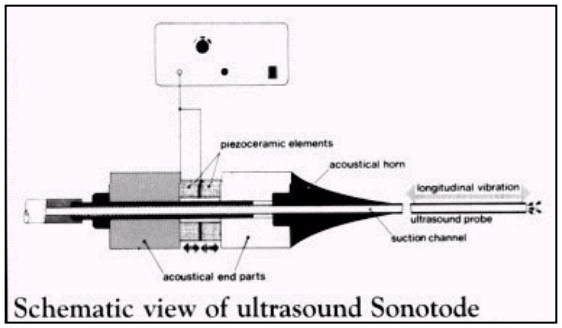
1964 - flexible ureteroscopy

1976 - Percutan stone removal



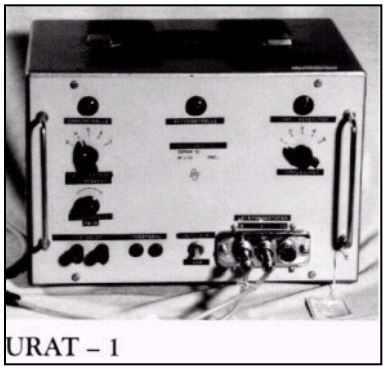
History

1953 US lithotripter



Schematic view of ultrasound Sonotode

1959 electro-hydraulic lithotripter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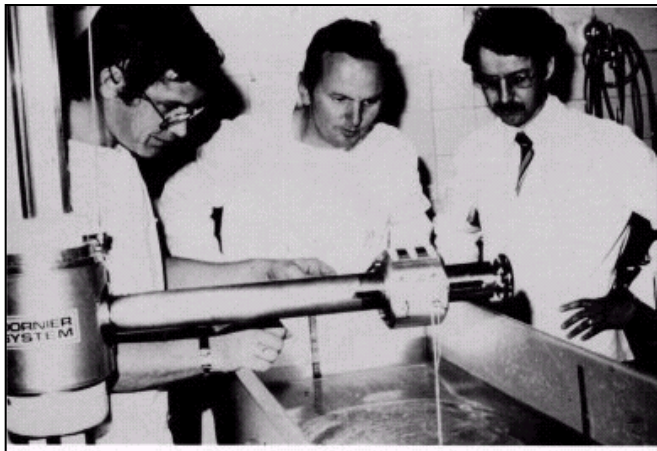
1980 Extracorporeal Shock Wave Lithotripter: ESWL


Chaussy, Eisenberger & Forssman reviewing prototype of Extracorporeal Shockwave Equipment

Epidemiology

- Stone related event (SRE):
  5% of the population in developed countries
- Incidence increases
- Male-female ratio: 3:1
- Most frequent between 20-50 years
- The recurrence rate is 50% in 10 years

Etiology: lifestyle

- Lack of physical activity
- Western pattern (unhealthy) diet
- Insufficient fluid intake
- Excessive intake of:

-Protein

-Salt

-Fett

-Carbohydrates

- Insufficient vegetable fibers intake
- Iatrogenic: Vitamin C, D; medicines, etc.

Etiology: endogenic factors

- Hyperparathyroidism
- Idiopathic hypercalciuria
- Cystinuria
- Primary hyperoxaluria
- Familial renal tubular acidosis

Theories of Stone Formations:

- **Nucleation theory:** urine is supersaturated and stone formation is initiated by the presence of a crystal or foreign body

- **Organic matrix theory:** an organ matrix of serum and urinary proteins (albumins, globulins, mucoproteins) provides a framework for deposition of crystals.

- **Inhibitor of crystallisation theory:**

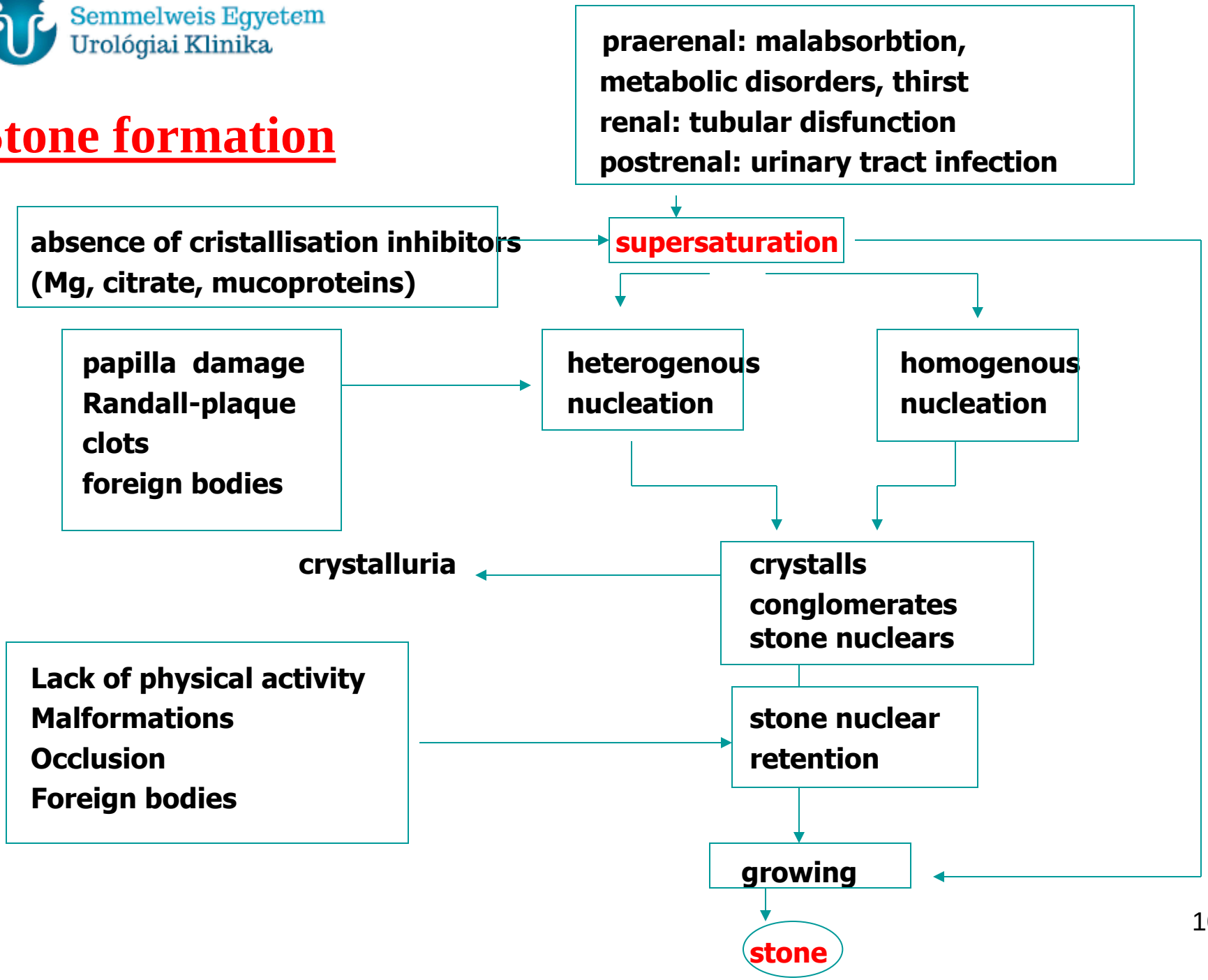
  Absence of inhibitors (Mg,citrate,mucoproteins) permits crystallisation.

It is likely that more than one factor operates in causing stone disease

Additional risk factors: metabolic state of the patient

- anatomic abnormalities
- infection

Stone formation



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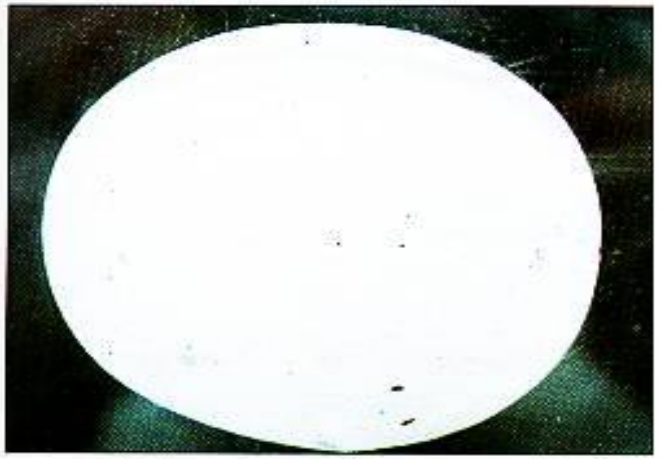
Stone composition

Chemical (mineralogical) name	Urine -pH	Color, appereance, fragility, radiological density
Calcium -oxalate-monohydrate (whewellit)	5,5 -6,4	Dark brown, smooth, Hard, Radiopaque
Calcium -oxalate-dihydrate (weddellit)	5,5 -6,4	Yellow, light brown, spiculated Fragile, radiopaque
Calcium -phosphates (hydroxy apatite, carbonate apatite Brushite)	6,2 -7,5	White, light brown, spiculated Hard, very radiopaque
Infected stones (struvite) - Magnesium ammonium phosphate hexahydrate	6,5 -8,3	Smooth, soft, light coloured rapidly growing into staghorn calculi, slightly radiopaque
Uric acid, Urate	4,6 -5,5	Yellow to brown, smooth, hard, radiolucent
Cystine	5,5 -7,0	Yellow to brown, smooth, hard, slightly radiopaque

Examples of stones

542

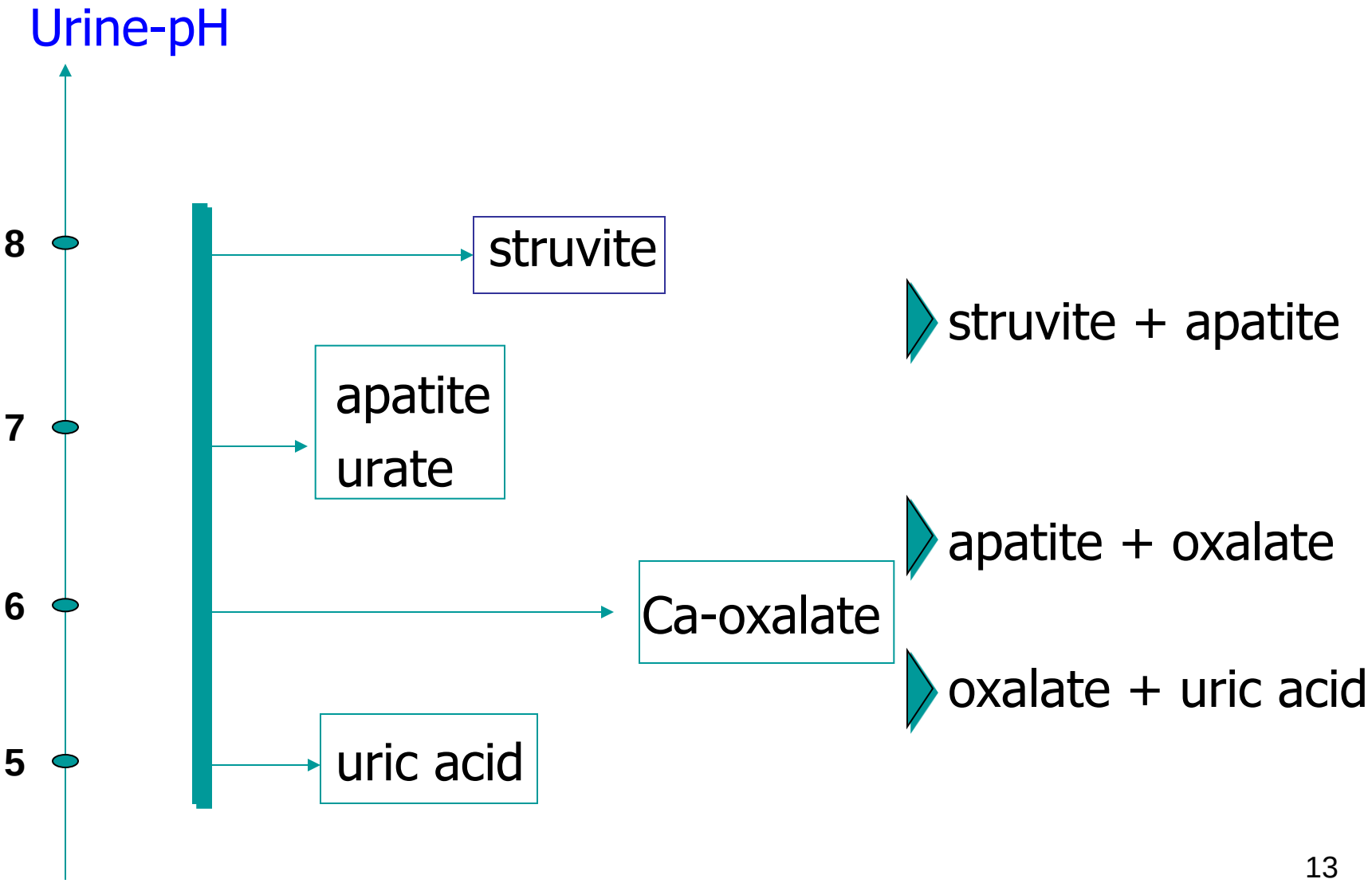


542 Phosphate stone. This is regular, spherical, and almost white.

543 Phosphate stone. The surface is irregular and pitted, but on section laminations are clearly seen with the central areas.

544 Uric acid stone. They show a brown discoloration caused by blood pigment. The stones are softer and the laminations and central nucleus are clearly seen. They are frequently radiolucent.

Stone composition and pH of urine



Symptoms of urolithiasis

Renal colic	Haematuria	Fever
Dilatation of renal pelvis Distension of capsula	microscopic	infection
Localisation, intensity of pain depends on the size and localisation of the stone	macroscopic	Chills
Radiation into the hypochondrium and external genitales Vomiting, frequency, urgency		

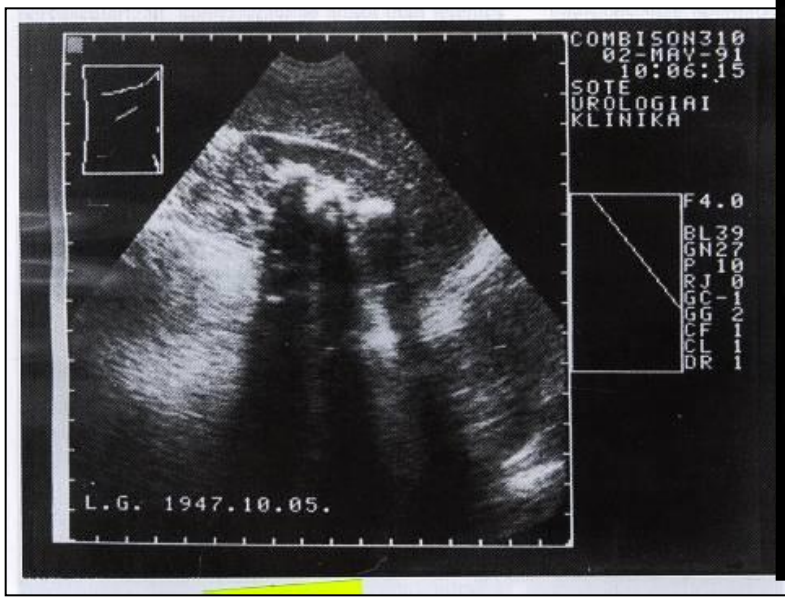
Urgent intervention:
Decompression:
Urinary diversion

DIFFERENTIAL DIAGNOSIS

– appendicitis
– ectopic gravidity
– ovarial cyst
– bowel diverticula
– cholelith
– ulcus
– ileus
– aortic aneurysm
– renal artery embolism

Imaging: Ultrasound

- Kidney stone: echogenic with shadow
- Ureteric or pyeloureteral located stone: dilatation



Imaging: XRay, ivp

XRay:

- Calcium content stones
- Bones, gas in the bowel system cover the stone
- Calcifications in the soft tissues

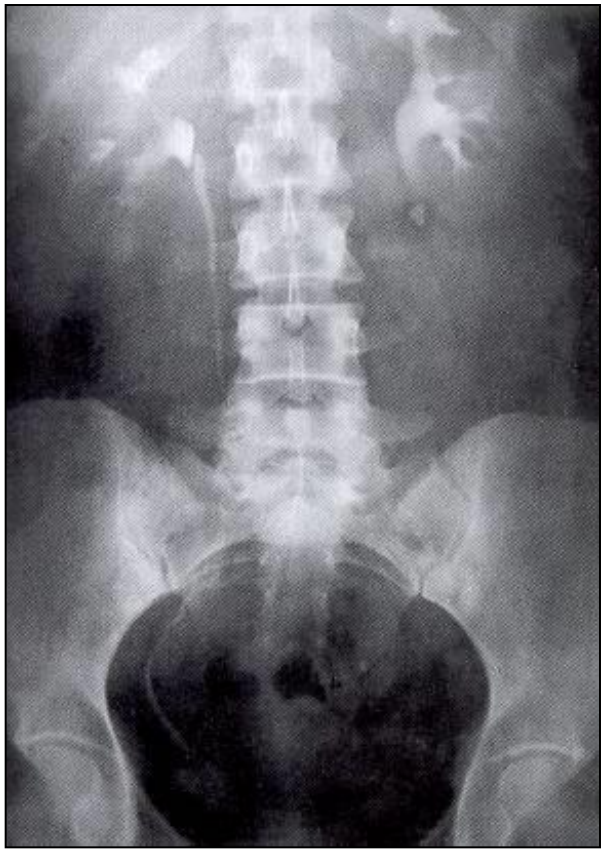
(pl: phleboliths, calcificated vessels, etc.)

IntraVenous Pyelogramm (ivp):

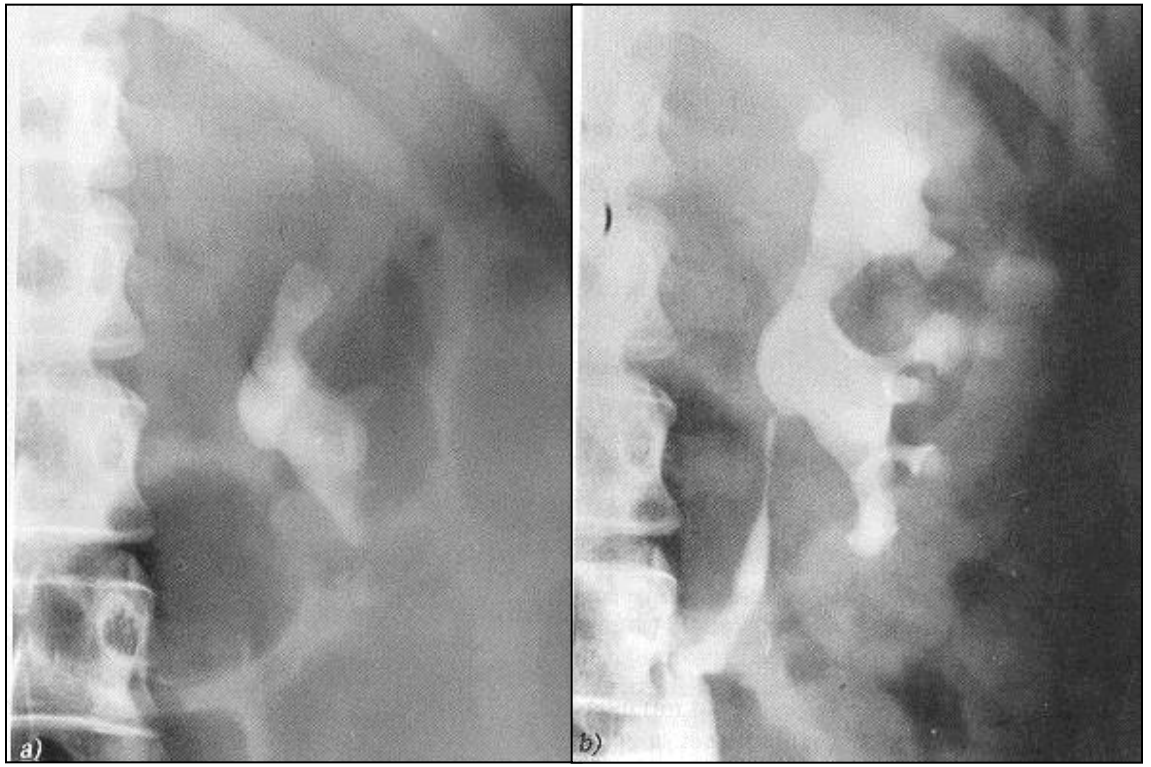
- Anatomy of the collecting system, exact localisation of the stone, operation plan
- Disadvantages: radiation, contrast

Imaging: XRay, ivp

Imaging: XRay, ivp



IVP



XRay + IVP

Imaging: retrograde pyelography

Imaging: CT scan

Non contrast, low dose CT: GOLD standard

- Fast, cheap, non invasive, reproducible
- Sensivity and specificity: above 95%
- Low radiation exposure
- Density of the stone

(correlates with fragility, above1000HU ESWL is less effective)

- Skin to Stone Distance

(above 10cm the ESWL is less effective)

Imaging: CT scan

Contrast enhanced CT:

- Correct operation plan

(exact location of the stone in the collecting system)

- Anatomical abnormalities/variaties

Lenght and width of the lower calix infundibulum,

Infundibulopelvical angle

- Surrounding organs

(retrorenale colon, spleno/hepatomegaly, etc.)

- Disadvantages: radiation exposure and contrast!!!

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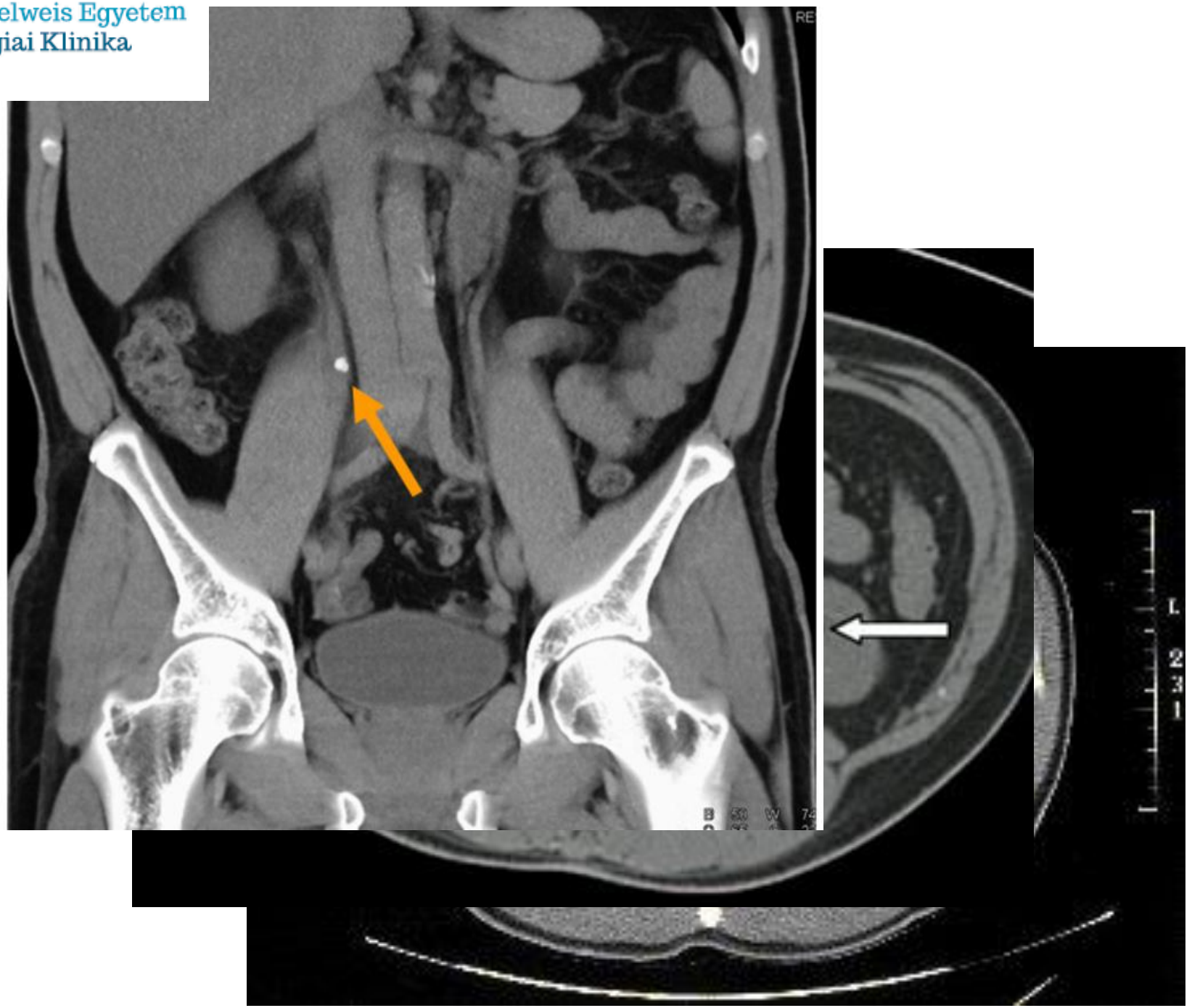

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Renal colic management

- Spazmolythics (Drotaverine)
- Analgetics (NSAID)
- Phytotherapy (Rowatinex)
- Excessive fluid intake
- Physical activity

Hospitalisation

Hospitalisation (<10%)

- ineffective medication (vomiting, unbearable pain)
- obstruction, fever:

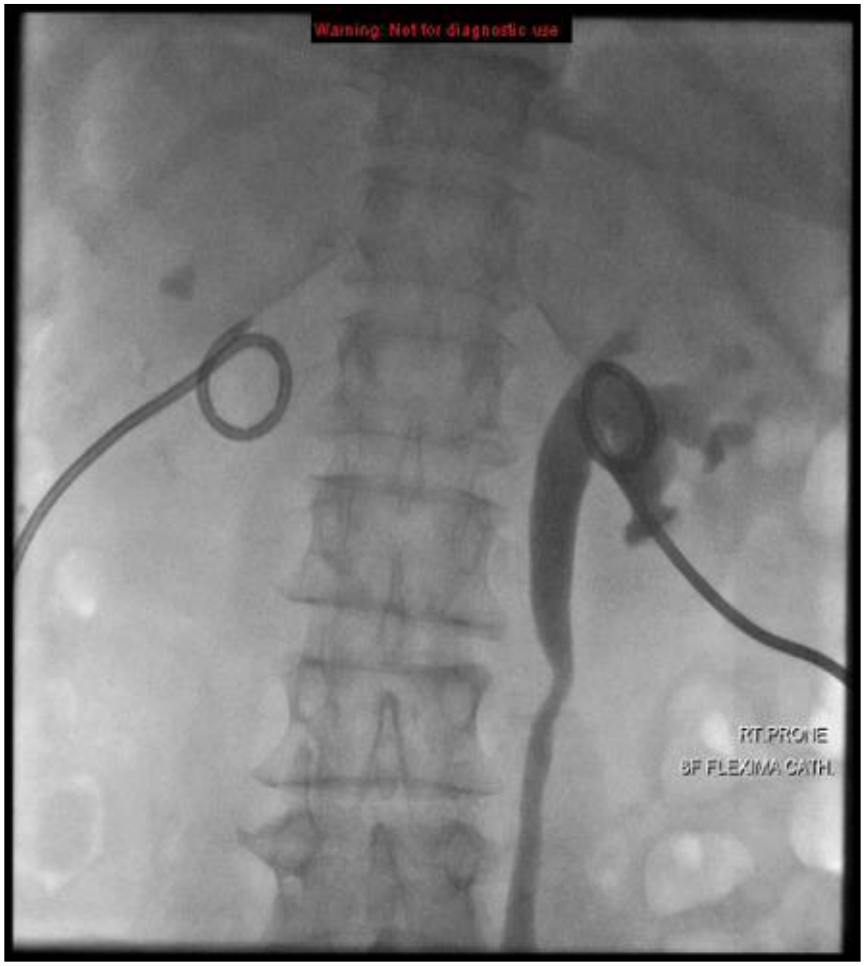
(urgent diversion of the renal pelvis nephrostomy / duble J ureter stent!!!)

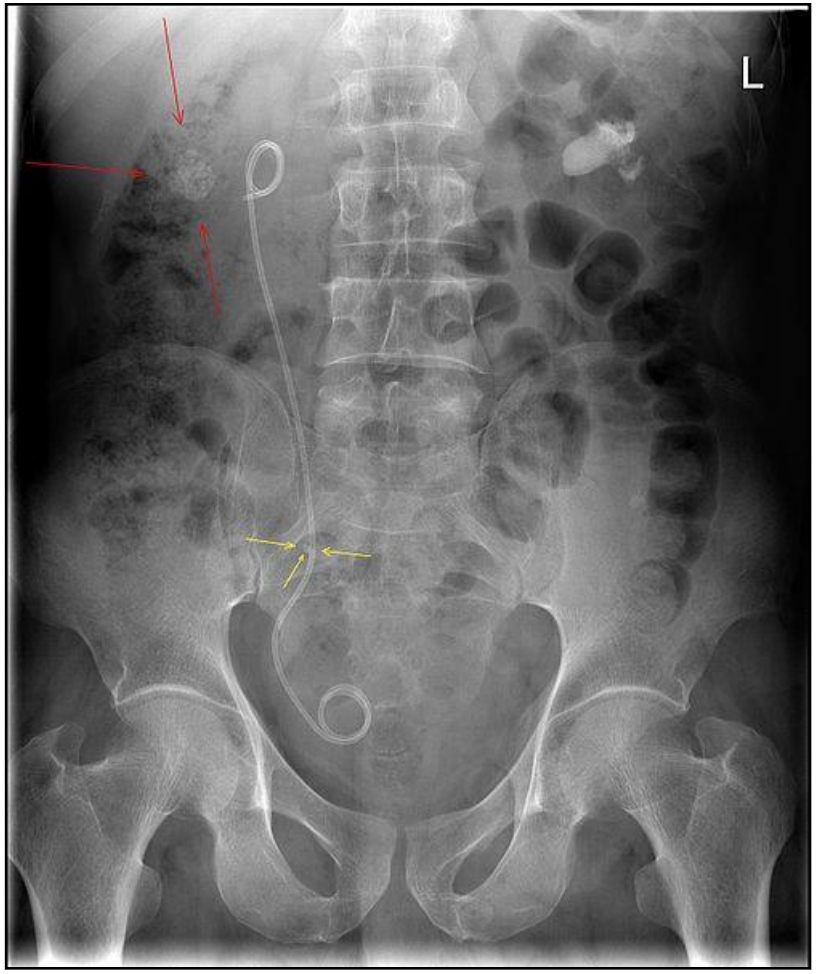
- anuria (solitary kidney/reflex)

Mostly (90%) outpatient care is sufficient:

- Collect the stone for further analyses
- You can wait for the spontaneous stone passage approximately 3-4 weeks without irreversible damage of renal function

Diversion of the renal pelvis





Percutaneous nephrostomy = PCN **Double J ureteric stent = DJ**

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CONSERVATIVE TREATMENT

OBSERVATION:

Follow up

(small, caliceal stones, asymptomatic, high risk patients)

PROMOTE SPONTANEOUS PASSAGE (max. 5 mm)

- Excessive fluid intake
- Physical activity
- Phytotherapy (ureteric peristalsis enhancement: Rowatinex, etc.)
- Selective alpha blockers (tamsulozin, alfusozin)
- In symptomatic cases: smooth muscle relaxants + NSAID

DISSOLVE THE URIC ACID AND URATE STONES:

- Alkalizing urine (Blemaren N, Solutio Nephrolythica)

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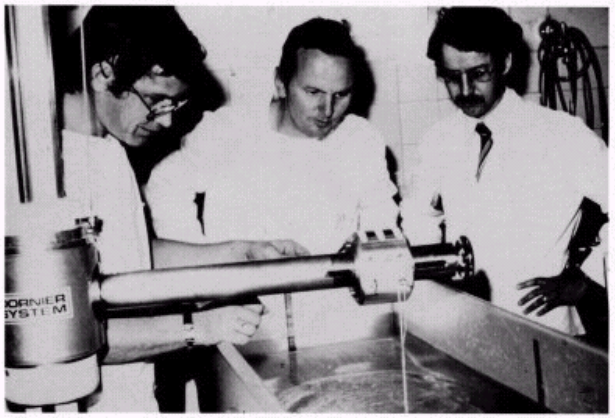
ESWL: Extrocorporeal shock wave lithotripsy

- acoustic amplitude sound wave
- spreads in soft tissues with minimal loss
- desintegrate the structure at the border of a solid stone

Energy source

- electrohydraulic
- electromagnetic
- piezoelectric



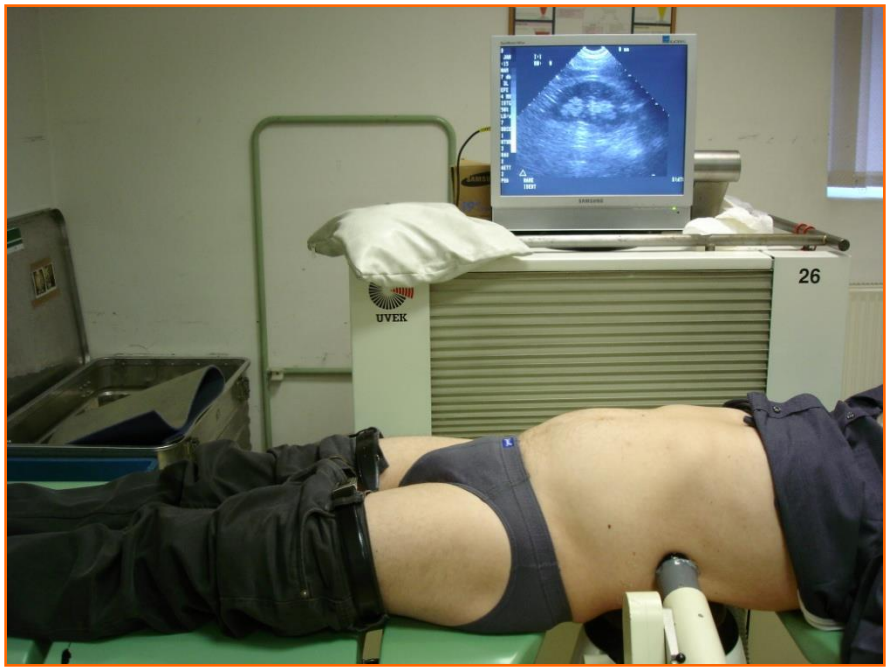
Chaussy, Eisenberger & Forssman reviewing prototype of Extracorporeal Shockwave Equipment

Indication: kidney (max.: 2cm) / ureteric stones (max.:1cm)

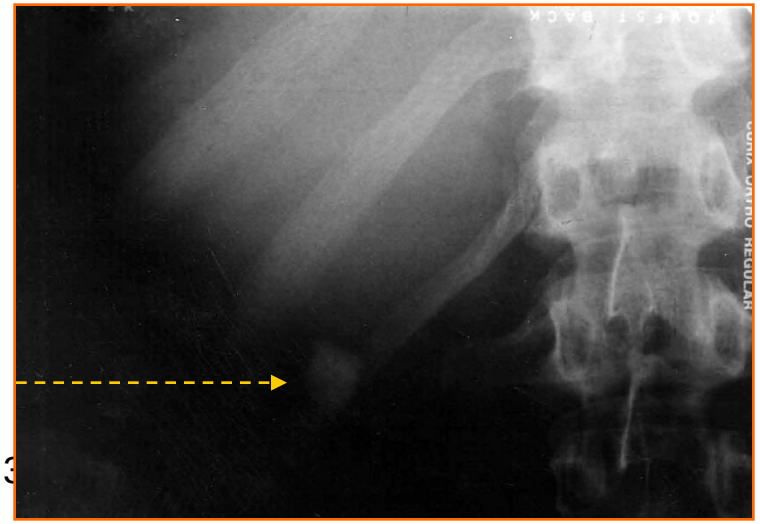
- target the stone with Xray or US
- efficacy approximately: 80%

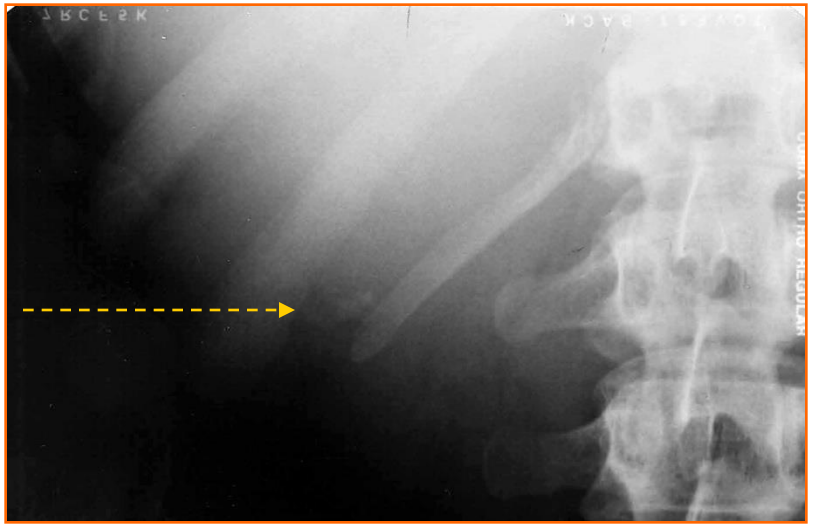
(depends: hardness, BMI, localisation (lower calyx, etc.))

SWL: Ultrasonic targeting



SWL: Xray targeting

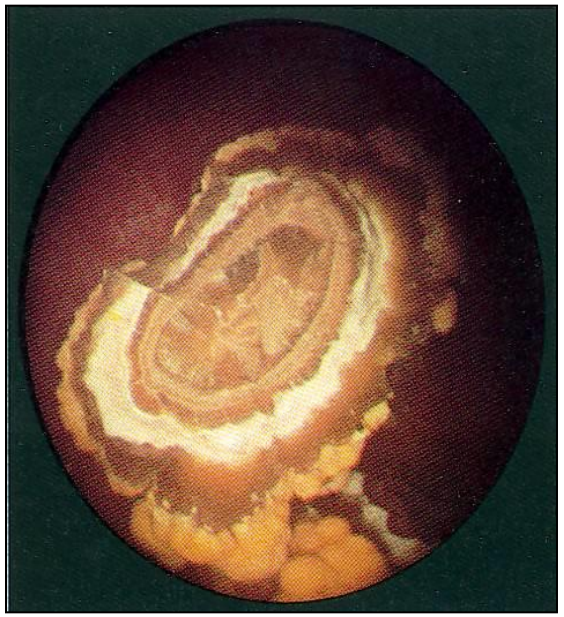


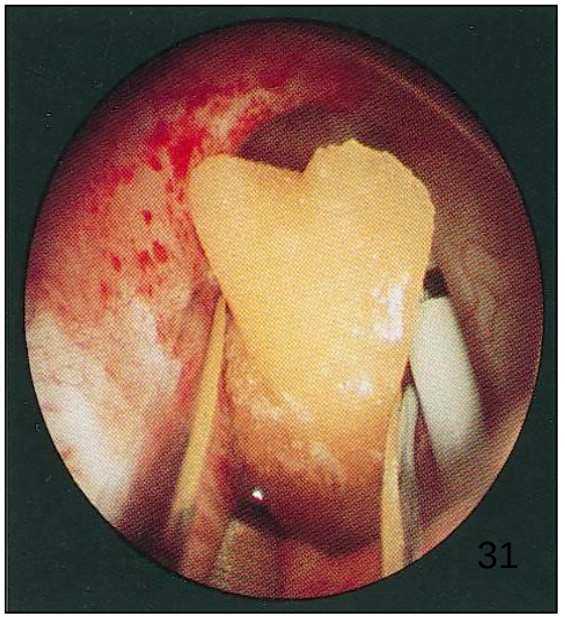


Endourology: stone surgery

- Smarter devices
- Better skills
- Less ESWL, more endourology

(cystin, lower calyx stones, anatomical abnormalities)





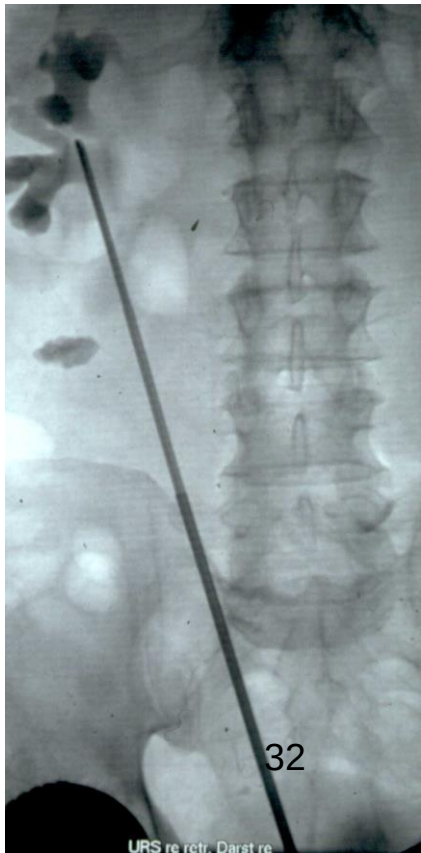
Ureteroscopy: URS

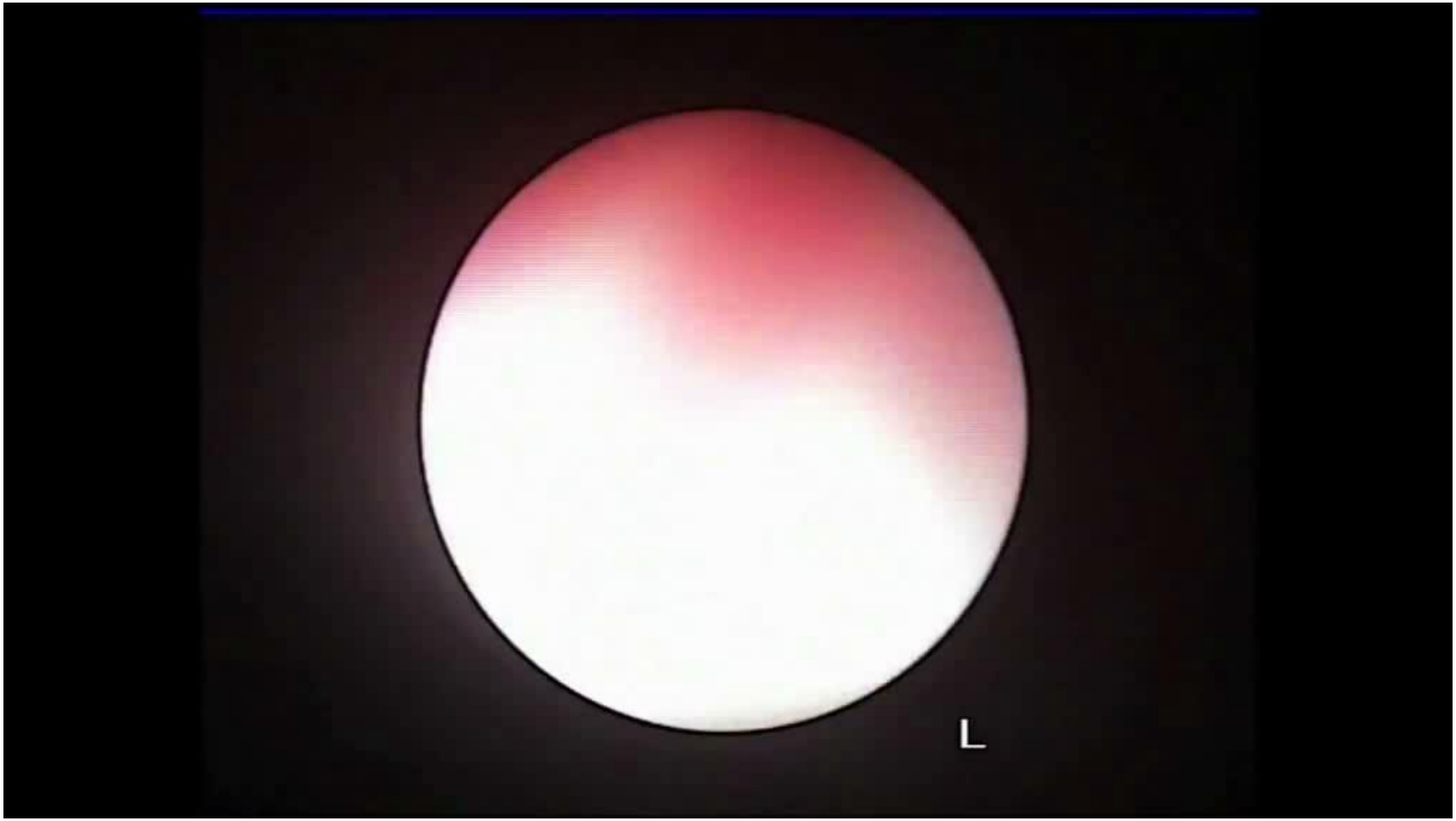
Indication:

- Stone is bigger, than 1cm
- Impacted stone (did not move in the last week)
- Cystin, calcium oxalate monohydrate
- Anatomical abnormalities
- ESWL: was not effective

Fragmentation: laser, US, pneumatic

Stone removal: forceps, Dormia baskets

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URS + Dormia basket

Percutaneous nephrolythotrypsy: PCNL

Indications:

- Stones bigger than 2cm
- ESWL was not effective
- Anatomical abnormalities, lower calix stones, etc.
- SFR (stone free rate): 68-100%

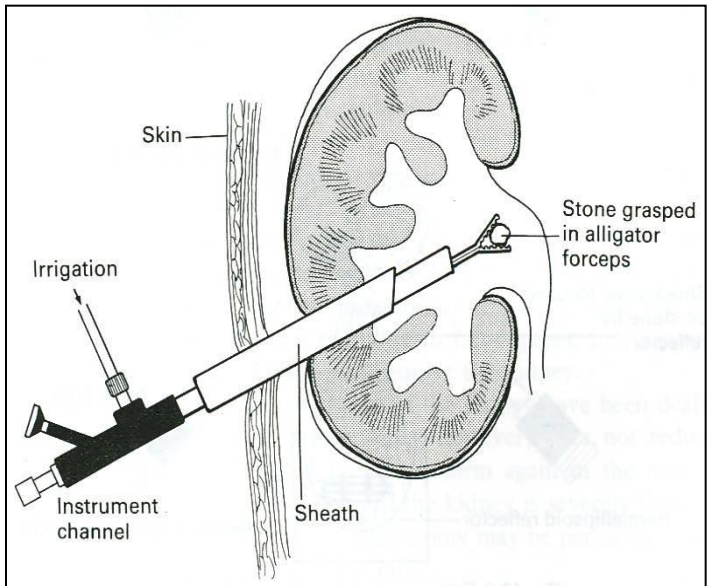

Fig. 10.7 Percutaneous stone removal

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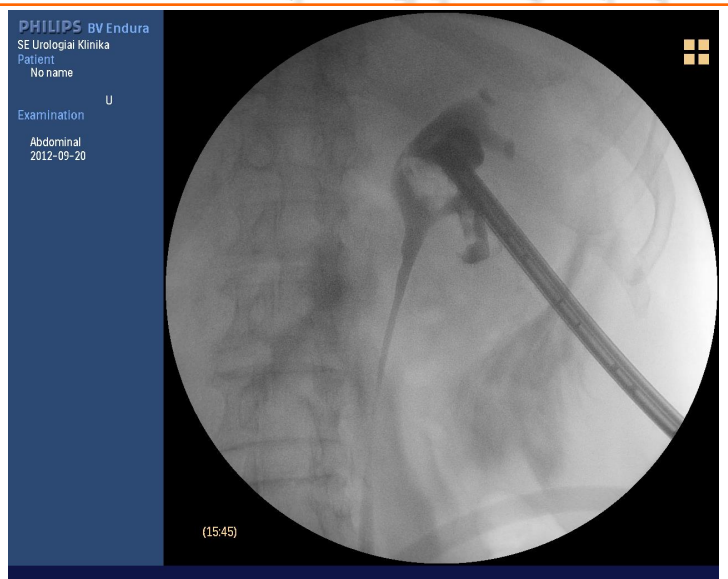
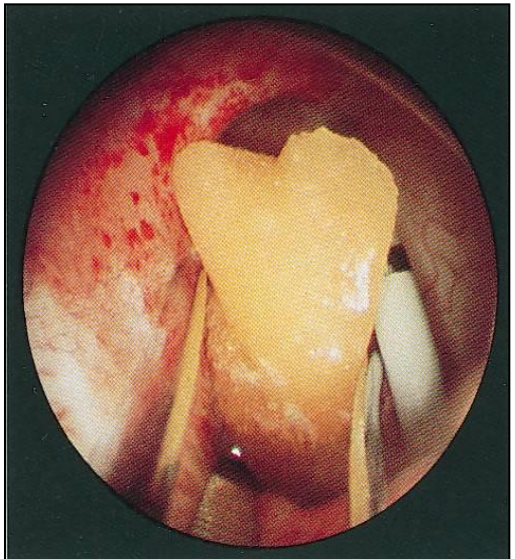
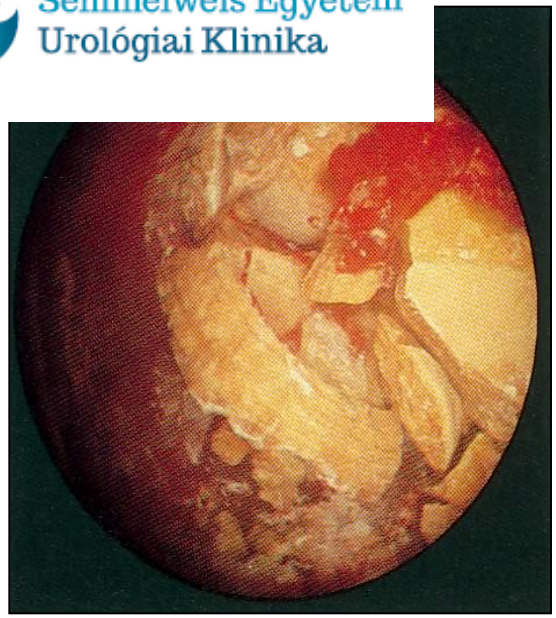
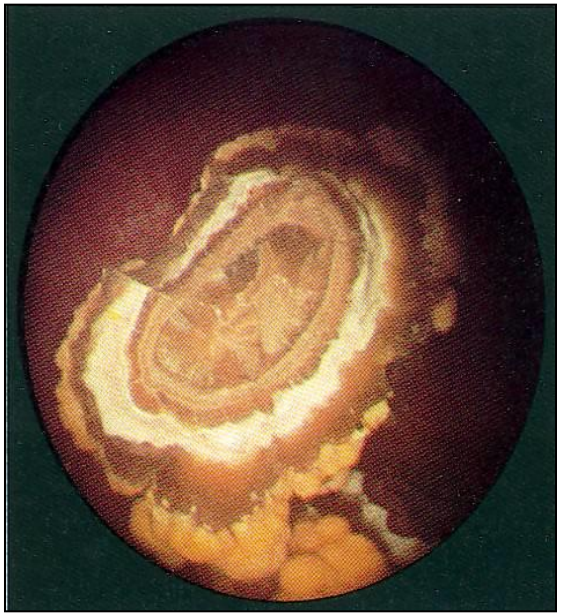
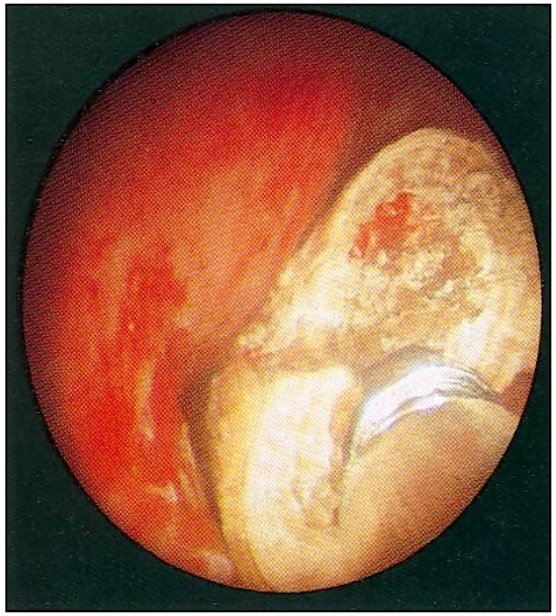
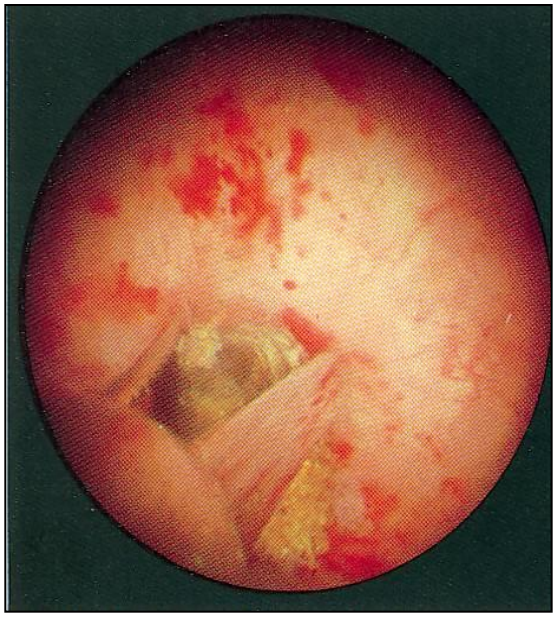
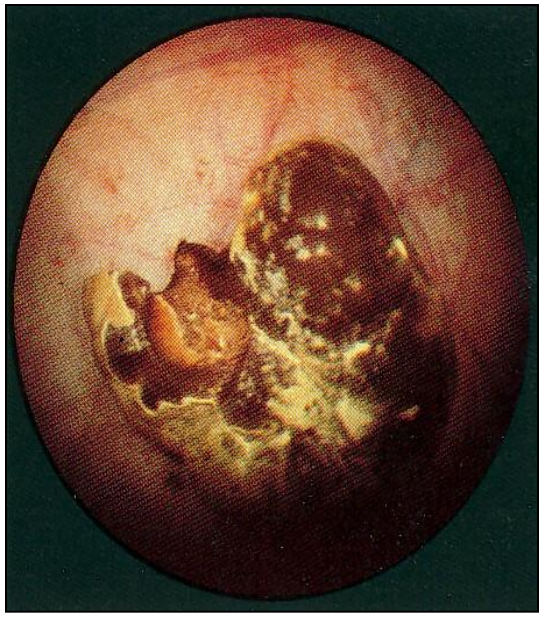
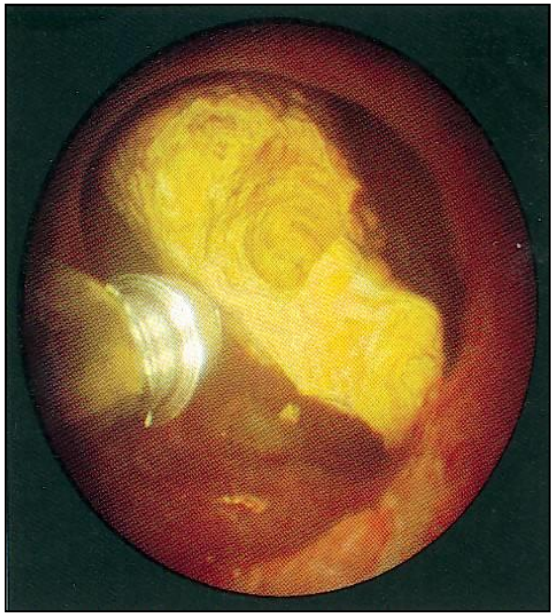
Percutaneous nephrolythotripsy (PCNL)





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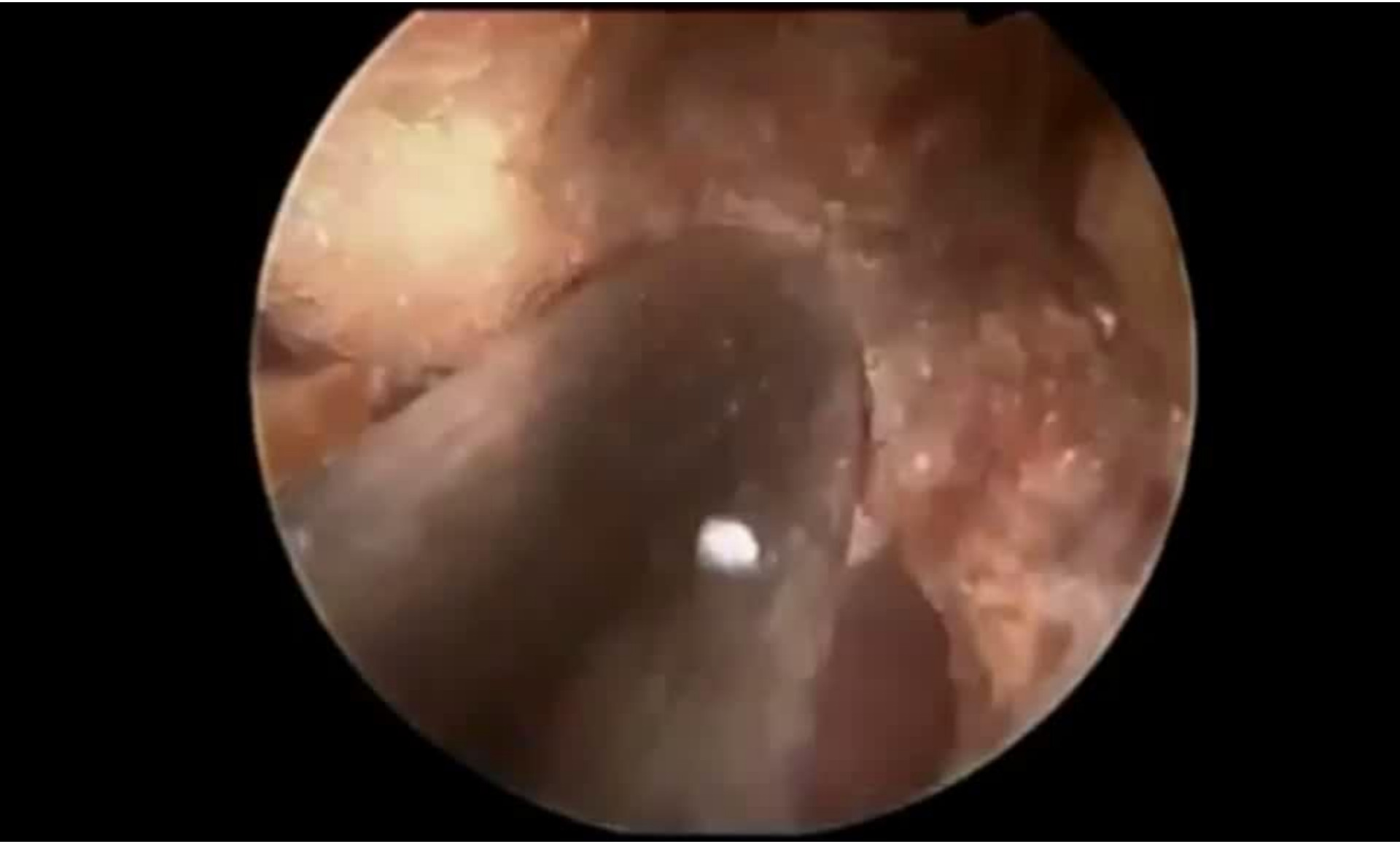
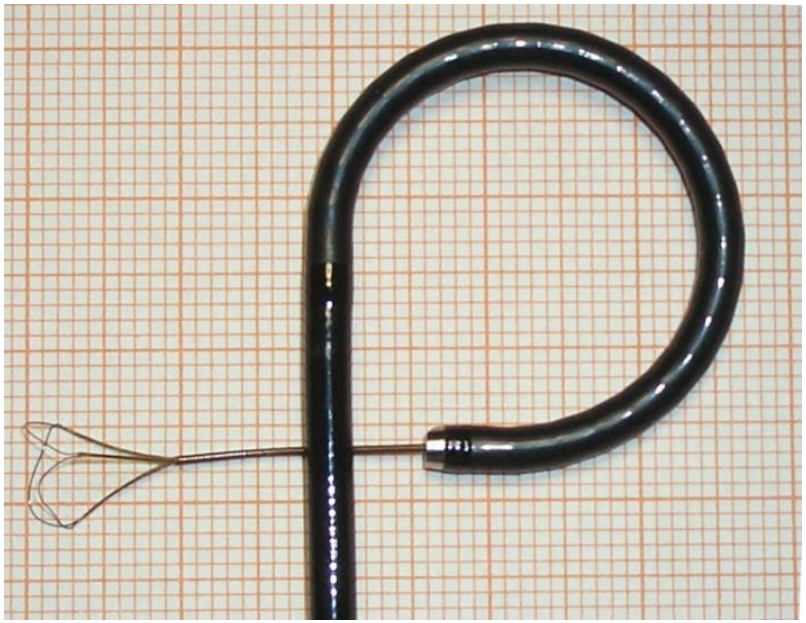


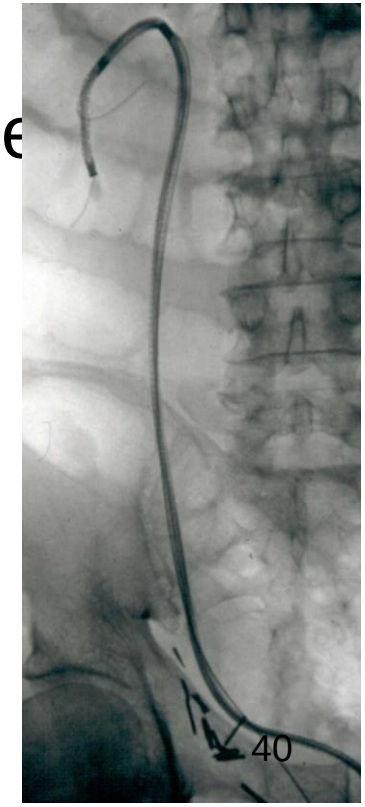
Flexible Ureteroscopy

RIRS= retrograde intrarenal surgery

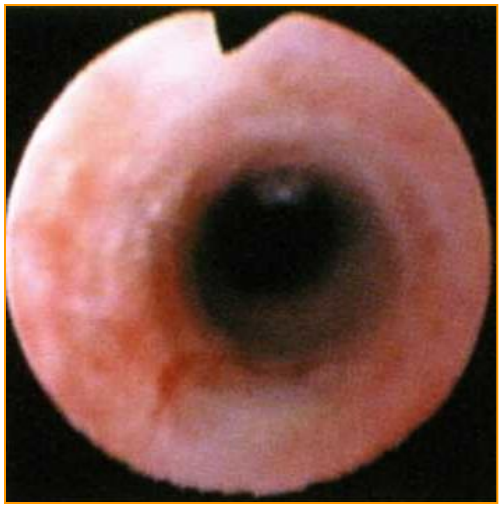
<u>Indications:</u>

- Lower calix stones, anatomical abnormalities, etc.
- ESWL was not effective
- Not suitable in case of for big stone burde





Flexible ureterorenoscopy



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Flexible URS vs. miniPCNL

- **RIRS:**

-less radiation

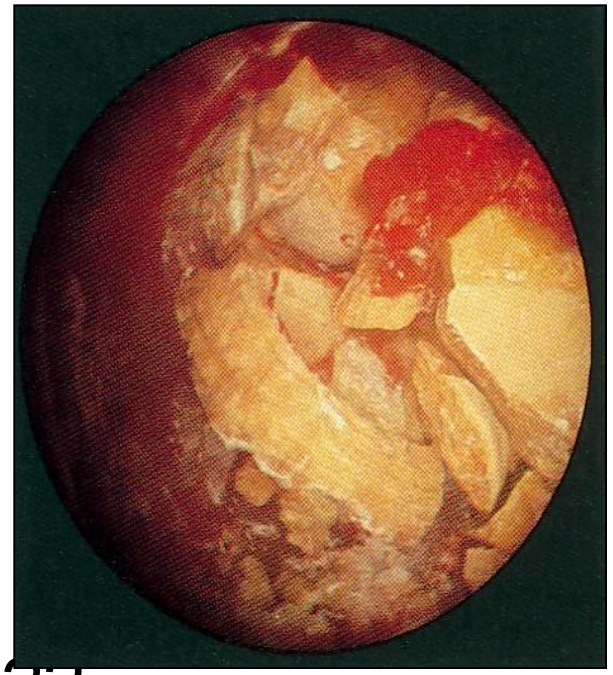
-less complication

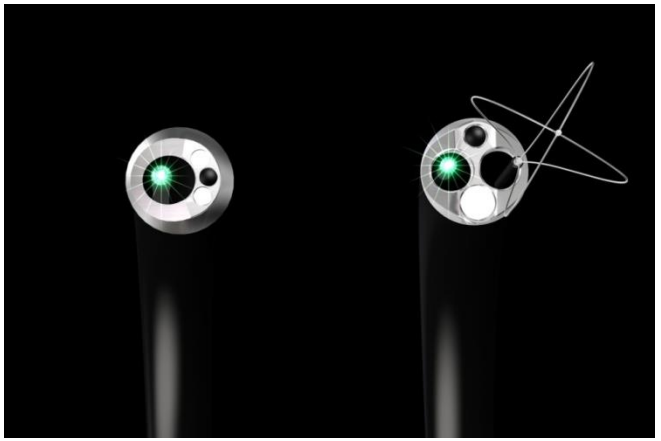
-shorter hospitalisation time

- **miniPCNL:**

-more effective

-ultramini PCNL: all seeing needle??



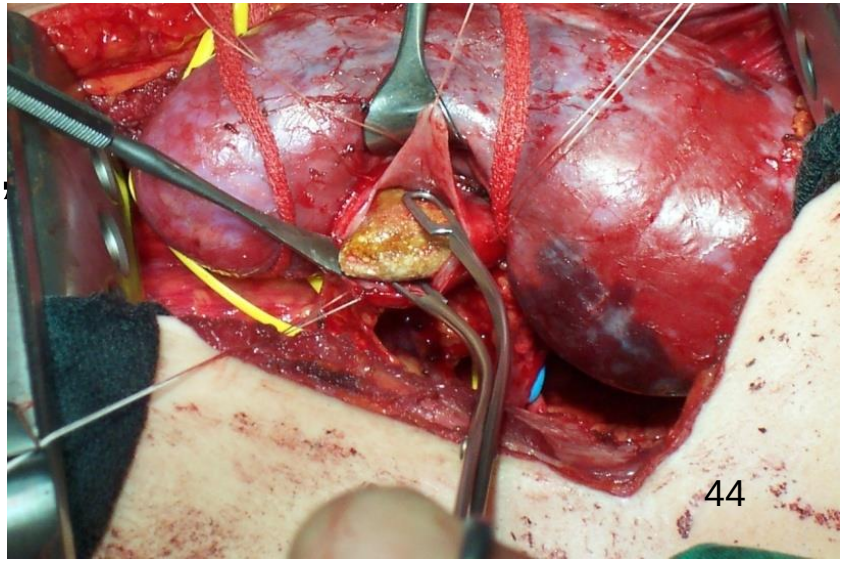


Open/laparoscopic stone surgery

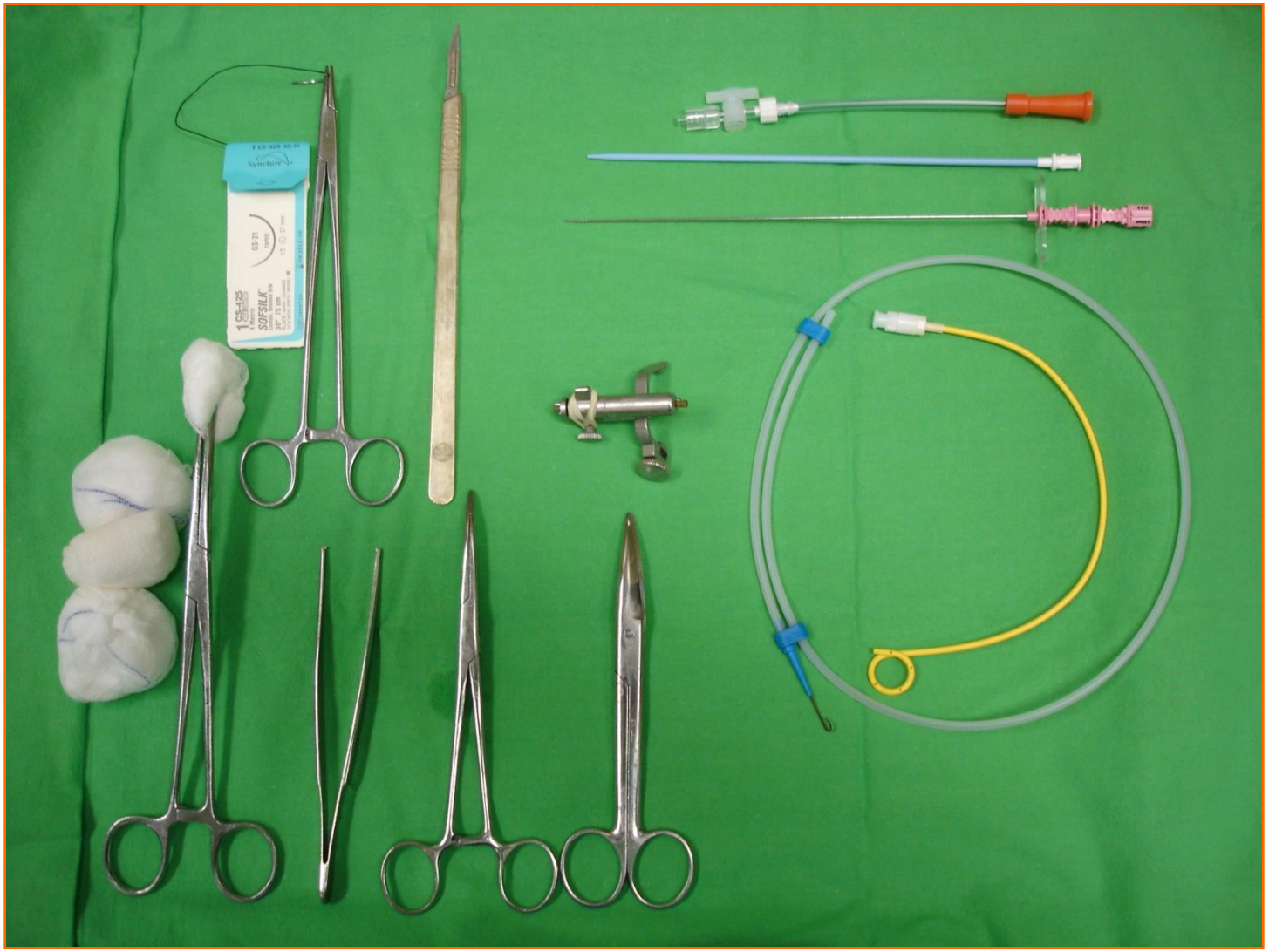
- Less, than 1% of all stone interventions

Indications

- If the other, minimally invasive techniques were not effective
- Stones with anatomical abnormalities (pyeloureterale stricture)
- Ortopaedic deformities
- Newborn babies with huge, complex staghorn calculi



Percutaneous nephrostomy (PCN)



Factors determining the stone treatment

Size and location	- < 2,5 cm - > 2,5 cm - Staghorn - lower calix
Hardness	- Fragile - „Hard” Ca oxalate-monohydrate, cystine, uric acid
Urinary tract	- Sterile - Infected - Drained - Obstructed
Anatomy	- Normal/Complex/Abnormal

Prevention: General advices

- **Fluid intake** - min. 2 liters of urine/day (beverages are prohibited!!!)
- **Salt intake** - (5g/day)
- **Protein** (1g/kg/day)
- Less fat, carbohydrate, more fibre
- In case of **hypercalciuria** - hypothiazid diuretikum
- (Oxalate restriction (tea, spinach, chocolate))
- (Ca restriction (dairy products))

Prevention: Struvite (infected) stones

- treatment and prevention of infections→ antibiotics (Proteus, Pseudmonas)

- complete stone removal

- acetohydroxam acid (ureaz inhibitor)

- urine pH - acidification

Prevention: Uric acid stones

- urine alkalization (Blemaren, Solutio nephrolythica)

- restriction of red meat intake

- Allopurinol (Milurit) – decrease the serum uric acid level

Prevention: cystine stones

- autosomal recessive

- congenital tubular transport disturbance

- excretion of cystin, lysin, arginin, ornitin increases

- hexagonal crystalls in urine sediment

- stone formatting from poorly soluble cystin

Prevention: cystine stones

- excessive fluid intake- 3-4 liter/day

- strict restriction of protein intake

- urine alkalization: citrate - pH: 6,8-7,2

- facilitate complex emergence:

D-penicillamin
merkaptopropionilgylcin –Thiola

- reduces excretion: captopril