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Surgery Illustrated – Surgical Atlas
Open staghorn stone surgery

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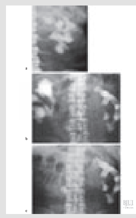
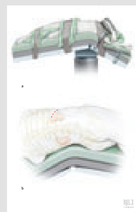
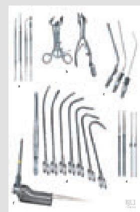
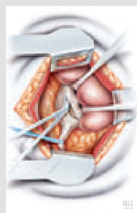
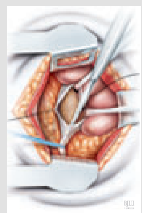
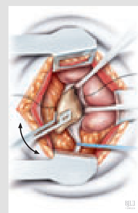







INTRODUCTION

With the advances in ESWL and endourological surgery, i.e. ureteroscopy and percutaneous nephrolitholapaxy (PNL), over the past 20 years, indication for open stone surgery has markedly decreased. Centres with the equipment, expertise and experience in surgical treatment of renal tract stones report a need for open surgery in 1–5.4% of cases [1–5], therefore, under special circumstances, there is still a place for open surgical removal of renal calculi.

An open surgical procedure may be preferred whenever the major stone volume is located peripherally in the calyces, especially if these calyceal necks are narrow, so that either several percutaneous accesses, multiple shock-wave sessions and mostly several endourological additional procedures would be necessary for complete stone removal. By contrast, complete stone removal, especially in the case of complete staghorn calculi, can be achieved in one session by open surgery.

However, today's experience in complex open stone surgery is limited in many hospitals, so it may be advisable to send patients to centres experienced in the technique of extended pyelocalycotomy [6] and multiple radial nephrotomies [7,8].

Intraoperative use of B-mode scanning and duplex ultrasonography (US) [9,10] for identification of nearly "avascular" renal areas by localization of the intraparenchymal vessels and detection of the shortest access to the calyceal stone portions allows removal of even extended staghorn calculi by pyelocalycotomy and multiple small radial nephrotomies, without clamping the renal artery and cooling the kidney and without any significant loss of renal function.

The intraoperative use of small-part scanners allows identification and exact localization of residual stone fragments with a diameter of <1 mm, thus complete stone removal is safely feasible.

INDICATIONS FOR OPEN RENAL STONE SURGERY

- Extended stone burden of the kidney
- Treatment failure with ESWL and/or PNL
- Intrarenal anatomical abnormalities: calyceal infundibular stenosis, stones in calyceal diverticula (particularly in anterior calyces), obstruction of the PUJ
- Stones in ectopic kidneys, where percutaneous access and ESWL may be impossible
- Staghorn calculi (Figure 1a, b, c)

LIMITATIONS AND RISKS

In staghorn stone surgery there are no limitations concerning extent of stone mass and numbers of radial nephrotomies necessary for complete stone removal. However, in case of poor function of the affected kidney (split renal function of <20%), nephrectomy should be considered instead of extended reconstructive surgery.

DIAGNOSTIC PROCEDURES BEFORE SURGERY SHOULD INCLUDE

- Urine culture
- Kidney US
- Renal clearance
- X-ray plain film and IVU and/or retrograde ureteropyelography to visualize the anatomy of the collecting system.

INSTRUMENTS AND MATERIALS

- Standard instruments for renal surgery.
- Vessel loops, atraumatic vascular clamps.
- Special stone equipment including brain spatulas, fibre optic-illuminated nasal specula, fibre optic-illuminated suction with combined irrigation.
- A dental drill and saw.
- Flexible nephroscope.
- Intraoperative small part B-Scan and duplex US
- Intraoperative x-ray (e.g. mobile x-ray C-arm)

Figure 1

a) Plain x-ray picture: left-sided extended renal staghorn calculus.
b) Plain x-ray picture: Bilateral partial renal staghorn calculi.
c) Plain x-ray picture after removal of the right-sided stones before attempt to the left-sided stones.

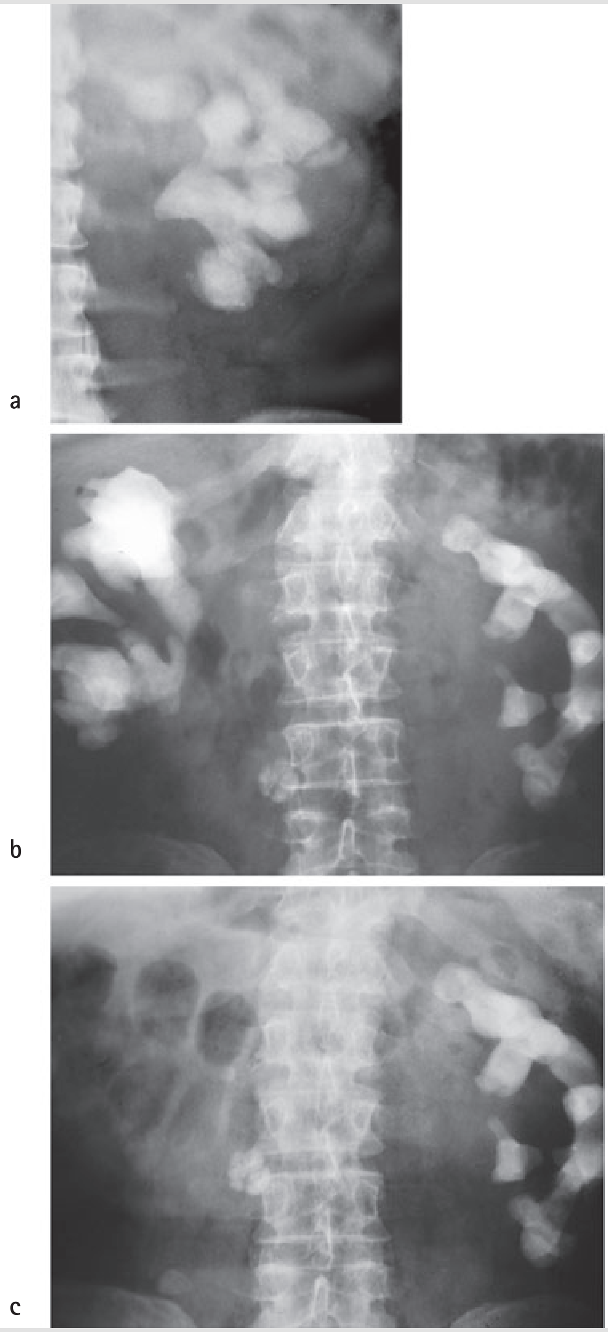
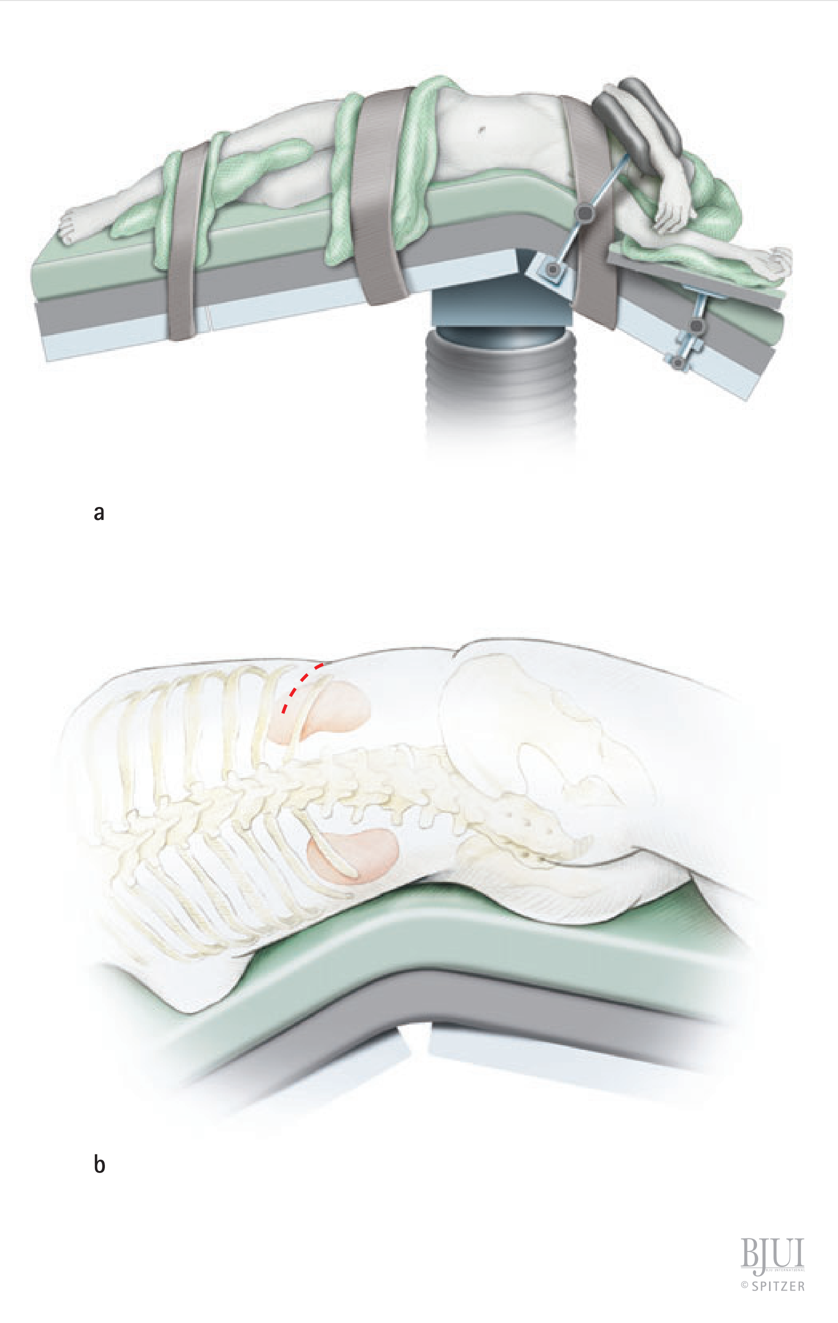


Figure 2

Intercostal approach to the kidney, patient in flank position. Supracostal 12th or 11th rib incision. Transsection of Gerota's fascia. Placement of a Finocchietto retractor supported by a rolled towel. Dissection of the perirenal fat sharply and bluntly and exposure of the entire kidney as well as of the renal vessels. A vessel loop should be placed around the renal artery, to enable possible later quick clamping of the renal artery in the very rare case of severe bleeding from the nephrotomies.



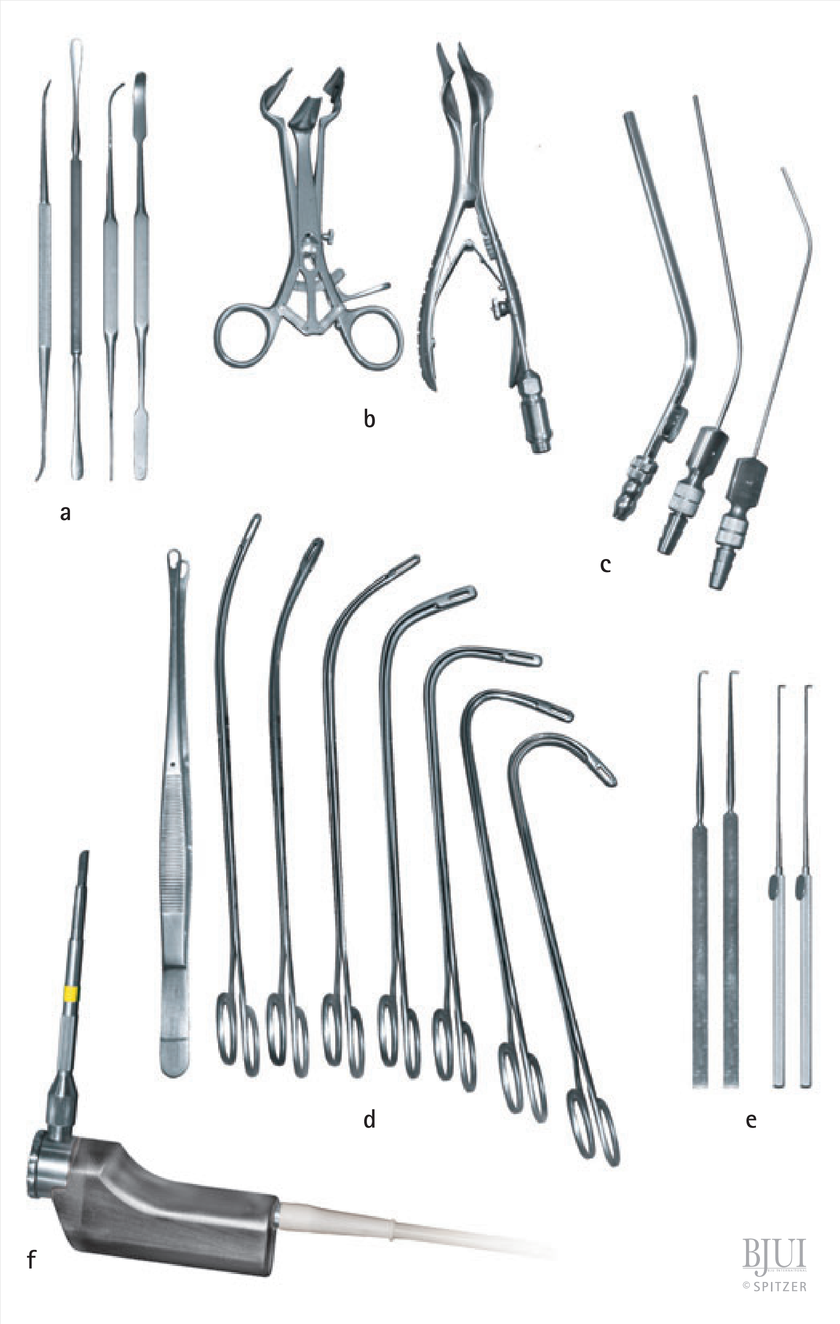


Figure 3

Set of special instruments:

a) Brain spatulas
b) Fibre optic-illuminated nasal specula (2 or 3 branches)
c) Suction with combined irrigation
d) Stone forceps
e) Stone hooks
f) Dental saw/drill

Figure 4

Extraction of the staghorn calculus is started via a pyelocalycotomy. Wide intra-sinusoidal preparation of the renal pelvis and calyceal necks. The extent of the 'V'-shaped incision by Pott's scissors is adapted to the configuration of the pelvi-ureteric calyceal portion of the stone, but the PUJ should be excluded from incision.

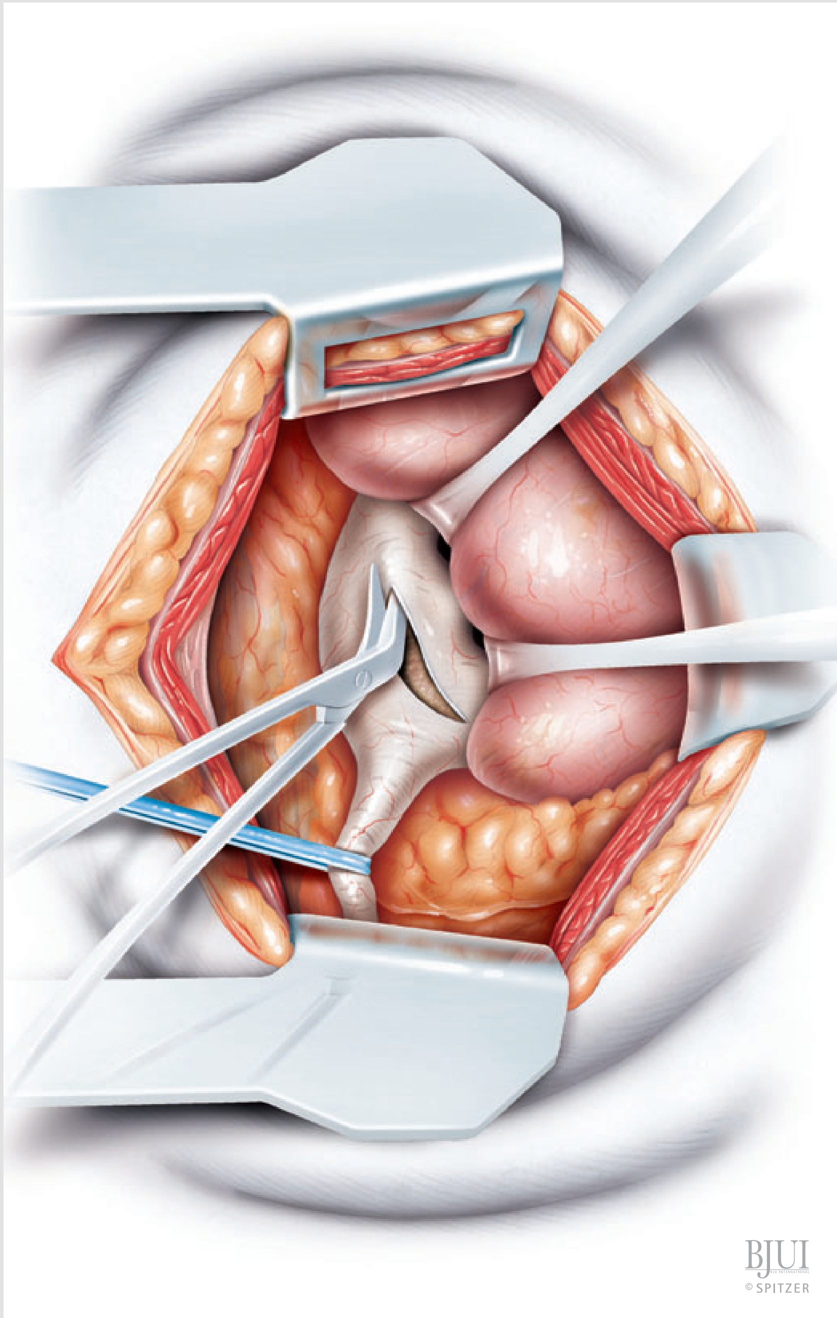


Figure 5

The calyceal necks are exposed by traction of 'lid retractors'. Using brain spatulas and small stone hooks, the stone is separated from the urothelial walls of the collecting system, starting at the PUJ.

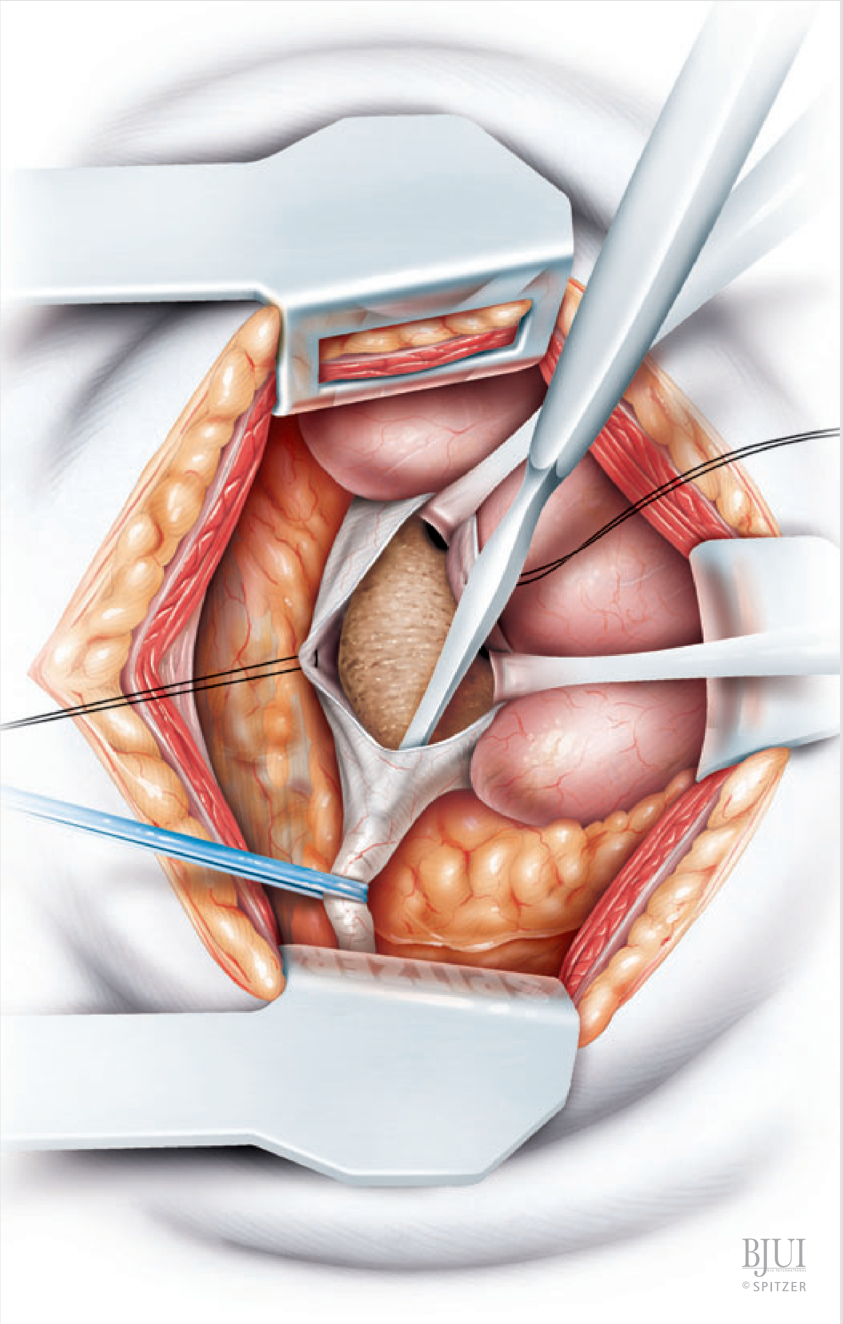


Figure 6

The stone is grasped with a forceps and subsequently mobilized by gentle rotation towards its calyceal extensions, which are transected by scissors or, even better, with the use of a dental drill/saw. Extraction of the stone starts with freeing the ureteric and pelvic portion first and thereafter freeing the calyceal extensions.

Obstructed calyceal infundibula often can be gently dilated with forceps to allow additional extraction of clubbed calyceal portions of the stone.

Intraoperative nephroscopy with extraction of further stone portions helps to remove as much of the stone mass as possible via the pyelocalycotomy to reduce the number of subsequent radial nephrotomies.

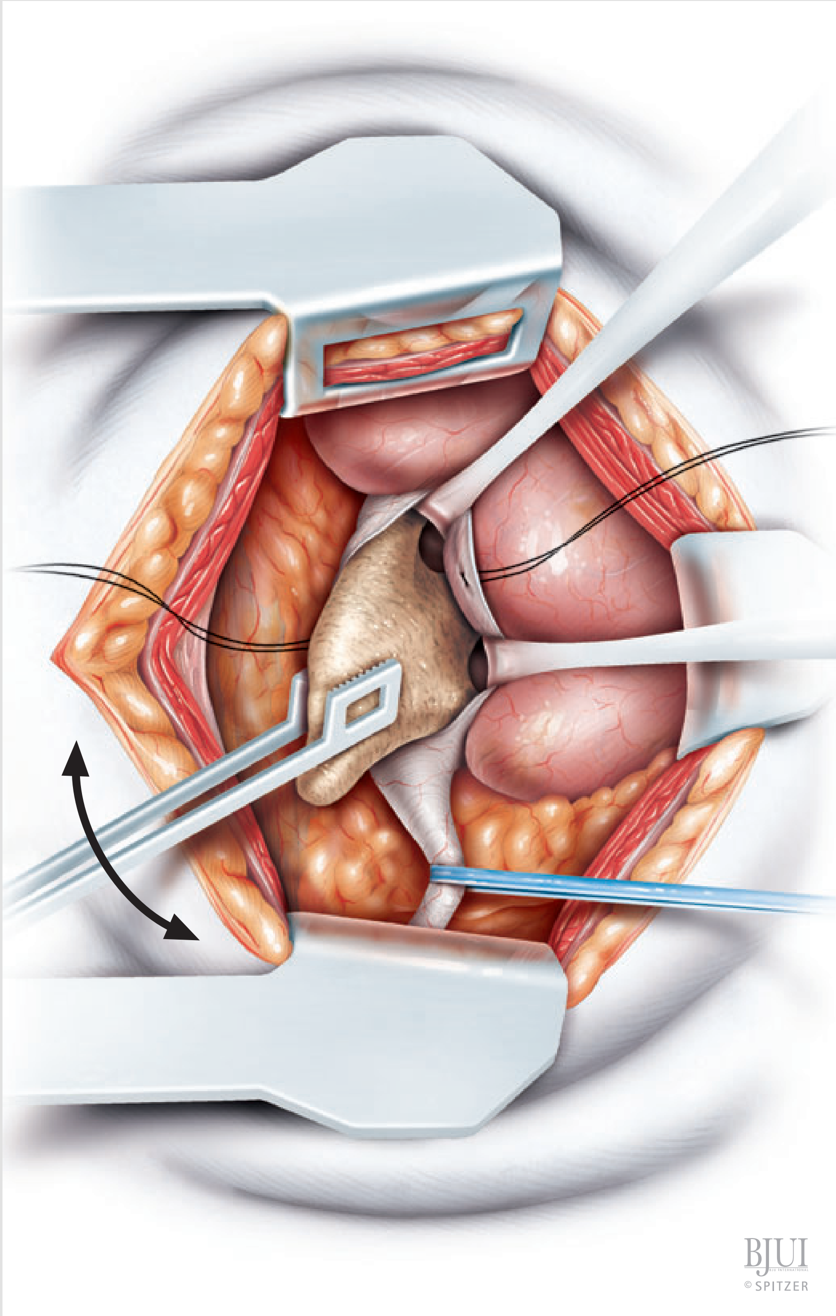
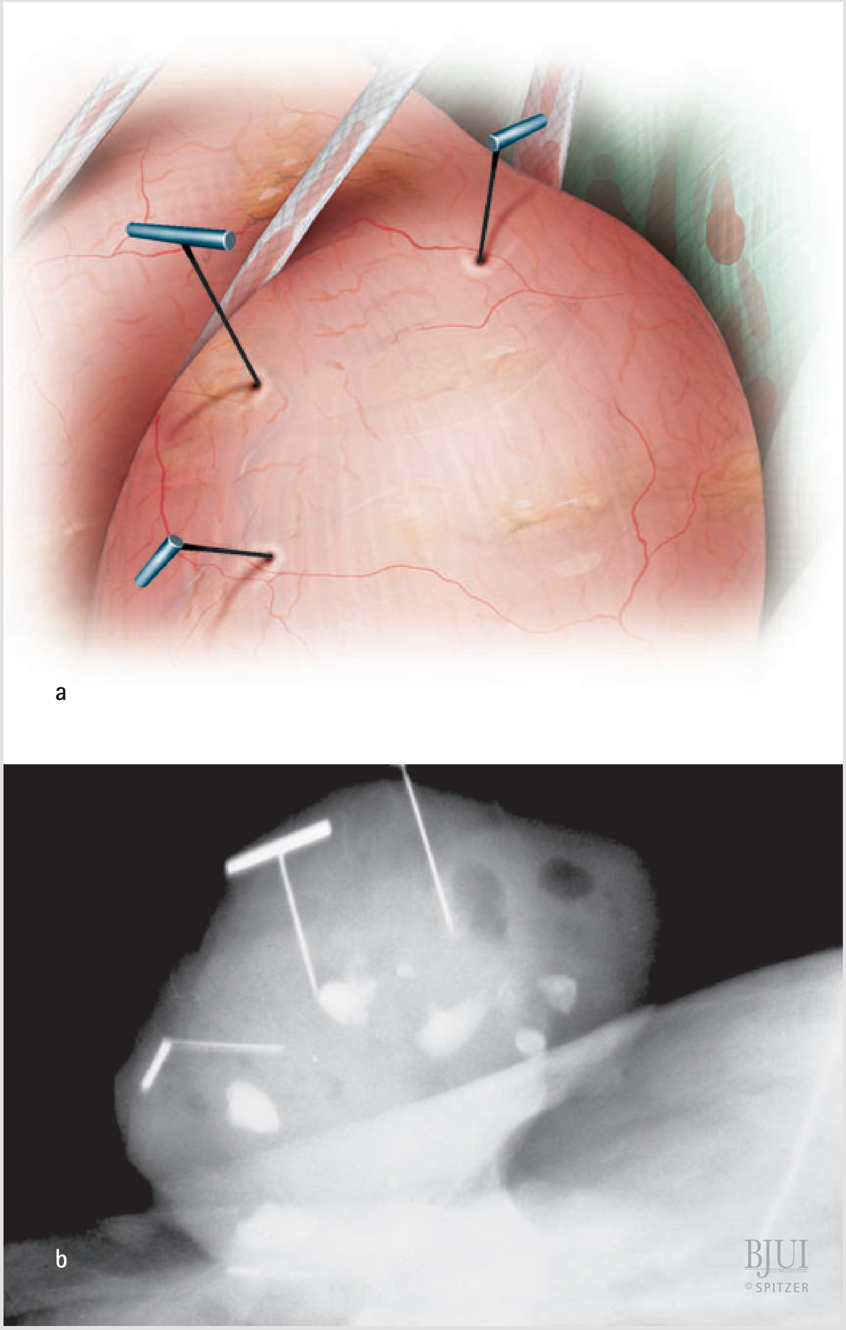


Figure 7

a) To allow easy access to all areas, the kidney should be mobilized completely and pulled out of its bed as far as possible.
b) An intraoperative plain x-ray of the entire kidney, marked with small metal 'flags' for better orientation, delivers a perfect overview of the distribution of the residual stone mass inside the collecting system.



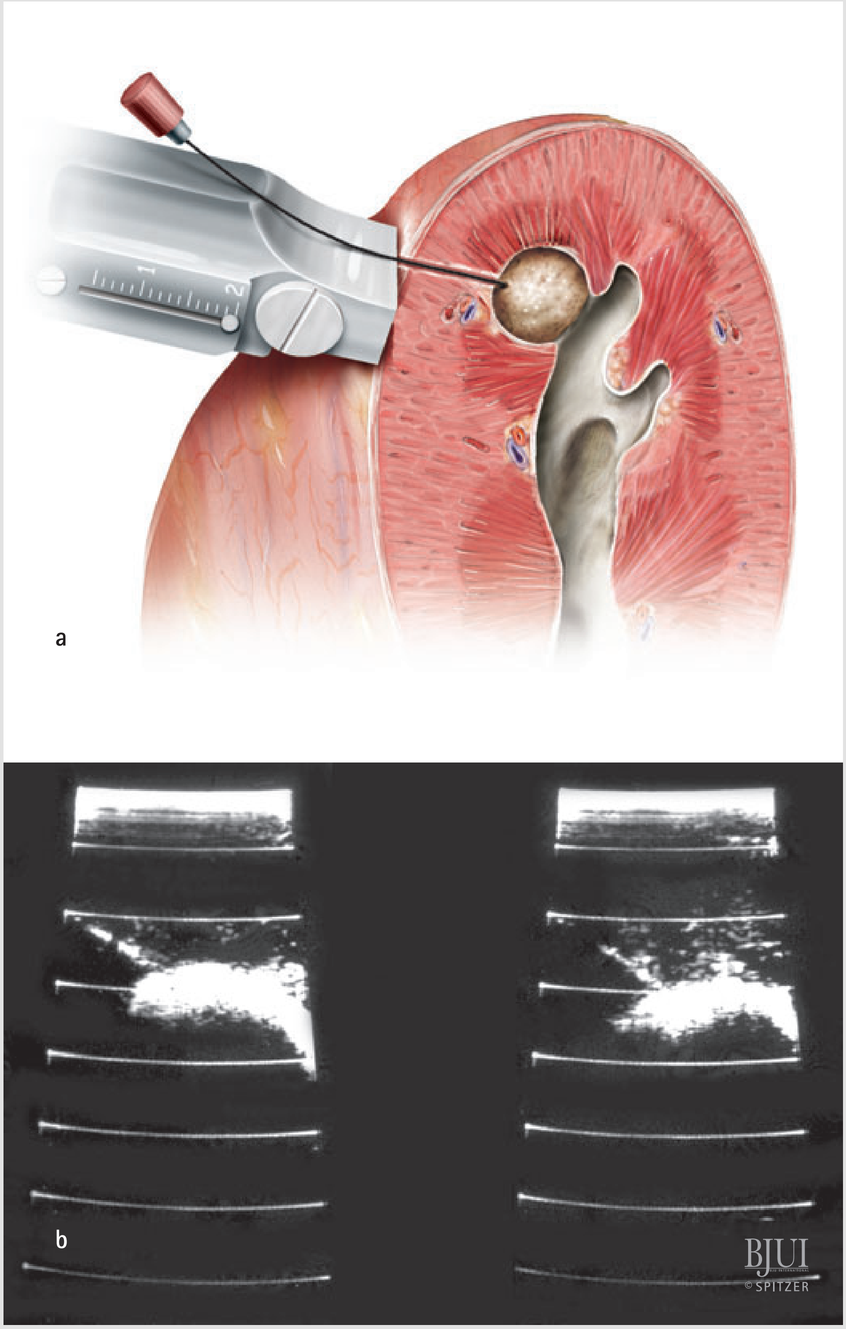


Figure 8

a) Careful intraoperative B-mode scanning (small part scanner, 7.5/10 MHz) of the entire kidney shows remaining or isolated calyceal stones that could not be removed via the renal pelvis. After exact US localization of the calyceal stone, a needle is guided transparenchymally on the shortest route directly to the stone.
b) The entire needle, as well as the stone, are clearly visible under continuous US control.

Figure 9

At the site of the intended nephrotomy along the needle, intraoperative duplex US allows identification of the individual intraparenchymal architecture, thus exposing nearly 'avascular areas' as ideal access to the stone-bearing calyx.

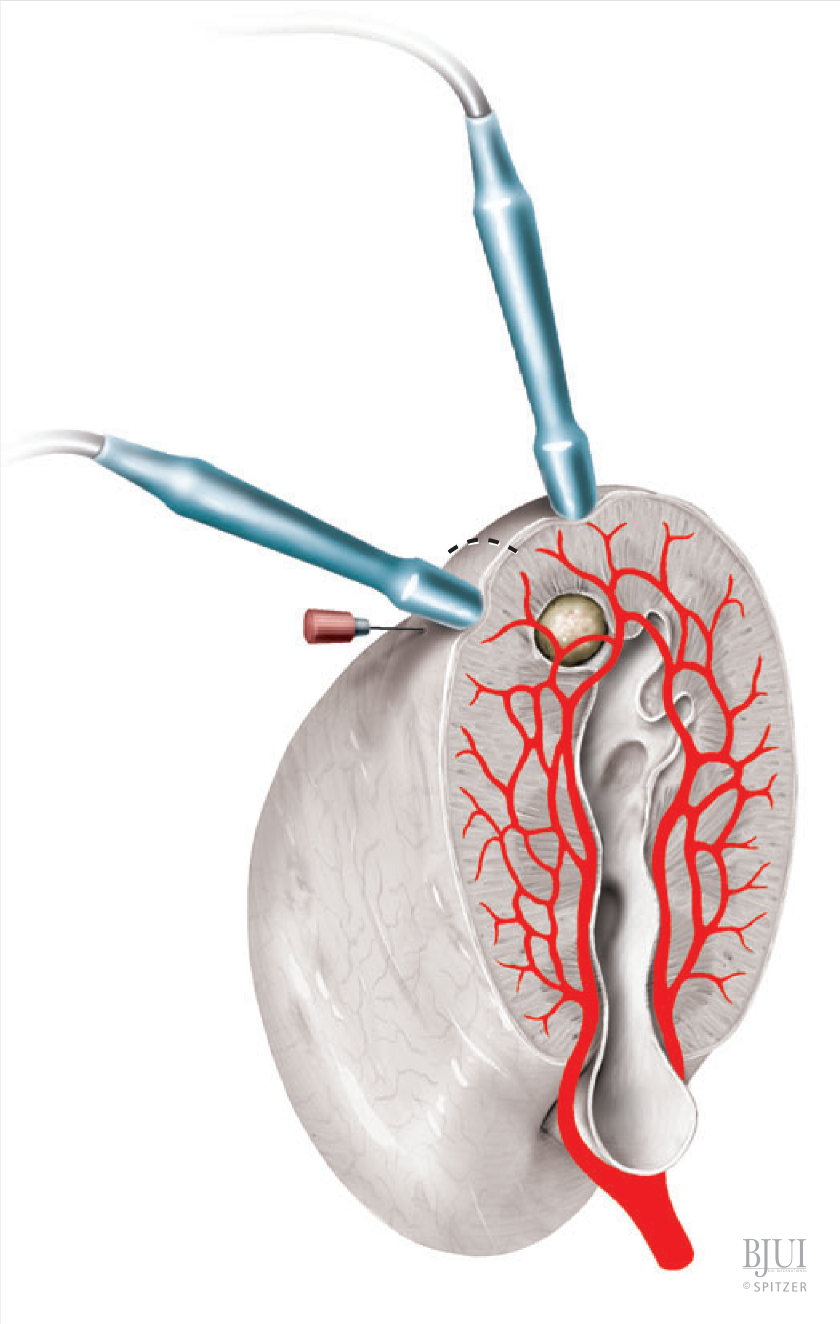


Figure 10

After incision of the renal capsule, the parenchyma is radially and bluntly dissected with the use of a brain spatula, towards the stone-bearing calyx, which is incised sharply.

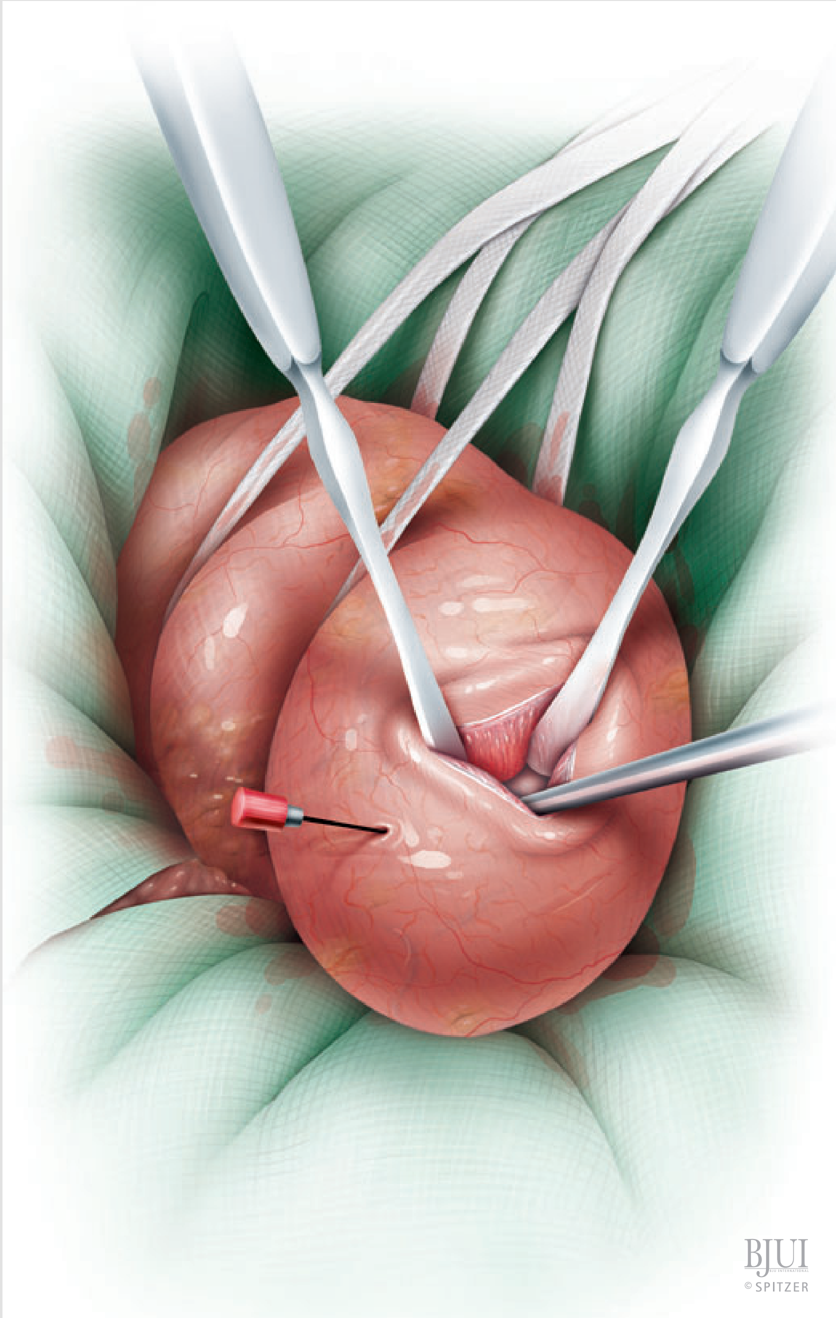


Figure 11

Insertion of a fibre optic-illuminated nasal speculum (two or three branches) and a gentle dilatation of the nephrotomy channel offers perfect exposure of the stone-bearing calyx, while venous bleedings out of the renal parenchyma are compressed.

Suction combined with simultaneous irrigation and illumination allows best visibility inside the calyceal system.

The calyceal-stone parts are meticulously separated from the urothelial walls, again using a brain spatula and preferably blunt instruments, and are finally extracted.

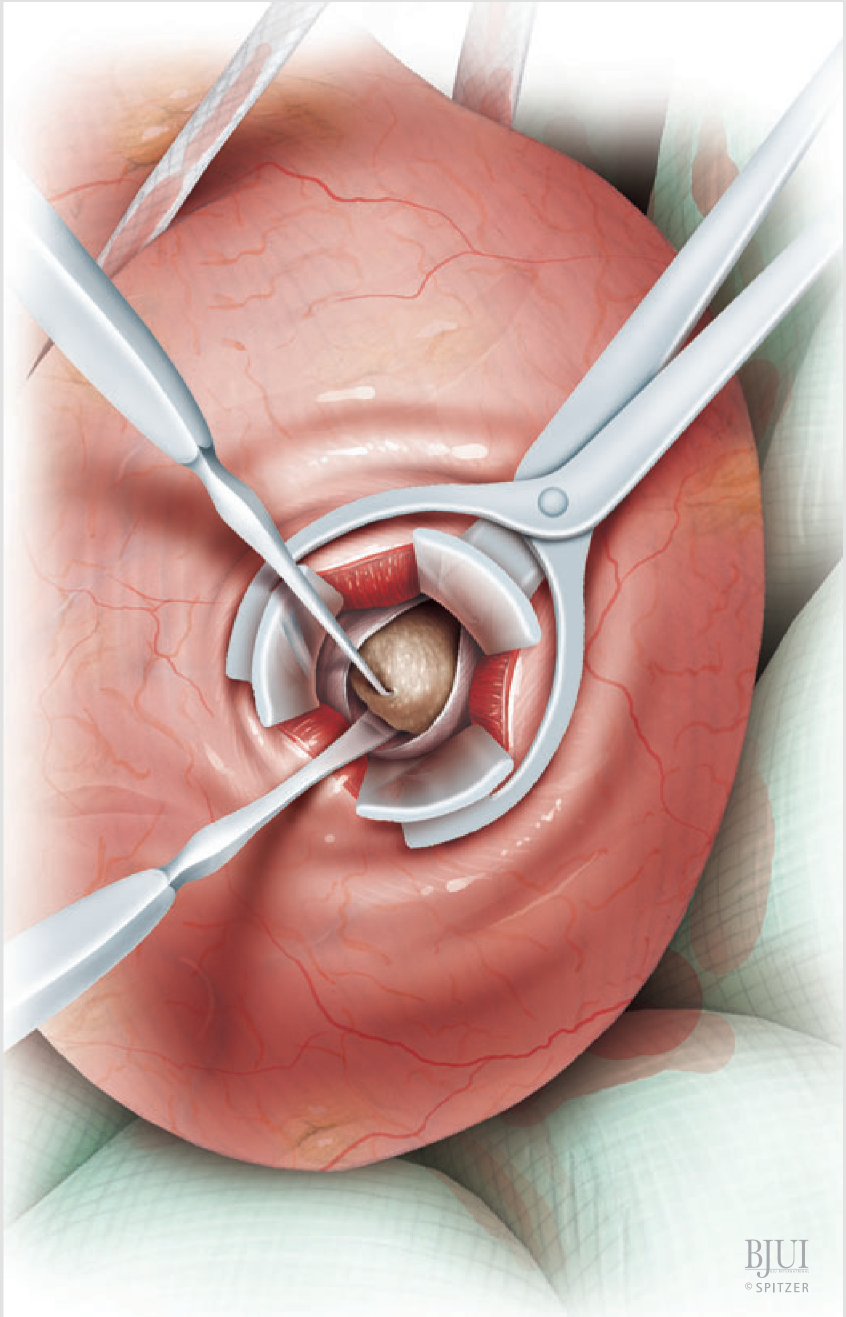


Figure 12

After assumed complete removal of the staghorn calculus, the whole collecting system is extensively irrigated with saline. Careful endoscopy of the entire collecting system, as well as via the nephrotomies and also via the renal pelvis, together with a final intraoperative US investigation and plain x-ray picture of the entire kidney, document complete stone clearance.

After complete removal of the staghorn calculus, the kidney is entirely well vascularized, without bleeding from the nephrotomies.

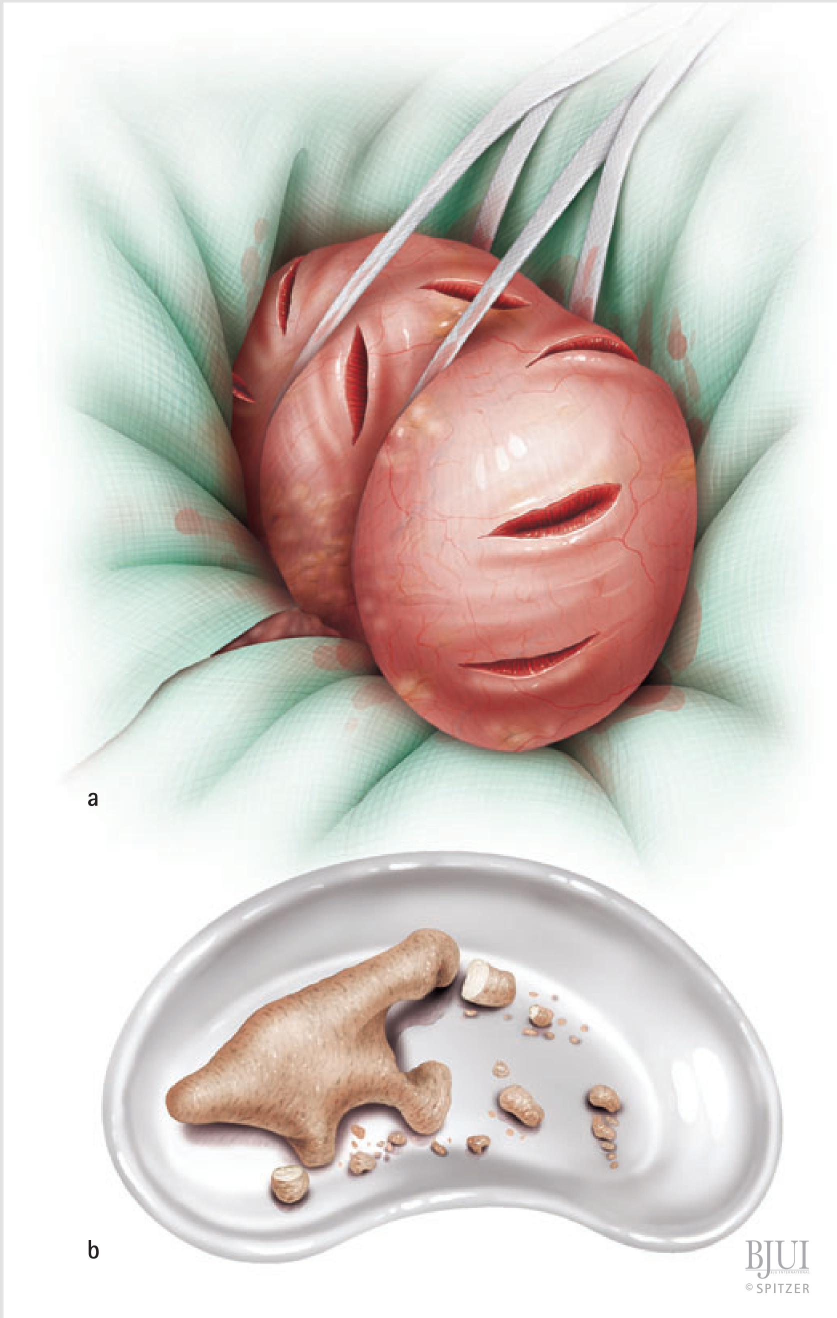


Figure 13

A 10–12 F nephrostomy tube is inserted preferably via one of the lower pole nephrotomies and its tip is placed in an upper pole calyx. Additionally, an antegrade 8–10 F ureteric stent is guided via one of the nephrotomies through the renal pelvis into the upper ureter.

Closure of the nephrotomies is accomplished with superficial atraumatic polyglycolic 4-0 sutures, avoiding deep parenchymal traction and subsequent loss of renal function.

Additionally the renal capsule is closed with running polyglycolic 5-0 sutures.

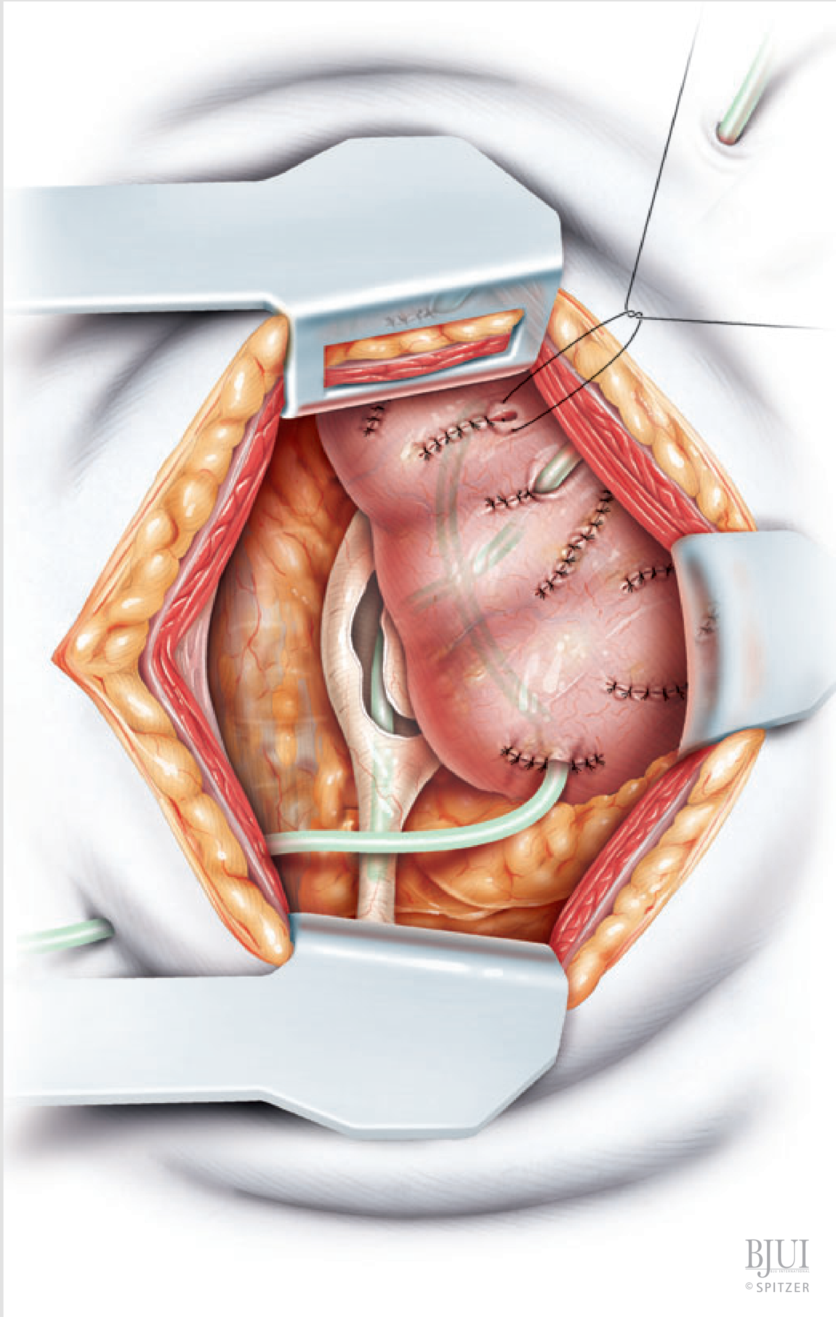
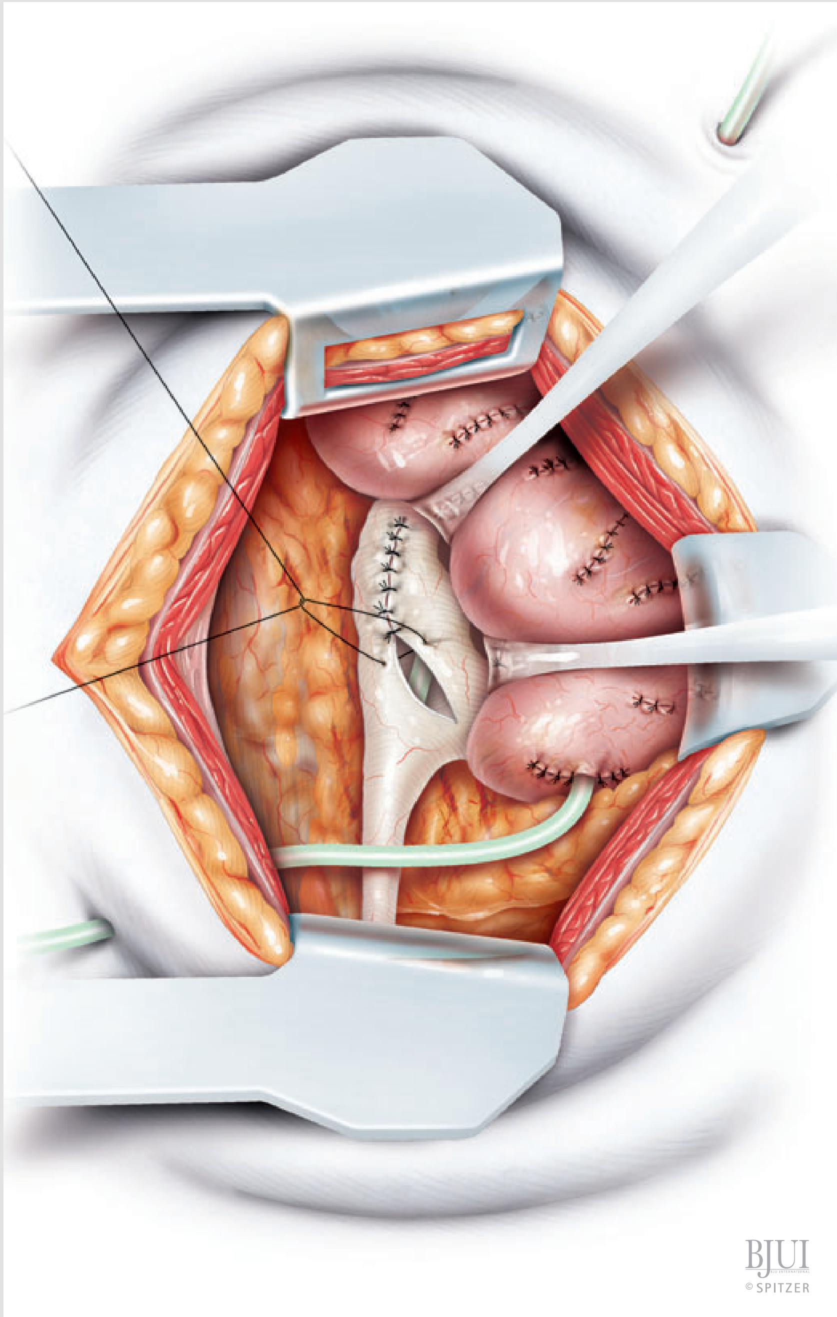


Figure 14

Finally, the pyelocalycotomy incision is closed watertight with interrupted 5-0 self-absorbing suture or 6-0 poliglecaprone 25 sutures.

A penrose or Jackson-Pratt drain should be placed in the retrorenal space before wrapping the entire kidney with the perirenal fatty tissue and closing the wound.



POSTOPERATIVE CARE

- Plain x-ray of the kidney on one of the first postoperative days.
- Removal of the retrorenal drain on postoperative day 3–4, according to the amount of drained fluid.
- Removal of the transparenchymal ureteric stent on postoperative day 7.
- IVU with closed nephrostomy on postoperative day 7.
- Removal of the nephrostomy, after IVU documenting free drainage of the contrast dye.

FROM SURGEON TO SURGEON

Removal of an extended staghorn calculus sometimes might be a time-consuming real challenge for the surgeon.

In case of previous ipsilateral renal surgery, the approach to the kidney should be chosen one intercostal space above the pre-existing scar. A broad access to the kidney is mandatory to guarantee easy access to both the upper as well as the lower renal pole. Extended mobilization of the entire kidney and its vessels allows the organ to be pulled out of its bed and to be fixed with sterile cotton bands.

Although clamping of the renal artery and cooling of the kidney became necessary in only ≈6% of the cases in our series of >200 patients with multiple nephrotomies, we recommend placement of a vessel loop around the renal artery to facilitate quick clamping of the artery if needed.

Wide intra-sinusoidal preparation of the calyceal necks can easily be achieved bluntly using the so called "Gil-Vernet" technique.

Extended pyelocalicotomy and meticulous preparation within the collecting systems help to remove as much of the stone mass as possible via the renal pelvis and to reduce the number of subsequent nephrotomies. Small radial nephrotomies in almost avascular areas and blunt dissection of the renal parenchyma towards the calyces minimize damage of the functional tissue and, thus, we were able to perform up to 13 nephrotomies in our patients without relevant blood loss. The decrease in function of the operated kidneys in our series was 7% on average.

In extended pyelocalycotomy and multiple radial nephrotomies, the use of intraoperative Doppler and B-scan US allow complete removal of all types of stones without ischaemia and cooling, and deliver excellent morphological and functional results.

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Abbreviations: **PNL**, percutaneous nephrolitholapaxy; **US**, ultrasonography.