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MINIMALLY INVASIVE PERCUTANEOUS NEPHROLITHOLAPAXY (MIP)

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Some of the treatment algorithms in this monograph differ from current treatment guidelines and represent the author's personal opinion. The author will not accept any liability for treatment performed in deviation from guidelines. Such treatment must be discussed in detail and agreed upon individually with the patient.

The author would like to thank *Hannes Schramm* (Tübingen, Germany) for preparing the illustrations and Prof. *David Schilling,* M.D. (Frankfurt/Main, Germany) for granting permission to use the caseload charts (Fig. 1).

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1 Basics

1.1 Introduction

In an era where computed tomography is used to confirm stone-free condition[24], the use of endourological stone treatment has become increasingly widely accepted. However, the initial euphoria surrounding the introduction of the third generation of flexible uretero-renoscopes has subsided due to limitations of use in routine urological practice. Percutaneous nephrolitholapaxy has proved superior in terms of stone-free rates with regard to the treatment of larger stone burdens and particularly in flexible ureterorenoscopy performed on patients with unfavorable kidney geometry. It also presents an alternative for treating small and large stones, particularly due to the minimally invasive procedure's low complication rates and high primary stone-free rates.

In recent years, the concept of minimally invasive percutaneous nephrolitholapaxy (MIP) has become an accepted standard in miniaturized percutaneous surgery and has been corroborated in many publications.

The KARL STORZ *Nagele* MIP system allows atraumatic and effective stone treatment with low complication rates. It offers the following key advantages:

- Single-step dilation
- Automatic pressure management
- Stone extraction through "vacuum cleaner effect" or "whirlpool effect"
- Optional closure of the access tract using a gelatin-thrombin matrix

The success of the first-generation MIP system has spurred the effort to meet future challenges in endourology and has given rise to the introduction of next generation tools.

The second generation of the modular MIP system features four instrument sizes to match various indications. This enables urologists to adapt the benefits of minimally invasive percutaneous nephrolithotomy (PCNL) to individual stone sizes and choose the best possible lithotripsy option as determined by size.

PCNL has been used as a treatment option in clinical routine for many years. Based on retrospective analysis, minimally invasive surgical techniques are making headway and are considered well-tested and reliable. Complication rates are much lower than in standard PCNL, and the mean duration of operative procedures has dropped when compared to miniaturized PCNL (mini-PCNL) without the "vacuum cleaner effect" or "whirlpool effect".[1] Length of hospital stay has been reduced, and patient satisfaction has risen significantly.

1.2 History

In 1941, *E. Rupel and R. Brown* reported about the first stone removal procedure performed through a surgically created nephrostomy tract.[25] In the course of the 1970s, *J. Fernström and B. Johannsen* perfected the approach and dilated the fistula tract in order to permit stone extraction.[7] Following its initial publication, the technique underwent further modification until it became well-established and widely used. In 1977, it was *P. Alken* in collaboration with KARL STORZ, who managed to develop a percutaneous nephroscope that met the technical requirements for continuous suction / irrigation. This technical advancement was another leap forward and considerably facilitated the use of percutaneous lithotripsy.[4] In 1982, *J.W. Segura's* group followed.[29]

However, during the heyday of extracorporeal shock wave lithotripsy (ESWL) in the 1980s, urologists viewed PCNL with some skepticism due to its inherently invasive nature and high morbidity rates. The literature reported transfusion rates of up to 18%, extravasation rates of 7%, and sepsis rates of up to 5%,[19] which finally contributed to a distinct decline in PCNL procedures.

Although ESWL still has some value in urolithiasis treatment, the initial enthusiasm has subsided due to high retreatment rates and relatively low stone-free rates, particularly in the inferior calyx and in cases of anatomical variation.[8] As a result of improved instruments and further refinement of the surgical technique, percutaneous procedures have returned to routine clinical use, alongside endoscopic retrograde techniques. Advantages of percutaneous invasive techniques over ESWL or ureterorenoscopy (URS) include higher primary stone-free rates and efficient removal of large stones as well as improved outcomes in the treatment of stones located in unfavorable positions, such as in calyx diverticula or the inferior calyx.[3,13,18]

To reduce the complication rates of standard PCNL, miniaturized percutaneous stone treatment procedures were developed before the turn of the millennium, but except for reduced blood loss, they failed to meet expectations.[9,17]

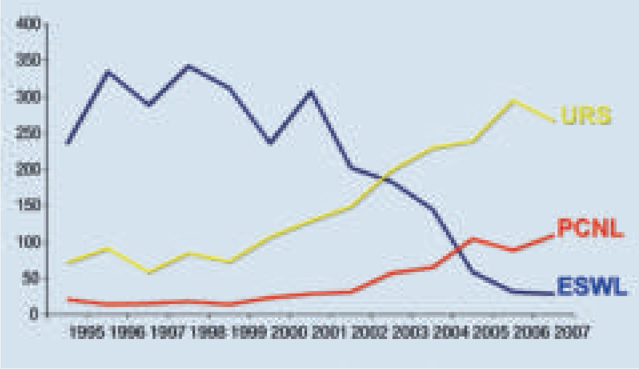


Fig. 1 Caseload charts obtained from the University Medical Center (URS, ESWL, and PCNL) of Tübingen, Germany. Courtesy of *Prof. D. Schilling*, *M.D.,* Frankfurt /Main (Germany).

In 2005, the author developed a modified technique for miniaturized PCNL. The approach was geared mainly toward pressure management (to avoid peak pressures above 30 cmH_2O, which may lead to pyelovenous reflux and fluid overload), ergonomic redesigning of instruments, and primary closure of the nephrostomy tract. Ultimately, this has resulted in the concept of minimally invasive percutaneous nephrolitholapaxy (MIP).[19]

Inherent to the established concept of MIP is the fact that the indication range of percutaneous stone treatment now also includes smaller calculi. To render the procedure truly minimally invasive, the author opts to perform PCNL without nephrostomy.

As a side effect of these advancements, there has been a decline in the use of shock wave therapy in favor of those techniques that are based on a retrograde endoscopic and percutaneous concept of stone treatment (Fig. 1).

The new MIP generation of nephroscopes comes with more versions and even smaller diameters (MIP XS and S), and hence offers the chance for even less access trauma. In summary, this upgraded concept is geared to serve as an alternative to retrograde intrarenal surgery while at the same time allowing for an increase in size to select the best possible (including flexible) treatment option for the management of larger or multiple stones (MIP M and MIP L systems), thus taking most advantage of the specific features inherent to MIP.

2 Indications and Contraindications of MIP

2.1 Indications

Due to the wide range of instrument sizes available, MIP now encompasses many more indications than it did in the past.

MIP XS represents an alternative to flexible ureterorenoscopy (URS) for treating kidney stones ≤ 6–8 mm in size in the inferior calyx if access is impossible or has failed, for instance due to ureteral stenosis, mismatch of calyceal radius and instrument radius of curvature, or in case of a dead-end situation.[12, 31]

MIP S is used to treat calculi in the inferior calyx that are 6–12 mm in size (typically stones that cannot be easily moved into other renal calyxes via flexible URS, with correspondingly lower stone-free rates associated with in situ disintegration).[28] MIP M covers 12–24 mm stones in all calyxes and in the renal pelvis; in case of a large stone burden > 24 mm, MIP L is available for straightforward stone treatment.

Additional indications include special cases such as diverticular stones and other anatomical variations as well as stone persistence following ESWL (Fig. 2).

2.2 Contraindications

The contraindications for percutaneous stone removal are essentially the same as those for transurethral treatment. In addition, particular consideration should be given to coagulation disorders and anatomical abnormalities that may complicate puncture – such as renal malrotation, morbid obesity with larger skin-to-stone distance, skeletal deformities, etc.

Untreated urinary tract infections and pregnancy must be ruled out.[20]

Further contraindications for this procedure are typically at the discretion of the anesthesiologist.

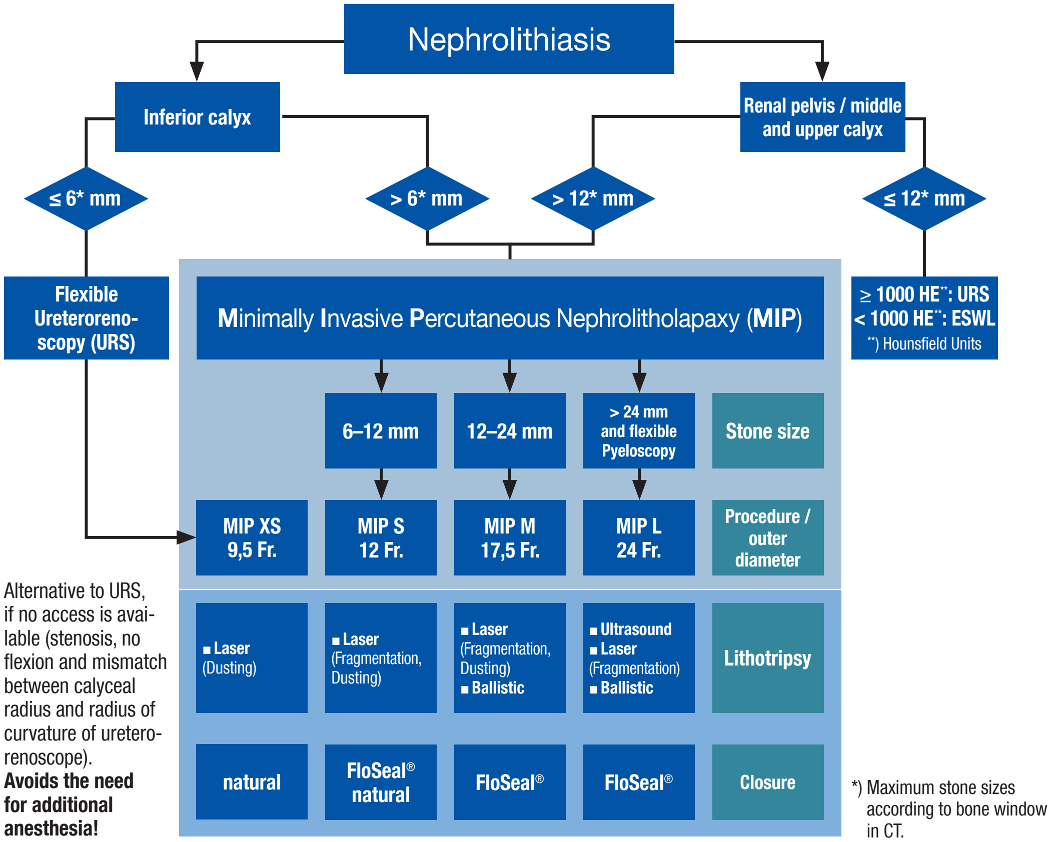


Fig. 2 Minimally Invasive Percutaneous Nephrolitholapaxy (MIP) treatment algorithm according to *U. Nagele* (2015).

2.3 Preoperative Diagnostics

Patient preparation for MIP is similar to preparation for other endoscopic procedures to treat nephrolithiasis. First, take a detailed medical history and ensure diagnostic clarification of symptoms. An adequate, most recent diagnostic imaging survey should typically be available, e.g., low-dose unenhanced computed tomography and assessment of calculi in the bone window.

In some cases, additional functional sonography or contrast-enhanced computed tomography may facilitate renal puncture. The full serum chemistry, blood count, kidney and liver function parameters, coagulation parameters, and urine status, possibly with urine culture, are taken preoperatively. Antibiotic prophylaxis is administered based on an antibiogram.

3 Surgical Preparation

3.1 General Notes

Carefully preparing the required MIP equipment guarantees a smooth workflow during surgery. First, check the technical armamentarium, such as the video camera system, X-ray system, ultrasound equipment, lithotripter, etc., make sure that instruments and consumables are complete and in working order, and warm up the irrigation solution.

If necessary, shave the lateral abdomen on the operative side before the procedure to achieve a completely clear ultrasound image and prevent wound healing problems. Placing the venous line on the patient's contralateral arm and attaching the tube laterally with respect to positioning changes will facilitate optimal intraoperative care on the part of the anesthesiologist.

Disinfect genitals using a mucosal disinfectant and, with the patient in prone position, disinfect the skin of the surgical site using an iodine-containing antiseptic agent.

3.2 Consumables

Mono-J or Occlusion Ureteral Catheters

Use of a mono-J (MJ) catheter is generally optional in MIP, but it is mandatory when using the MIP XS system since a large lumen is required for suctioning the irrigation fluid and stone dust. The catheter is fixed in place at the buttocks and is connected to the UROMAT E.A.S.I.™ (microprocessor-controlled suction/irrigation pump, KARL STORZ Tuttlingen). Advantages of MJ catheters over balloon catheters include reduced trauma to the ureteropelvic junction, which typically obviates the need for extended postoperative drainage via a double-J (DJ) catheter, and the fact that the MJ catheter can be removed on the first postoperative day.

Alternatively, a ureteral occlusion catheter can be placed in the pelvicalyceal system. The advantage of ureteral balloon catheters lies in the fact that the balloon volume can be blocked above the ureteropelvic junction. Doing so prevents calculi from passing intraoperatively and additionally allows extracorporeal fixation of the balloon catheter at the buttocks under slight tension, which caudally dislodges the kidney to obviate supracostal puncture. Disadvantages of occlusion catheters include their low irrigation volume and swelling at the ureteropelvic junction as mentioned above.

Both catheters permit retrograde pyelography.

Puncture Needle

For puncture under sonographic guidance, use a puncture needle with pyramid tip or a sonographically visible material alteration at the tip to ensure echogenicity throughout the procedure. Two-part puncture needles can be easily handled and are sufficiently stable.

Guide Wire and Safety Wire

Guide wires with a hydrophilic floppy tip and semi-rigid shaft (0.035") are recommended. These guide wires reduce the risk of pelvicalyceal system perforation, and their material properties facilitate advancing the wire into the pelvicalyceal system or the ureter.

The same wire is used as safety wire; a 0.025" guide wire is required only when using the MIP XS/S system to apply the wire under nephroscopic view, for instance in the ureter.

Multi-length DJ catheter

If placing a DJ catheter at the end of the procedure, a steerable multi-length double-J (DJ) catheter can be used. These products facilitate antegrade insertion and can be easily disconnected from the pusher as needed as well as reconnected later if necessary. In addition, the length of the DJ catheter is variable and can be adapted to the specific situation.

Gelatin-thrombin matrix

Human gelatin-thrombin matrix is hyperosmolar. It achieves hemostasis by inducing the coagulation cascade and by swelling. The matrix should be prepared on time and then inserted into the puncture channel through the Amplatz sheath using the special applicator included in the MIP system to achieve closure. The matrix closes the puncture channel with slight compression, ensures optimal hemostasis, and prevents urine extravasation. In case of misrouted application, the gelatin-thrombin matrix fully dissolves in urine within hours.

3.3 Patient Positioning and Repositioning

For intubation purposes, the patient is initially positioned supine. For retrograde insertion of the ureteral and bladder catheter, the patient is placed in lithotomy position, ensuring pressure relief.

If puncture needs to be performed in prone position, standardized patient repositioning is recommended. Changing the patient's position requires close coordination between members of the surgical team.

To facilitate change of position, first place a draw sheet crosswise on the operating table.

This sheet assists staff in gently repositioning the patient step by step (Fig. 3a–i).

With the patient in prone position, place a weight-adjusted inflatable kidney rest under the costal arch at the level of the renal angle (Fig. 4).

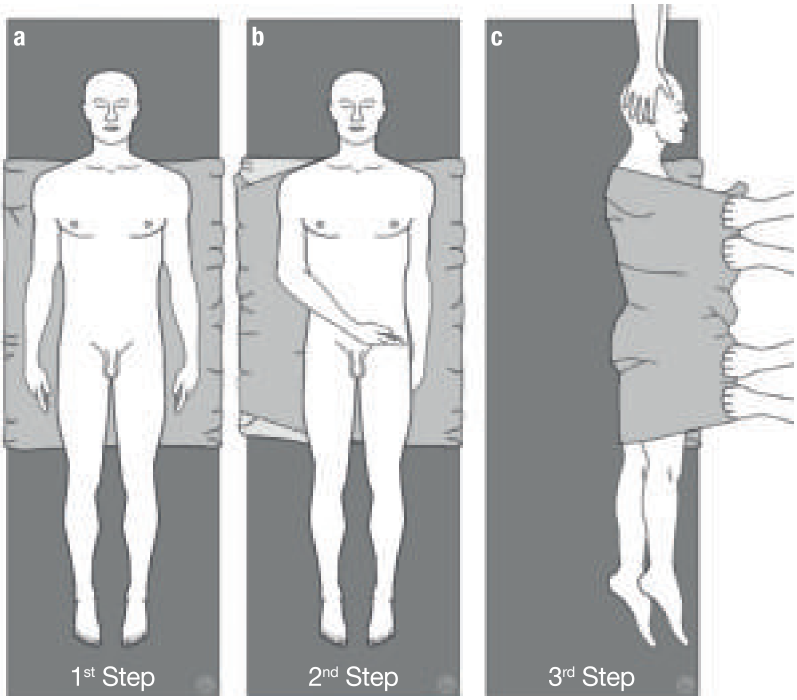
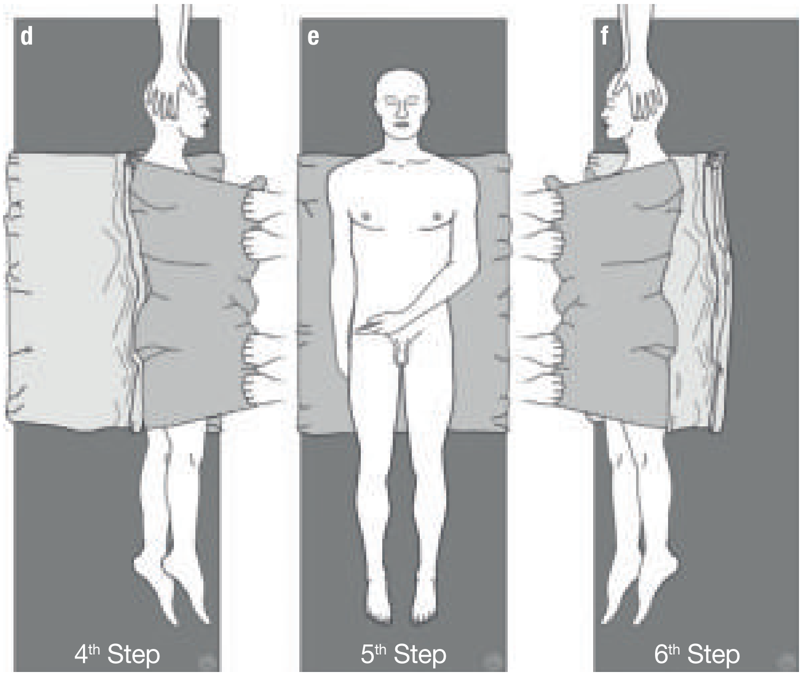


Fig. 3

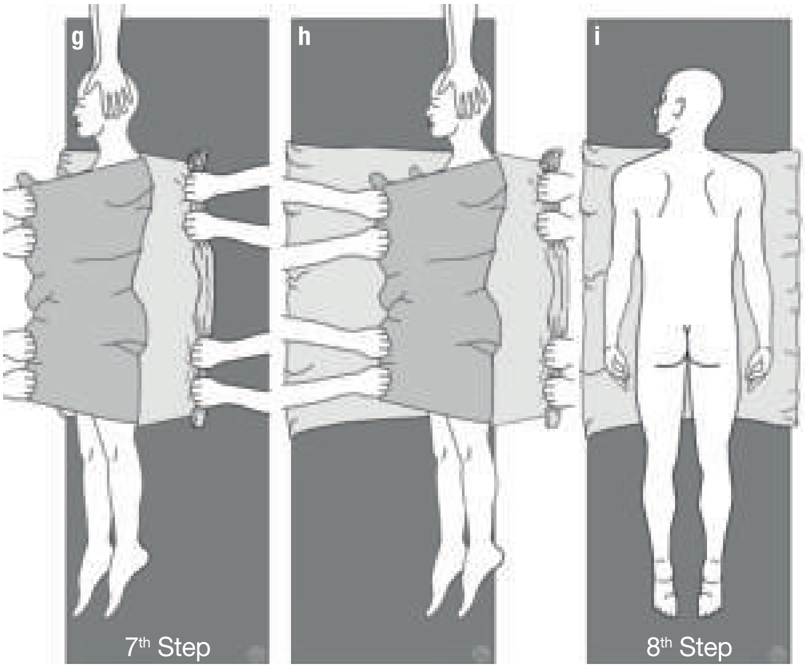
a Position patient supine on a draw sheet placed crosswise.
b Place the left hand below the buttocks and the right hand on the abdomen.
c Turn the patient onto the left side with the aid of the draw sheet.



d Patient position unchanged. Place a fanfolded second sheet, extending to the center of the operating table.

e Turn the patient to supine position. Place the right hand under the buttocks and the left hand on the abdomen.

f Turn the patient onto the right side. Now, the fanfolded half of the previously placed second sheet is visible.



g While maintaining the right lateral decubitus position, now pull on the fanfolded edge of the second sheet applying moderate force …

h … until the patient's back is at the opposite edge of the operating table. With assistive stabilization from the other side using the first sheet, the patient gently rolls into the desired prone position.

i The first sheet can now be removed. With the aid of the remaining sheet, the patient can be safely and easily lifted, and an inflatable cushion can be easily placed below the costal arch at the level of the renal angle.

Fig. 4 Proper positioning of the inflatable kidney rest to facilitate renal puncture. This allows holding the kidney "in place" below the $11^{th}/12^{th}$ rib.

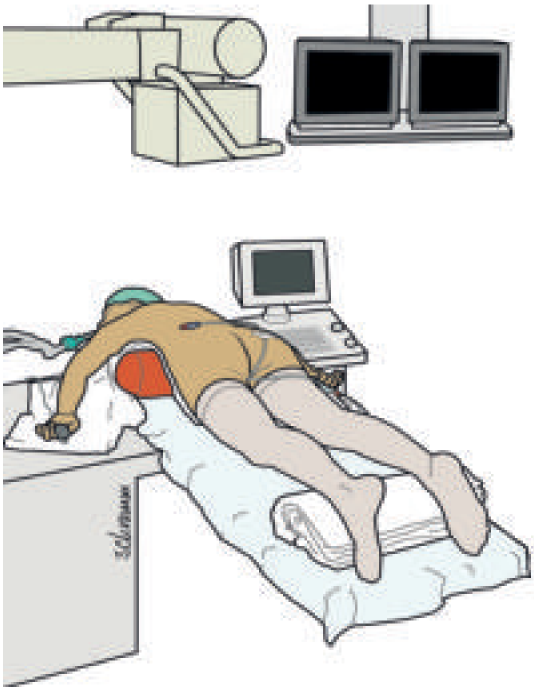


Fig. 5 Patient positioning on the operating table with adequate pressure relief.

Caveat: Vena cava Compression Syndrome

Position the head only on a flat gel pad to maintain patient flexion. Place both arms alongside the body to ensure physiological shoulder positioning and prevent positioning injuries. Ensure adequate pressure relief at the head, joints, and pressure-sensitive regions (Fig. 5).

4 Surgical Technique

Surgical percutaneous stone removal is performed in three steps.

After patient intubation, an MJ or occlusion catheter and an indwelling bladder catheter are first inserted in lithotomy position. In the second step, the patient is placed prone and carefully padded. In the third step, the kidney is punctured, followed by the actual stone removal in percutaneous technique involving nephroscopy, lithotripsy, stone retrieval, optional antegrade ureteral stenting, and closure of the access tract.[22]

4.1 Anesthesia

Endotracheal anesthesia is the suitable anesthesia method for PCNL in prone position. Regional anesthesia is not a suitable alternative for this procedure due to the special prone positioning. General anesthesia is administered in the form of total intravenous anesthesia (TIVA), typically using the hypnotic *propofol* (Disoprivan® 1%) in combination with the highly potent ultra-short-acting opioid *remifentanil* (Ultiva®). Relaxation is exclusively administered for intubation. Due to their very short half-life periods, these anesthetics allow precise anesthesia management.

The special prone position gives rise to various considerations in anesthesiological care:

1) Controlled ventilation typically requires higher ventilation pressures due to the prone position itself and due to the use of the kidney rest below the costal arch. *Use a pressure-controlled ventilation* (PCV) mode, which typically ensures good ventilation even for patients with chronic respiratory disease (asthma, COPD, etc.). In rare extreme situations, the volume of the kidney rest has to be reduced.

2) The inflated cushion placed in the upper abdominal area increases intra-abdominal pressure via compression of the intra-abdominal parenchymal structures, potentially resulting in a vena cava compression syndrome, occasionally with severe hypotension. Patient-specific prehydration with about 1–1.5 l crystalloid solution typically compensates the relative hypovolemia caused by compression of the vena cava.

In case of persistent hypotension, particularly in patients with existing arterial hypertension, administer catecholamine therapy for the duration of surgery.

3) In difficult cases, surgery may take up to several hours. This further increases the importance of correct patient positioning to prevent pressure/positioning injuries (pressure ulcers, compression of facial soft tissues, reclination of the cervical spine, etc.).

4) In light of the potentially large quantities of irrigation fluid used, make sure that the patient is protected from direct exposure. Consistent application of heat through warm irrigation fluid, heating pads, etc., is paramount because patients undergoing this procedure can be at significant risk of perioperative hypothermia. Measuring the patient's core temperature is recommended in prolonged procedures.

4.2 Cystoscopy, Retrograde Pyelography, and Ureteral Catheter Placement

MIP XS

Once the patient assumes a lithotomy position, first perform cystoscopy and rule out the presence of any bladder tumors.

Intubate the corresponding orifice with an MJ catheter via a guide wire and advance the catheter. The position of the MJ catheter is taken to the records using retrograde pyelography. The loop of the ureteral catheter should be located in the renal pelvis. If necessary, repeat retrograde visualization of the renal pelvicalyceal system.

Fix the catheter in place on the inserted bladder catheter. Close the bladder and ureteral catheters.

Next, place the patient in prone position.

MIP S, M, and L

Perform thorough cystoscopy as with the MIP XS system. Insert either an MJ catheter as with MIP XS or a ureteral balloon catheter. In the latter case, locate the corresponding orifice, intubate with the occlusion catheter, and advance it into the ureter. If it cannot be advanced, use a guide wire.

Perform retrograde pyelography via the inserted ureteral stent. Then advance the ureteral balloon catheter into the renal pelvis and block above the ureteropelvic junction with no more than 2–3 ml of a mixture of distilled water and contrast agent following fluoroscopic confirmation of the balloon position. If necessary, conduct another retrograde visualization of the renal pelvicalyceal system and ensure radiological documentation (Fig. 6).

The balloon can be used to take advantage of the normal mobility of healthy kidneys (without history of pyelonephritis or prior surgery) to mobilize the kidney caudally by up to one vertebra.

Insert an indwelling bladder catheter – close the indwelling bladder catheter and ureteral catheter (Fig. 7).

In case of sharp or pointy calculi, use an MJ catheter instead of the occlusion catheter to prevent balloon rupture.

Next, place the patient in prone position.

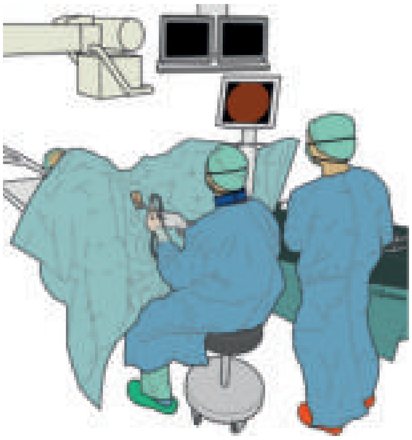


Fig. 6 Cystoscopy and placement of the ureteral catheter under fluoroscopic vision in a patient in lithotomy position.

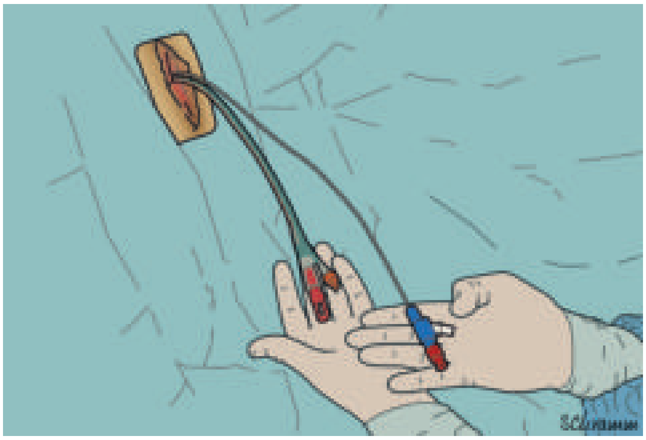


Fig. 7 Closure of the ureteral catheter and indwelling bladder catheter.

4.3 Puncture – MIP XS/S, M, and L

After placing the patient prone and applying an inflatable kidney rest under the xyphoid, sonographically check the kidney position before sterile draping. Connect the bladder catheter to the drainage bag, sterilize the surgical site by wiping it down, and drape it. Then carefully begin to dilate the renal pelvicalyceal system via the MJ or balloon catheter attached to the patient's buttocks using a mixture of methylthioninium chloride and X-ray contrast agent. Doing so improves the condition for the procedure.

Adding blue dye to the contrast agent allows to readily evaluate success or failure of puncture.

Under sonographic and X-ray view, surgeons typically aim for the calculus-containing calyx. To avoid hemorrhage and achieve the best possible starting conditions for successful stone extraction, the puncture trajectory should pass through the papilla at an angle corresponding to the calyceal axis (Figs. 8, 9). Note that the posterior calyx is punctured.

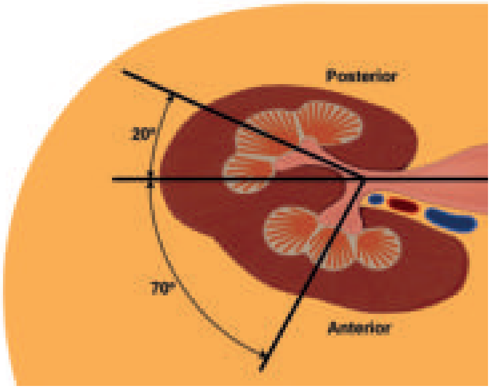


Fig. 8 Kidney position with patient in prone position. Axially aligned puncture of the posterior renal calyx provides optimal access to the renal pelvis and anterior calyces.

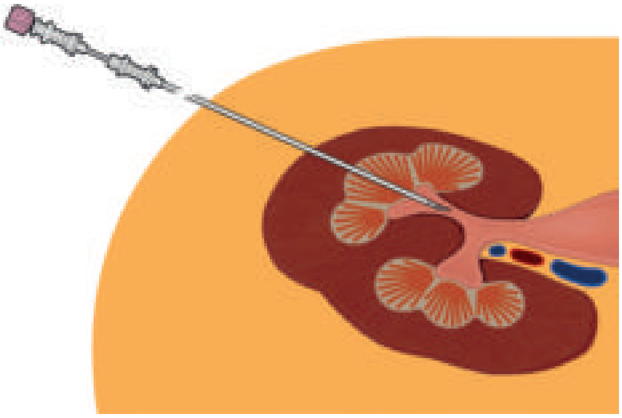


Fig. 9 Axially aligned puncture of the renal pelvicalyceal system via the papilla of the posterior calyx.

4.4 Dilation and Positioning of the Operating Sheath

MIP XS/S

Following successful puncture, insert a guide wire with hydrophilic floppy tip into the pelvicalyceal system via the puncture cannula. Try to place the wire securely in the renal pelvis or calyx or, if possible, pass the ureteral catheter into the bladder.

Then perform a skin incision along the puncture cannula. After removing the cannula, enlarge the access tract with a metal dilator using the one-step bougie technique. Via this dilator, the suitable operating sheath is placed in the renal pelvicalyceal system. Dilation and advancement of the access sheath is accomplished under X-ray view (Fig. 10).

Remove the metal dilator, leaving the guide wire in place. Insert a second guide wire directly through the operating sheath under fluoroscopy. If a second guide wire is to be inserted under endoscopic vision via the nephroscope's working channel, please note that it must not be larger than 0.025".

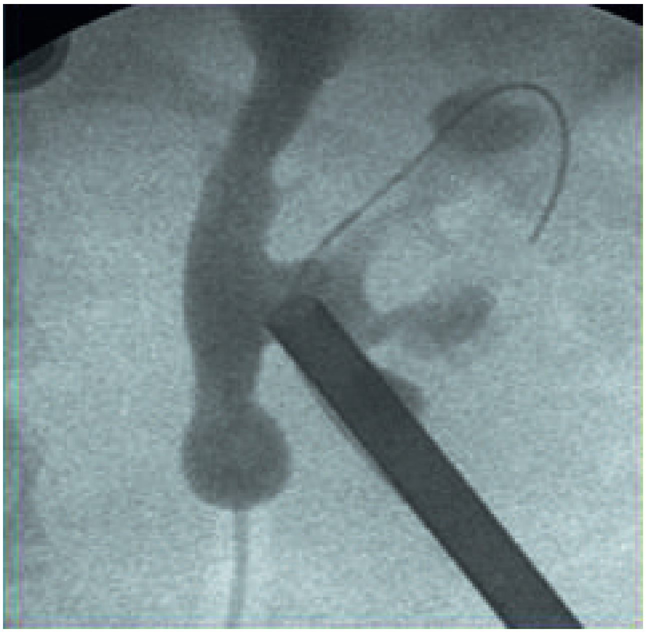


Fig. 10 X-ray position check of the inserted operating sheath.

Also note that concurrent nephroscopy cannot be performed when a wire is located in the XS/S operating sheath. While securing the wires, remove the Amplatz sheath again and re-insert the bougie over one of the guide wires in the dilated puncture channel to access the pelvicalyceal system (Seldinger technique). Proceed as rapidly as possible to prevent bleeding and ensuing clot formation.

The safety wire then securely rests between the dilated puncture channel and the operating sheath.

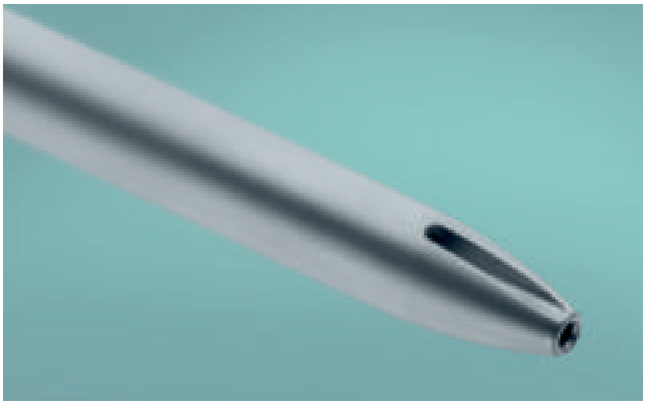


Fig. 11 One-step dilator with a second eccentric central channel and a channel for guide probes. To be used with the NAGELE operating sheaths (KARL STORZ Tuttlingen).

MIP M and L

As discussed under the MIP XS/S system, following puncture of the renal pelvicalyceal system, insert a guide wire with hydrophilic floppy tip into the pelvicalyceal system via the puncture cannula. Try to place the wire securely in the renal pelvis or calyx or ideally advance it via the ureter into the bladder.

Place a deep skin incision along the puncture cannula. After removing the cannula, enlarge the access tract with a metal dilator using the one-step bougie technique under X-ray view. Via the dilator's eccentric distal lumen (Fig. 11), the correct position in the pelvicalyceal system can be assessed on the basis of the reflux of the methylthioninium chloride mixture. Next, the appropriate Amplatz sheath is placed in the renal pelvicalyceal system under fluoroscopy (Figs. 12, 13).

Withdraw the metal bougie while leaving the guide wire in place and conduct initial exploratory nephroscopy – which is possible with wires up to 0.038". A second wire can then be optimally positioned through the sheath or optionally inserted under endoscopic vision via the nephroscope's working channel (up to 0.038").

Using the Seldinger technique, as with MIP XS/S, remove the Amplatz sheath while securing the wires, pass the bougie over one of the guide wires through the dilated puncture channel into the pelvicalyceal system, and advance the operating sheath again under X-ray view. In this way, the safety wire is fixed in place between the operating sheath and the dilated puncture channel.

The guide wire remaining in the lumen of the Amplatz sheath can now be removed.

Fig. 12 One-step dilation with metal dilator via the inserted guide wire.

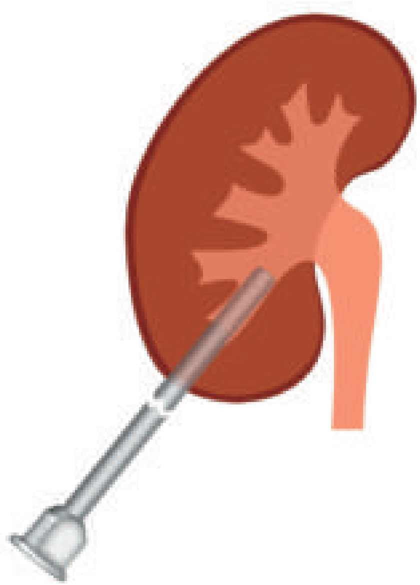


Fig. 13 Positioning of the operating sheath in the renal pelvicalyceal system.

4.5 Nephroscopy, Lithotripsy, and Stone Extraction

MIP XS/S

Before starting a detailed nephroscopic examination with the MIP XS system (Fig. 14a), irrigation fluid inflow and outflow should be established via the UROMAT E.A.S.I.™ (KARL STORZ Tuttlingen) in continuous flow mode. For this purpose, first connect the inflow tubing to the nephroscope to allow direct application of the irrigation fluid through the device. Connect suction to the MJ catheter to ensure outflow of irrigation fluid and stone dust (Fig. 14). If necessary, the same procedure can be used with the MIP S system.

Following exploratory nephroscopy and orientation, you can proceed with lithotripsy of the calculus.

A laser fiber up to 1.9 Fr. in size (up to 300 µm, depending on design) may also be introduced through the nephroscope's working channel. First set up the laser system following manufacturer instructions. To achieve maximum stone dusting, in principle, the default setting should involve a high pulse repetition rate, low energy output, and if possible, long pulse length. To achieve fragmentation, a low pulse rate, high energy output, and if possible, short pulse length is chosen. Ideally, the kidney stone is comminuted and the stone dust suctioned off via continuous flow irrigation through the MJ catheter. Of course, the stone may also be fragmented and flushed out via the MIP S operating sheath, taking advantage of the vacuum cleaner effect discussed below.

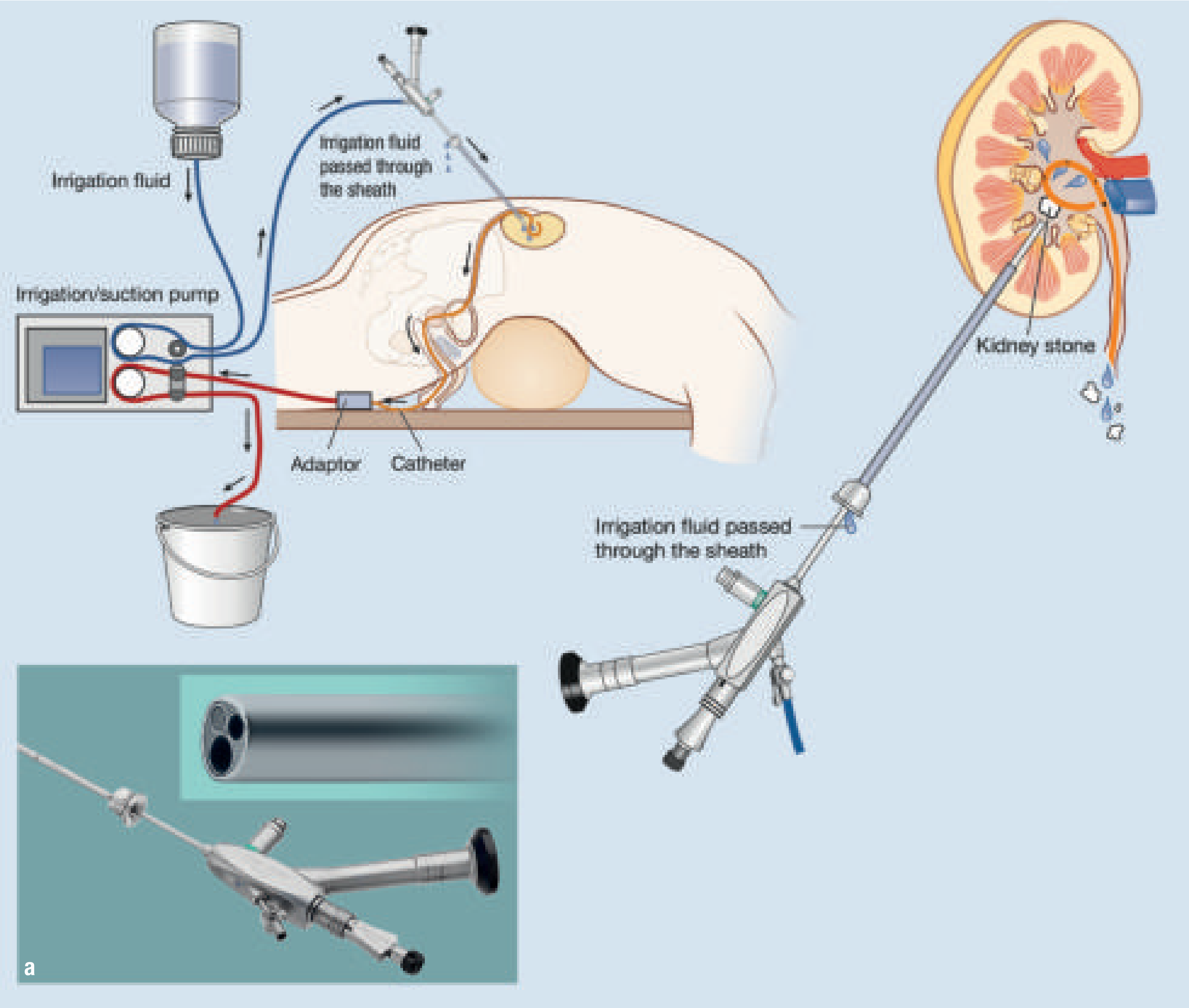


Fig. 14 Schematic diagram of percutaneous nephrolitholapaxy with the MIP XS system.
MIP XS/S – 7.5 Fr. nephroscope with a 3-Fr. irrigation channel and a 2-Fr. working channel (**a**).

MIP M and L

First perform another exploratory nephroscopy to view the calculus and make sure that it is positioned immediately in front of the nephroscope tip.

In case of multiple calculi that are smaller than the sheath's inner diameter, you may start extraction immediately. When using the MIP M, larger calculi can be disintegrated using ballistic lithotripsy (probes up to 5 Fr.) (Fig. 15) or using lasers with fibers up to 380 µm in size. It is vital to avoid generating many tiny fragments because their extraction can be difficult and time-consuming. MIP L also allows the alternative use of ultrasound lithotripsy with transducers up to 11.5 Fr. in size. Additional suction via the ultrasound transducer is not required taking into account the "vacuum cleaner effect".

The optimized design of the operating sheath – featuring a specially shaped lead-in section at the proximal end – facilitates stone retrieval taking advantage of the "vacuum cleaner effect". Special sheath geometry and concomitant pressure control significantly contribute to the prevention of pyelovenous reflux and fluid overload. When withdrawing the instrument under continuous flow of irrigation fluid, a vortex develops in the lumen of the working sheath inducing a vacuum effect ("vacuum cleaner effect") (Figs. 16a, b). Owing to this effect, stone fragments and stone dust are flushed out through the sheath without necessitating the use of a stone basket.

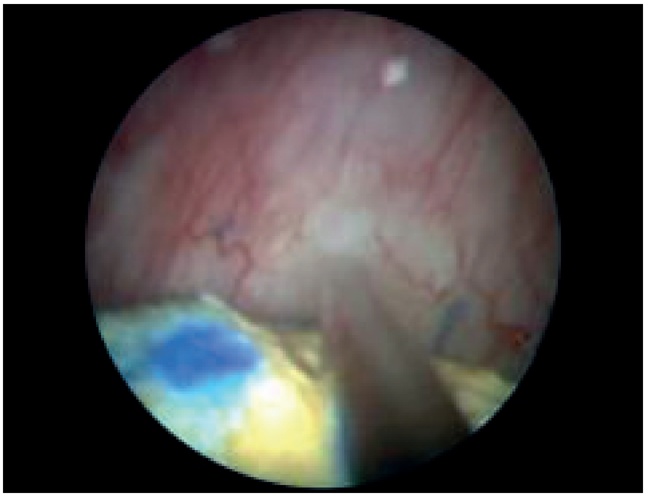


Fig. 15 Lithotripsy of the renal calculus using ballistic lithotripter

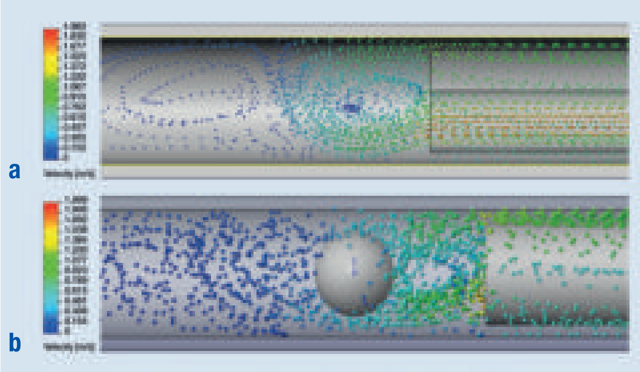


Fig. 16 Vacuum cleaner effect in 16.5/17.5 Fr. operating sheath and 12 Fr. nephroscope (MIP M) in the absence of calculus (**a**). Vacuum cleaner effect in 16.5/17.5 Fr. operating sheath and 12 Fr. nephroscope (MIP M) in the presence of calculus (**b**).

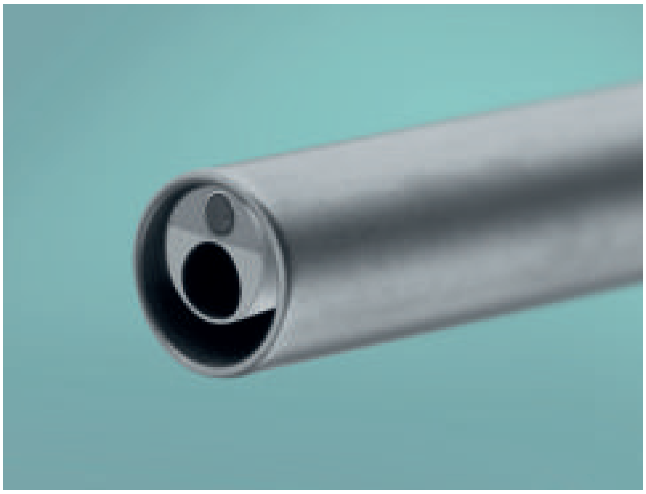


Fig. 17 MIP M system: Close-up view of the distal tip of the 16.5/17.5 Fr. operating sheath with 12 Fr. nephroscope with round working/irrigation channel.

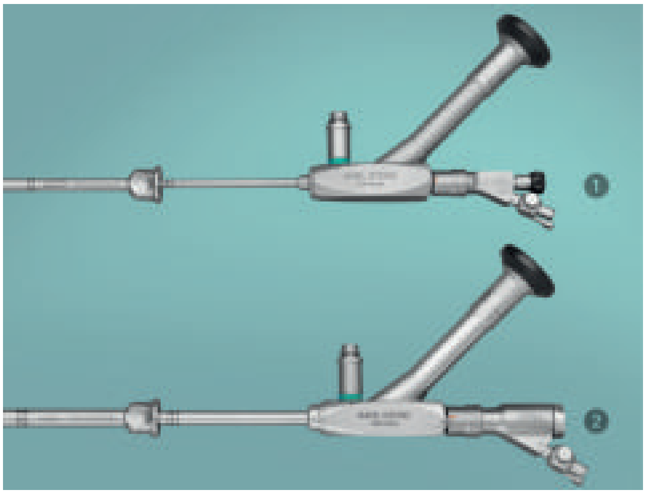


Fig. 18 Proximal side views: MIP M system (16.5/17.5 Fr. operating sheath and 12 Fr. nephroscope) (**1**) and 19.5 Fr. nephroscope of the MIP L system (**2**).

4.6 Optional Antegrade Ureteral Stenting and Nephrostomy Tract Closure

MIP XS/S

Provided a stone-free status is confirmed both by nephroscopic and fluoroscopic evaluation, the guide wire and operating sheath can be removed under visual control. Antegrade ureteral catheterization is not necessary because the primary MJ catheter can be left in place to ensure renal drainage. Manual compression of the puncture channel for about 2–3 minutes is recommended. If profuse bleeding is noted in the nephroscopy access tract, a gelatin-thrombin matrix can be applied to the puncture channel using the properly fitting two-part applicator. Steri-Strips® are sufficient for skin closure.

Ureteral and bladder catheters are generally removed on the first postoperative day, following sonographic assessment of renal drainage. Low-dose computed tomography within the first postoperative month is used to confirm a stone-free status.

Fig. 19 Antegrade ureteral stenting via the MIP operating sheath.

MIP M and L

First verify the stone-free status via endoscopy and X-ray. If a balloon catheter was used and the safety wire could not be advanced into the bladder via an antegrade approach, insert a guide wire in retrograde fashion through the ureteral catheter. With the aid of the nephroscope, guide it to the outside through the operating sheath using flexible grasping forceps. Then unblock the occlusion catheter and withdraw it, leaving the guide wire in place.

Typically, a DJ catheter (8 Fr.) is then inserted in antegrade direction (Fig. 19). Once proper placement of the DJ catheter in the bladder has been confirmed under fluoroscopy, disconnect the pusher of the ureteral stent in the renal pelvicalyceal system. If necessary, readjust the proximal end using the nephroscope and flexible grasping forceps. When using an MJ catheter, this maneuver is typically not necessary, and the MJ catheter can be left in place until the first postoperative day. Only in case of pelvicalyceal injuries or residual calculi, insert a DJ catheter as described above.

Once the ureteral stent has been correctly positioned, retract the nephroscope sheath to the junction between urothelium and parenchyma. Next, withdraw the nephroscope and apply the hemostatic matrix (gelatin-thrombin matrix) to the access tract with the aid of the two-part applicator while retracting the applicator. (Figs. 20, 21). Only the kidney needs to be sealed; the hemostatic agent does not need to be applied to the renal fascia.

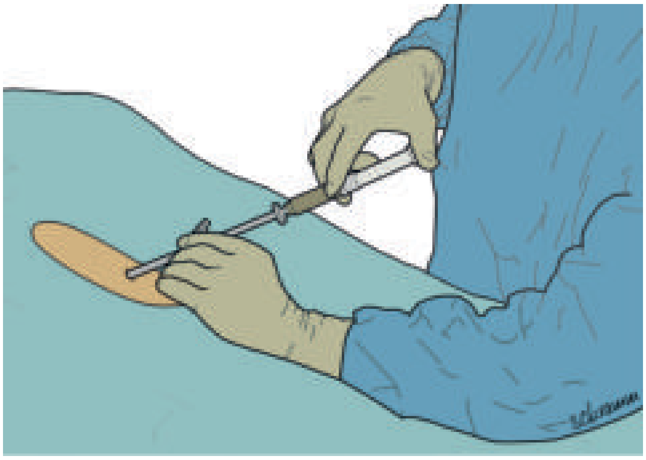


Fig. 20 Inserting the gelatin-thrombin matrix using the MIP applicator to close the percutaneous access tract.

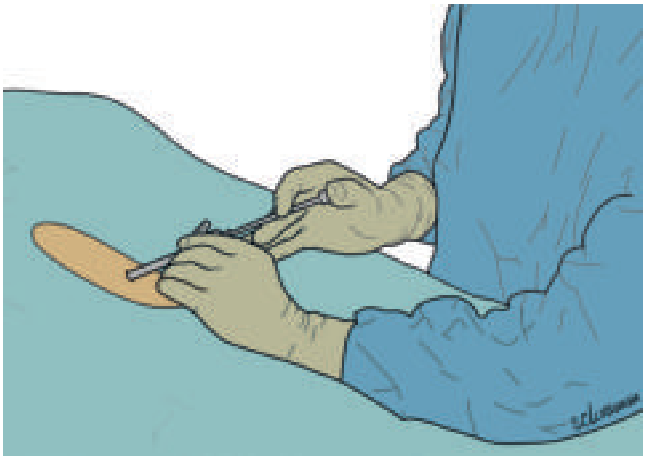


Fig. 21 Pushing on the special mandrin causes the remaining hemostatic matrix to be released from the applicator.

Ideally, only seal the tract through the renal parenchyma from the urothelium to the pararenal space. Likewise, sealing of the puncture channel passing through the trunk muscles is not required. Close the skin with Steri-Strips®.

Leave the bladder catheter in place until the first postoperative day. The DJ stent is typically removed after 5–7 days. If an MJ catheter is used instead, remove it on the first postoperative day following renal sonography.

4.7 Management of Complications

Intraoperative complications of MIP may include hemorrhage. First assess the blood loss volume and consider terminating the surgery in consultation with the anesthesiologist if the patient is unstable. The access tract is typically closed using a hemostatic matrix as described above. In case of residual stone load and profuse bleeding, an alternative approach is placement of a percutaneous nephrostomy catheter and tamponade of the renal pelvicalyceal system. In case of larger residual calculi, a second-look MIP can be easily performed. In case of hemodynamic instability, conduct a computed tomography with arterial phase enhancement and close the artery involved by endovascular coiling, if necessary.

Despite careful surgical preparation, pyuria caused by an occluding stone may only be noticeable after puncture. In that case, it is recommended to place a nephrostomy catheter and drain the kidney, administer antibiotic therapy following antibiotic susceptibility testing. Moreover, you may need to plan a second-look MIP.

If access to the renal pelvicalyceal system via the Amplatz sheath is lost, methylthioninium chloride can be instilled via the ureteral catheter, and the surgeon can attempt probing the puncture channel with a guide wire and tracking the blue contrast agent into the pelvicalyceal system with the nephroscope.

In case of rupture of the renal pelvicalyceal system without injury to adjacent organs, e.g., due to excessive dilation of the balloon catheter or failed puncture, surgery can be continued since the low-pressure irrigation system should prevent the occurrence of any significant complications.[21]

However, be aware that immediate clarification is needed, if there are any signs of impending complication.

5 Discussion

Percutaneous stone treatment was initially associated with considerable morbidity rates. Due to advancements in terms of surgical technique and instrumentation, complication rates were seen to decline. Nevertheless, the transfusion rate can be as high as 18%.[19]

In its original approach, miniature PCNL (mini-PCNL) was geared toward treating pediatric patients,[11] but subsequently, the procedure was also used on adult patients[10,17] and combined with nephrostomy-free techniques.[5] Advantages of minimally invasive nephrostomy-free procedures include lower morbidity, less postoperative pain, and shorter recovery.[27] Mini-PCNL has failed to meet expectations, except for reduced bleeding complications.[6,16] In an effort to further reduce morbidity rates, minimally invasive percutaneous stone treatment (MIP) was introduced, which uses the smallest-diameter working channel necessary for effective stone treatment as well as single-step dilation and a low-pressure system throughout the entire surgery (Fig. 22).

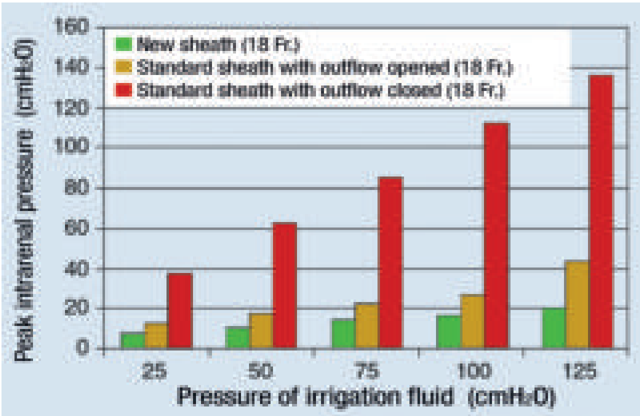


Fig. 22 Comparison of peak intrarenal pressures (cmH_2O) recorded at minute intervals with various nephroscope sheaths.[21]

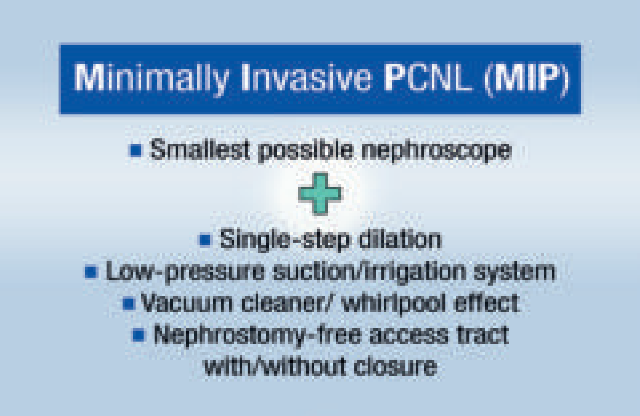


Fig. 23 Definition of Minimally Invasive Percutaneous Nephrolitholapaxy (MIP) according to *U. Nagele.*

Additional key features of the MIP concept are stone retrieval utilizing the “vacuum cleaner effect” (or suction of stone dust via the MJ catheter with the XS system) and a nephrostomy-free approach with optional closure of the access tract.[22]

Use of a special nephroscope sheath has shown that intrarenal pressure remains below the irrigation pressure required for intrarenal reflux.[21] The “vacuum cleaner effect” was first described and explained by *Nicklas et al.* [23] It allows the retrieval of stone fragments as well as the continuous removal of stone dust to ensure a completely stone-free status. Combining all the factors that are a sine qua non for a minimally invasive approach (Fig. 23) has reduced the intraoperative stress response to levels found in shock wave therapy or ureterorenoscopy.[15]

The surgical technique is easy to learn, even for surgeons without experience in percutaneous stone therapy. Only initially, surgeons can be faced with a slightly longer duration of surgery, increased complication rates and lower stone-free rates.[26]

Originally, the method was mainly used to treat smaller stones, but it was *Abdelhafez et al.*[1,2] who demonstrated effective treatment also in cases of large stone burdens and even staghorn calculi.

6 Conclusion

Based on our own experience, we hold the opinion that minimally invasive nephrolitholapaxy (MIP) has earned its place alongside ESWL and URS in the treatment of stones of the pelvicalyceal system.[14] To date, experience suggests, that MIP is associated with much lower complication rates than conventional percutaneous stone therapy. Considerable differences to classic PCNL are particularly observed in terms of postoperative fever, septicemia, and transfusion rates.[1,30]

In order to comply with the basics of a truly minimally invasive approach, a complete set of instruments, available in various sizes/diameters (XS, S, M, and L), has been developed and introduced on the market. Choosing the proper MIP instruments, the surgeon is enabled to utilize a standardized surgical approach for treating a wide range of indications, from small kidney stones to large staghorn calculi. This minimally invasive technique permits high stone-free rates to be achieved rapidly and effectively with few complications. Even inexperienced surgeons will benefit from a steep learning curve, which facilitates implementation of the standardized procedure in clinical routine.[26]

7 Author’s Note

Some of the treatment algorithms in this monograph differ from current treatment guidelines and represent the author’s personal opinion. The author will not accept any liability for treatment performed in deviation from guidelines. Such treatment must be discussed in detail and agreed upon individually with the patient.

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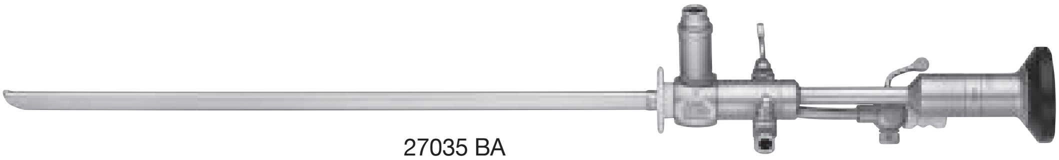

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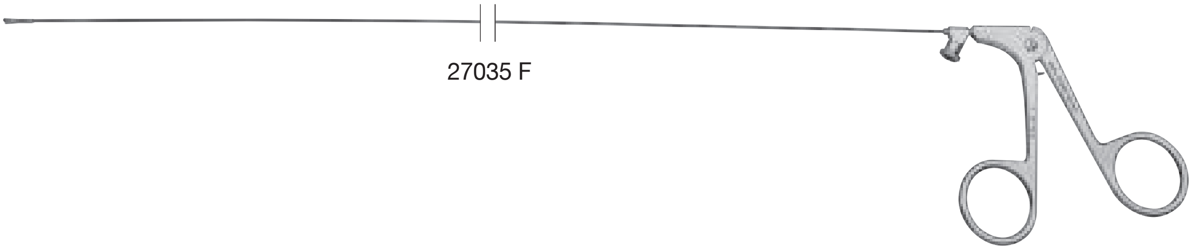

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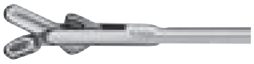

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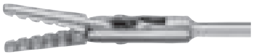

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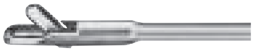

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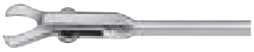

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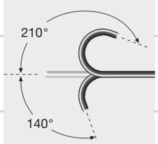
11272 VP **PAL**	with positive deflection		0°	120°	37 cm	6.5 Fr.	16 Fr.
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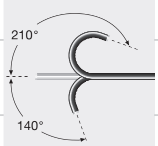
11272 VPI **PAL**	for Photodynamic Diagnosis (PDD) and with positive deflection		0°	120°	37 cm	6.5 Fr.	16 Fr.
11272 VNI **NTSC**	for Photodynamic Diagnosis (PDD) and with positive deflection		0°	120°	37 cm	6.5 Fr.	16 Fr.
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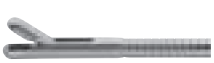
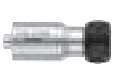
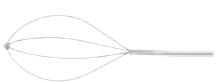
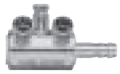
	27023 ZE	**Biopsy Forceps,** single action jaws, flexible, 5 Fr., length 73 cm
	11025 E	**Pressure Compensation Cap,** for ventilation during gas and plasma sterilization
	13242 XL	**Leakage Tester,** with bulb and manometer
	27651 B	**Cleaning Brush,** round, flexible, outer diameter 3 mm, for working channel diameter 1.8 – 2.6 mm, length 100 cm
	27014 Y	**LUER-Adaptor,** with seal
	202130 70	**Video Connecting Cable**

Optional accessories:

	27023 KF	**Stone Basket,** nitinol, without tip, straight, 3 Fr., length 70 cm, 4 wires, basket diameter 12 mm, sterile, for single use
	27723 T	**Coagulation Electrode,** unipolar, 4 Fr., length 73 cm
	27550 N	**Seal,** for Instrument Ports 27001 G/GF/GH/GP, package of 10, single use recommended
	27001 RA	**Cleaning Adaptor**

MIP L – Percutaneous Nephroscope

Special Features:

- **Open system allows a particularly atraumatic therapy under low-pressure conditions**
- **Bougie with a second eccentric channel for guide wire deflection enables precise steering of the wire**
- **Large working channel allows the use of rigid standard instruments and large lithotripsy probes up to 11.5 Fr.**
- **For large stone burdens**

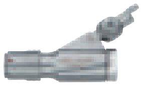
Specifications:

Instrument sheath:	19.5 Fr.
Working channel:	12.4 Fr. for use with instruments up to 11.5 Fr.
Telescope:	HOPKINS® rod lens telescope, direction of view 12°
Length:	22 cm
Eyepiece:	angled

27840 KAK

27840 KAK **Nephroscope for MIP L, autoclavable**

Following accessories are included in delivery:



27840 GP **Instrument Port with Sealing System and Quick Release Lock,** 1 channel for nephroscope for MIP L

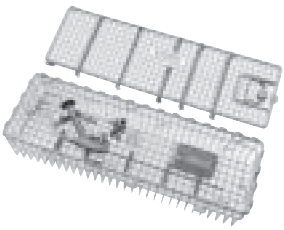
27500 **LUER-Lock Tube Connector,** male, tube diameter 9 mm

27502 **LUER-Lock Tube Connector,** with stopcock, dismantling

27001 E **Insertion Aid,** for guide wires

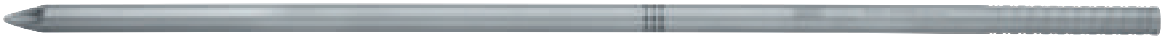
30160 XA **Silicone Leaflet Washer,** diameter 3–5.5 mm, type dome valve, package of 10

30160 XB **Seal,** package of 10



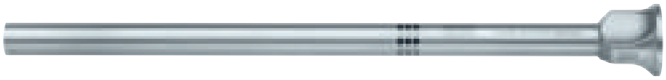
39501 XKL **Wire Tray**
including:
Cleaning Adaptor, for Instrument Port 27840 GP

Dilators, Sheaths and Applicators
for MIP L



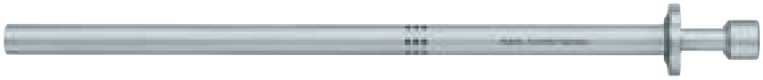
27840 AB

27840 AA	**One Step Dilator,** with central channel and a second eccentric channel for guide wires, for use with 23/24 Fr. Operating Sheaths 27840 BA/BAS
27840 AB	**Same,** for use with 25/26 Fr. Operating Sheaths 27840 BB/BBS



27840 BA

27840 BA	**Operating Sheath,** 23/24 Fr., working length 15 cm, for continuous irrigation and suction
27840 BB	**Same,** 25/26 Fr.
27840 BAS	**Operating Sheath,** for the supine position, 23/24 Fr., working length 18 cm, for continuous irrigation and suction, for use with Nephroscope 27840 KA, One Step Dilator 27840 AA and Applicator 27840 CFS
27840 BBS	**Operating Sheath,** for the supine position, 25/26 Fr., working length 18 cm, for continuous irrigation and suction, for use with Nephroscope 27840 KA, One Step Dilator 27840 AB and Applicator 27840 CFS



27840 CF

27840 CF	**Applicator for Sealant,** including sheath and rod, for use with Operating Sheaths 27840 BA/BB
27840 CFS	**Applicator for Sealant,** for the supine position, including sheath and rod, for use with Operating Sheaths 27840 BAS/BBS

MIP M – Percutaneous Nephroscope

Special Features:

- **Well-proven miniature nephroscope with optimized design**
- **One-step dilator with a second eccentric channel for guide wire deflection enables precise steering of the wire**
- **Large working channel allows the use of rigid standard instruments and large lithotripsy probes up to 5 Fr.**
- **For the treatment of medium stone burdens**

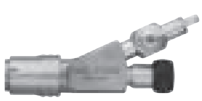
Specifications:

Instrument sheath:	12 Fr.
Working channel:	6.7 Fr. for use with instruments up to 5 Fr.
Telescope:	Fiber optic system, direction of view 12°
Length:	22 cm
Eyepiece:	angled

27830 KAK

27830 KAK **Nephroscope for MIP M, autoclavable**

Following accessories are included in delivery:



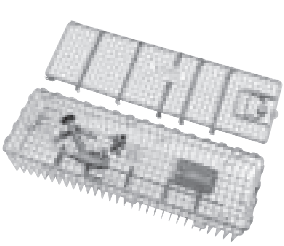
27001 GP **Instrument Port with Sealing System and Quick Release Lock,** 1 channel

27550 N **Seal,** for Instrument Ports 27001 G/GF/GH/GP, package of 10, single use recommended

27500 **LUER-Lock Tube Connector,** male, tube diameter 9 mm

27502 **LUER-Lock Tube Connector,** with stopcock, dismantling

27001 E **Insertion Aid,** for guide wires

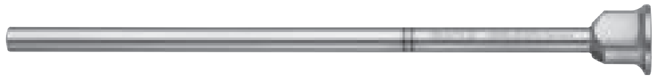


39501 XK **Wire Tray**
including:
Cleaning Adaptor, for Instrument Ports 27001 G/GF/GH/GG/GP

Dilators, Sheaths and Applicators
for MIP M

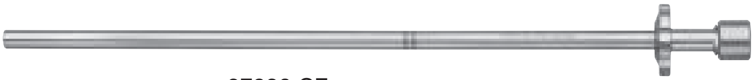
27830 AB

27830 AA	**One Step Dilator,** with central channel for guide wires, for use with 15/16 Fr. Operating Sheaths 27830 BA/BAS
27830 AB	**One Step Dilator,** with central channel and a second eccentric channel for guide wires, for use with 16.5/17.5 Fr. Operating Sheaths 27830 BB/BBS
27830 AC	**Same,** for use with 21/22 Fr. Operating Sheaths 27830 BC/BCS



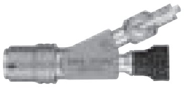
27830 BB

27830 BA	**Operating Sheath,** 15/16 Fr., working length 15 cm, for continuous irrigation and suction
27830 BB	**Same,** 16.5/17.5 Fr.
27830 BC	**Same,** 21/22 Fr.
27830 BAS	**Operating Sheath,** for the supine position, 15/16 Fr., working length 18 cm, for continuous irrigation and suction
27830 BBS	**Same,** 16.5/17.5 Fr.
27830 BCS	**Same,** 21/22 Fr.
27830 BK	**Operating Sheath for Children,** 16.5/17.5 Fr., working length 7.5 cm, for continuous irrigation and suction



27830 CF

27830 CF	**Applicator for Sealant,** including sheath and rod, for use with Operating Sheaths 27830 BA/BB/BC
27830 CFS	**Applicator for Sealant,** for the supine position, including sheath and rod, for use with Operating Sheaths 27830 BAS/BBS/BCS



27001 GG

27001 GG	**Instrument Port with Sealing System and Quick Release Lock,** large, 1 channel, for use with accessories up to 6 Fr. (diameter 2 mm) in combination with Miniature Nephroscope for MIP M 27830 KA

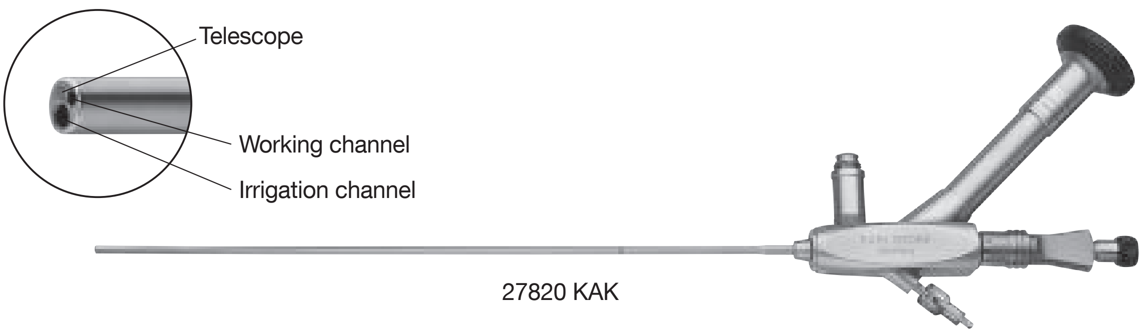
MIP XS/S – Percutaneous Nephroscope

Special Features:

- **Smaller system for minimal access tract**
- **Working channel with 2 Fr. for guided laser fibers allows safe use**
- **Separate irrigation channel for optimal irrigation and good visualization**
- **For low stone burdens**
- **Provides an alternative where flexible ureterorenoscopy is not possible**

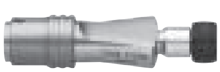
Specifications:

Instrument sheath:	7.5 Fr.
Working channel:	2 Fr.
Separate irrigation channel:	3 Fr.
Telescope:	Fiber optic system, direction of view 6°
Length:	24 cm
Eyepiece:	angled



27820 KAK **Nephroscope for MIP XS/S, autoclavable**

Following accessories are included in delivery:



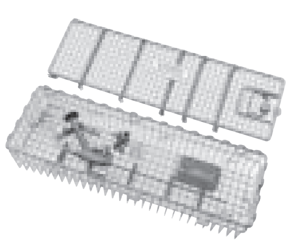
27001 G **Instrument Port with Sealing System and Quick Release Lock,** 1 channel

27550 N **Seal,** for Instrument Ports 27001 G/GF/GH/GP, package of 10, single use recommended

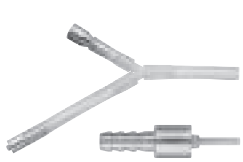
27500 **LUER-Lock Tube Connector,** male, tube diameter 9 mm

27502 **LUER-Lock Tube Connector,** with stopcock, dismantling

27001 E **Insertion Aid,** for guide wires



39501 XK **Wire Tray**
including:
Cleaning Adaptor, for Instrument Ports 27001 G/GF/GH/GG/GP



39501 XRV **Multiport Bridge**

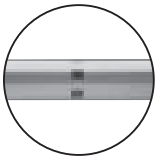
39107 ALK **Cleaning Adaptor,** for use with small LUER stopcocks

Dilators, Sheaths and Applicators
for MIP XS/S

Dilator and Operating Sheaths for MIP XS

27820 AA

27820 AA **One Step Dilator,** with central channel for guide wires,
for use with 8.5/9.5 Fr. Operating Sheaths 27820 BA/BAS



Dashed ring marking

27820 BA

27820 BA **Operating Sheath,** 8.5/9.5 Fr., working length 15 cm

27820 BAS **Operating Sheath,** for the supine position,
8.5/9.5 Fr., working length 18 cm

Dilator and Operating Sheaths for MIP S

27820 AB

27820 AB **One Step Dilator,** with central channel for guide wires,
for use with 11/12 Fr. Operating Sheath 27820 BB

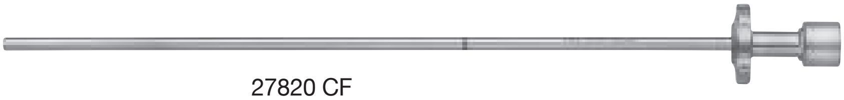
27820 BB

27820 BB **Operating Sheath,** 11/12 Fr., working length 15 cm,
for continuous irrigation and suction

27820 BBS **Operating Sheath,** for the supine position,
11/12 Fr., working length 18 cm,
for continuous irrigation and suction

27820 BK **Operating Sheath for Children,** 11/12 Fr.,
working length 7.5 cm, for continuous irrigation and suction

Applicators for MIP XS/S



27820 CF

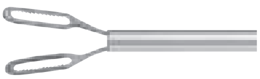
27820 CF **Applicator for Sealant,** including sheath and rod,
for use with Operating Sheaths 27820 BA/BB

27820 CFS **Applicator for Sealant,** for the supine position,
including sheath and rod,
for use with Operating Sheaths 27820 BAS/BB

Optional Accessories for MIP L

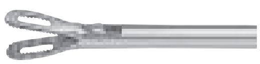
27840 LIK

27840 LIK **LASER Hand Instrument,** distal tip bent upwards, fixation for LASER fibers and sealing system, working length 35 cm, for use with Nephroscope for MIP L 27840 KA and Instrument Port MIP L 27840 GP as well as LASER fibers up to diameter 1 mm
including:
Cleaning Adaptor
Seal, package of 10

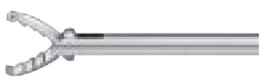


27290 F **Forceps,** for grasping stone fragments and coagula, with fenestrated jaws and U-spring handle, 11.5 Fr., length 38 cm, color code: red-black

27290 H **Forceps,** for grasping larger stones and stone fragments, with triple serrated jaws and U-spring handle, 10.5 Fr., length 38 cm, color code: red-black



27290 K **Forceps,** for grasping larger stones and stone fragments, with fenestrated jaws and ring handle, double action jaws, 10.5 Fr., length 38 cm, color code: red-black



27290 M **Forceps,** for grasping larger stones and stone fragments, with serrated jaws and ring handle, d ouble action jaws, 10.5 Fr., length 38 cm, color code: red-black

27294 S **Knife,** straight, with 3-ring-handle, 10.5 Fr., length 38 cm, color code: red-black

27294 SK **Knife** only

27294 SH **Knife,** sickle-shaped, with 3-ring handle, 10.5 Fr., length 38 cm, color code: red-black

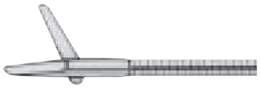
27294 SB **Knife** only

27840 DS **Sealing Ring,** for Instrument Port 27840 GP, bore 0.7 mm, package of 10, for use with thin lithotripsy probes

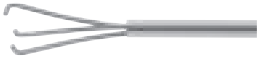
Optional accessories for MIP M

27830 FK **Forceps for Foreign Body Removal**, double action jaws, flexible, 5 Fr., length 40 cm

27830 FL **Biopsy Forceps,** double action jaws, flexible, 5 Fr., length 40 cm



27830 S **Scissors,** single action jaws, semiflexible, 5 Fr., working length 40 cm



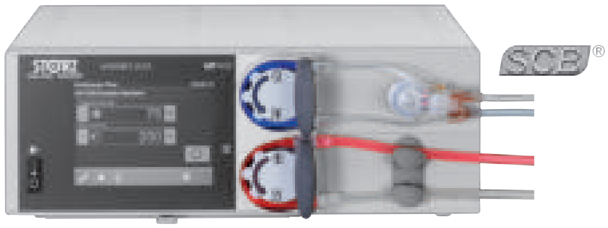
27830 H **Forceps,** rigid, for grasping large stones and stone fragments, with triple serrated jaw parts and U-spring handle, 5 Fr., length 36 cm

UROMAT E.A.S.I.® SCB

Pressure-regulated Suction and Irrigation System

Special Features:

- **Innovative:**
  Intelligent, pressure-regulated double roller pump (ensures a constant balance between inflow and outflow for highest patient safety)
- **Powerful:**
  Optimal power values for several endourological applications
- **Cost-efficient:**
  Continuous comparison of pressure and flow values enables optimal fluid use
- **Convenient:**
  Preset parameters for endo-urological applictions
- **Intuitive:**
  Pump parameters can be selected via touch screen
- **Market-oriented:**
  BOLUS function with adjustable parameters which can be activated via footswitch or touch screen
- **Easier identification:**
  Color coding of the tubing set
  Blue: Irrigation
  Red: Suction
- **Can be used for all indications in urology**



UP410 S1

UP410 S1 **UROMAT E.A.S.I.® SCB,** power supply 100 – 240 VAC, 50/60 Hz, UROMAT E.A.S.I.® SCB ready, compatible from RUI Release 45
including:
SCB Connecting Cable, length 100 cm
Basic Tubing Set*, for single use
Control Cable

Accessories:

031717-10* **Single-use IRRIGATION tubing set,** with two puncture needles. For use with KARL STORZ HYSTEROMAT E.A.S.I.® and UROMAT E.A.S.I., sterile, 10 per pack STERILE

031217-10* **Single-use SUCTION tubing set.** For use with KARL STORZ HYSTEROMAT E.A.S.I.® and UROMAT E.A.S.I., sterile, 10 per pack STERILE

Specifications:

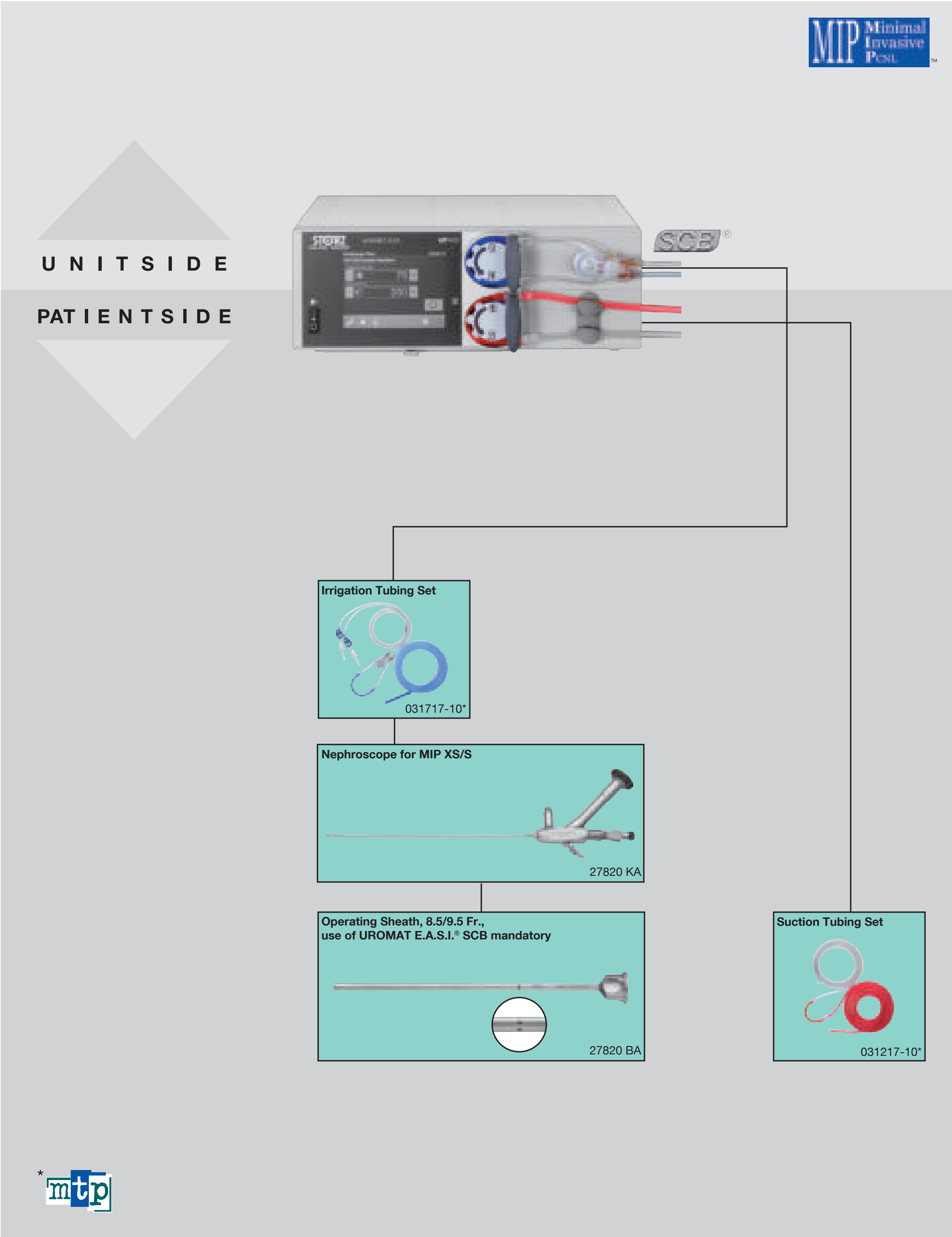
Flow-regulated	depending on mode
Irrigation pressure	adjustable 20-200 mmHg
Suction	100-1800 ml/min suction power
Power supply	100-240 VAC, 50/60 Hz

Dimensions w x h x d	447 x 155 x 313 mm
Weight	8.8 kg
Certified to	IEC 60601-1, CE acc. to MDD

*mtp

UROMAT E.A.S.I® SCB

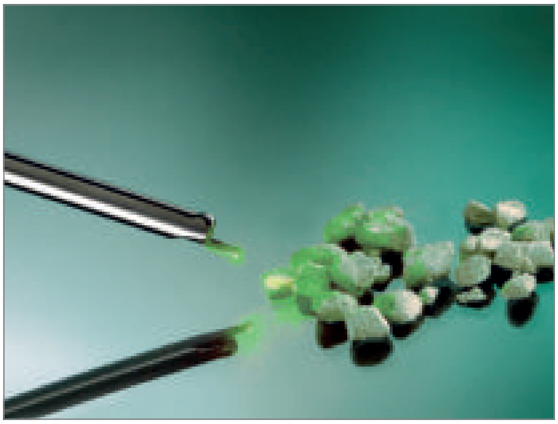
System Components for MIP XS



CALCULASE II

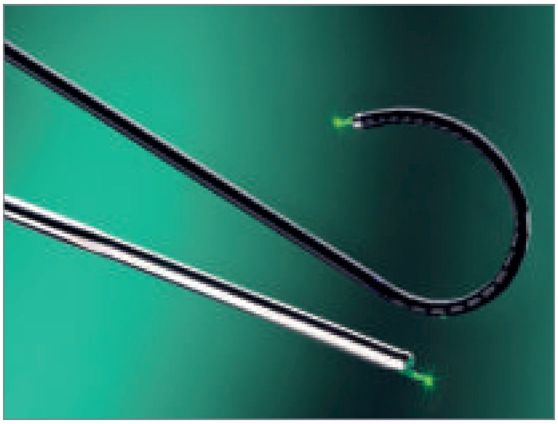
Holmium LASER System for Endoscopic Stone Therapy and Soft Tissue Treatment, Recommended Standard Set Configuration

20 Watt LASER Power
The brand CALCULASE II stands for a cost-effective and efficient Ho:YAG laser system for endoscopic fiber-guided laser lithotripsy. Furthermore, the system can be used for various soft-tissue treatments in the urinary tract including strictures in the uretero-pelvic junction (UPJ) and the ablation of transitional cell carcinomas.

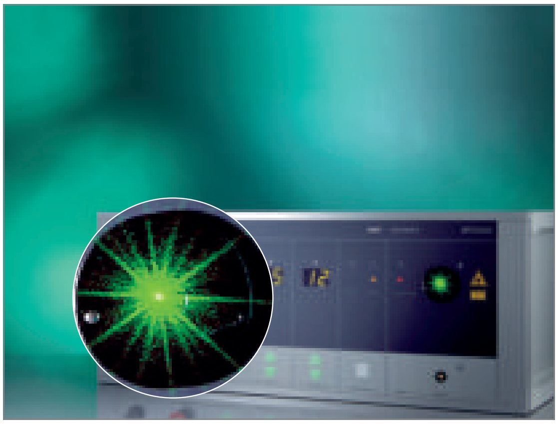


Multiple Laser Fibers and Instruments
KARL STORZ offers laser fibers in different sizes (230, 365 and 600 µm) for single and multiple use.

Together with our broad range of rigid and flexible ureterorenoscopes with fiberoptics and sensor technology, KARL STORZ provides the ideal and complete solution for stone therapy and soft tissue treatment.



Automatic Fiber Detection
CALCULASE II automatically assures the correct settings of maximal energy and therefore avoids any damage to fibers and devices.



Mobility
Due to its compact design, CALCULASE II is a highly versatile and portable system.

With its newly designed handles, the laser unit can be placed in the equipment cart and then rolled easily.

CALCULASE II

Holmium LASER System for Endoscopic Stone Therapy and Soft Tissue Treatment, Recommended Standard Set Configuration

27 750220-1

27 750201U1 **CALCULASE II,** Holmium LASER system
with KARL STORZ-SCB, power supply 115/230 VAC, 50/60 Hz
including:
Mains Cord
One-Pedal Footswitch
Key Set
Remote Interlock Connector
Safety Goggles Ho:YAG Laser, 2080 nm
Ion Exchanger

Please note:
Each lithotripsy system requires a LASER fiber basic set:
27 7500 87 or **27** 7502 86

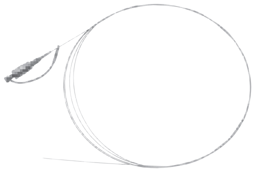
Parameter matrix for 230 µm fibers					
Frequency (Hz) / Energy (J)	**4 Hz**	**6 Hz**	**8 Hz**	**10 Hz**	**15 Hz**
0.5 J	2.0 W	3.0 W	4.0 W	5.0 W	–
0.8 J	3.2 W	4.8 W	6.4 W	8.0 W	–
1.2 J	4.8 W	7.2 W	9.6 W	12.0 W	–
1.7 J	–	–	–	–	–
2.0 J	–	–	–	–	–

Parameter matrix for 365 µm and 600 µm fibers					
Frequency (Hz) / Energy (J)	**4 Hz**	**6 Hz**	**8 Hz**	**10 Hz**	**15 Hz**
0.5 J	2.0 W	3.0 W	4.0 W	5.0 W	7.5 W
0.8 J	3.2 W	4.8 W	6.4 W	8.0 W	12.0 W
1.2 J	4.8 W	7.2 W	9.6 W	12.0 W	18.0 W
1.7 J	6.8 W	10.2 W	13.6 W	17.0 W	–
2.0 J	8.0 W	12.0 W	16.0 W	20.0 W	–

Parameters are selected via cable coding.

Accessories

for CALCULASE II



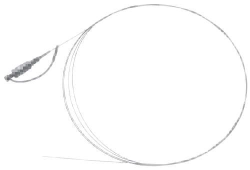
27 7502 71-P6 **CALCULASE II Fiber 230 µm,** reusable, sterile, length 300 cm, package of 6

27 7502 72-P6 **CALCULASE II Fiber 365 µm,** reusable, sterile, length 300 cm, package of 6

27 7502 73-P6 **CALCULASE II Fiber 600 µm,** reusable, sterile, length 300 cm, package of 6

27 7502 87 **CALCULASE II Fiber Kit,**
including:
3x **CALCULASE II Fiber 230 µm,** reusable, sterile
3x **CALCULASE II Fiber 365 µm,** reusable, sterile
3x **CALCULASE II Fiber 600 µm,** reusable, sterile

Fiber Sets, for single use



27 7502 77-P6 **CALCULASE II Fiber 230 µm,** for single use, sterile, length 300 cm, package of 6

27 7502 78-P6 **CALCULASE II Fiber 365 µm,** for single use, sterile, length 300 cm, package of 6

27 7502 79-P6 **CALCULASE II Fiber 600 µm,** for single use, sterile, length 300 cm, package of 6

27 7502 86 **CALCULASE II Fiber Kit,**
including:
3x **CALCULASE II Fiber 230 µm,** for single use, sterile
3x **CALCULASE II Fiber 365 µm,** for single use, sterile
3x **CALCULASE II Fiber 600 µm,** for single use, sterile

Optional accessories

27 7502 80 **Fiber Stripper Set,** sterilizable, for use with CALCULASE II fibers
including:
Silicone Pad
Ceramic Knife
Fiber Strippers 230, 365 and 600

27 7500 95 **Safety Goggles Ho:YAG LASER,** suitable for 2080 nm, for both spectacle and non-spectacle wearers, absorbing plastic filter, flexible earpieces, lightweight, for use with CALCULASE II **27** 7502 20-1 and CALCULASE **27** 7501 20-1

CALCULASE II Equipment Cart

Special Features:

- **Flexible use of CALCULASE II in various ORs**
- **Spacious storage room for accessories and expendable materials in two lockable drawers (LASER safety goggles or LASER fibers)**
- **Integrated cable winding and footswitch holder maintain an uncluttered OR**
- **Easy to transport due to large, smoothrunning and antistatic dual wheels**
- **Powder-coated panels and shelves meet the most stringent quality and hygiene standards**

UG 210

UG 210 **Equipment cart,**
wide, low, rides on 4 antistatic dual wheels equipped with locking brakes, mains switch on cover, double rear panel with integrated electrical subdistributors with 6 sockets, potential earth connectors,
Dimensions in mm (w x h x d):
Equipment cart: 830 x 1265 x 730,
shelf: 630 x 25 x 510,
caster diameter: 150 mm,
including:
Base module, equipment cart, wide
Cover, equipment cart, wide
Beam package, equipment cart, low
Shelf, wide
2x **Drawer unit with lock,** wide
2x **Equipment rail,** long

CALCUSPLIT®

System for Pneumatic Lithotripsy,
Recommended Standard Set Configuration

27 630020

27 630003 — **CALCUSPLIT®,** power supply 100/120/230/240 VAC, 50/60 Hz
including:
Mains Cord
One-Pedal Footswitch, digital, two-stage
Fabric Tube, for connection to the central compressed air supply, length 400 cm
CALCUSPLIT® Handpiece, autoclavable
Sealing Rings, for use with CALCUSPLIT® handpiece, package of 5
Spare Damping Unit, autoclavable, for use with CALCUSPLIT® lithotripsy probes, package of 20
Silicone Tube, autoclavable, for connecting handpieces, length 200 cm
Cleaning Brush, outer diameter 2.5 mm, length 35 cm
Instrument Oil, bottle of 50 ml

Optional Accessories:

20 031001 — **Air Compressor,** 0 – 8 bar, power supply 230 VAC, 50/60 Hz, dimensions (w x d x h): approx. 500 x 320 x 340 mm, weight approx. 22 kg
including:
Fabric Tube, for connecting CALCUSPLIT® SCB **27** 630020 and HYDROMAT® **26** 311020 to Air Compressor **20** 031020

20 031001 C — **Same,** power supply 115 VAC, 50/60 Hz

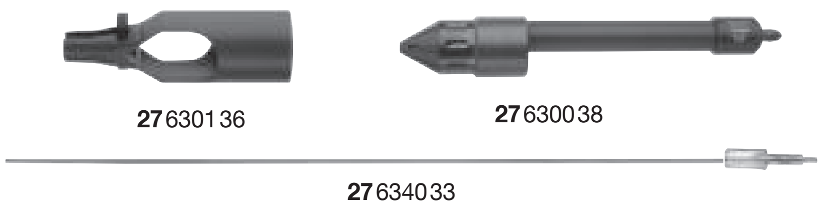
Specifications:

Working frequency	- single shot - continuous shot 12 Hz
Power supply	110/120/230/240 VAC, 50/60 Hz

Dimensions w x h x d	305 x 164 x 260 mm
Weight	5 kg
Certified to	IEC 60601-1, CE acc. to MDD

Accessories
for CALCUSPLIT®

Lithotripsy Wire Probes for use with Handpiece 27 6300 38



CALCUSPLIT® Lithotripsy Wire Probes

Order No.	Diameter	Working L.	for use with
27 6325 34	0.8 mm	48.5 cm	**Ureteroscopes** 27000 K, 27001 K, 27002 K, 27002 KP, in conjunction with Instrument Port 27001 G and Handpiece **27** 6300 38
27 6325 35	1.0 mm		
27 6325 36	1.6 mm	48.5 cm	**Ureteroscope 27002 K,** in conjunction with 48.5 cm Instrument Port 27001 G and Handpiece **27** 6300 38
27 6326 34	0.8 mm	57.5 cm	**Uretero-Renoscopes** 27000 L, 27001 L, 27002 L, 27003 L, in conjunction with Instrument Port 27001 G and Handpiece **27** 6300 38
27 6326 35	1.0 mm		
27 6326 36	1.6 mm	57.5 cm	**Uretero-Renoscope** 27002 L, in conjunction with Instrument Port 27001 G and Handpiece **27** 6300 38

27 6322 31	0.8 mm	31 cm	**HOPKINS® Telescopes** 27092 AMA, 27093 AA, 27095 AA, in combination with Operating Sheaths 27093 BD/CD, 27095 B and Handpiece **27** 6300 38
27 6322 32	1.0 mm		
27 6322 33	1.6 mm		
27 6322 34	2.0 mm		
27 6340 31	0.8 mm	37.5 cm	**HOPKINS® Telescopes** 27292 AMA, 27293 AA, 27294 AA, 27295 AA, Operating Sheaths 27293 BD/CD and Nephroscope for MIP M 27830 KA in conjunction with Instrument Port 27001 GP and Handpiece **27** 6300 38
27 6340 32	1.0 mm		
27 6340 33	1.6 mm		
27 6340 34	2.0 mm	37.5 cm	**HOPKINS® Telescopes** 27292 AMA, 27293 AA, Operating Sheaths 27293 BD/CD and Nephroscope for MIP M 27830 KA in conjunction with Instrument Port 27001 GG and Handpiece **27** 6300 38

Adaptor, autoclavable, for KARL STORZ uretero-renoscopes, new generation

27 6301 36	–	–	**Uretero-Renoscope,** new generation, for use with CALCUSPLIT® in – conjunction with Instrument Port 27001 G and Handpiece **27** 6300 38

IMAGE1 S™

As individual as your requirements

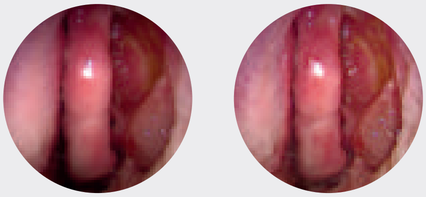
With the IMAGE1 S™ camera platform, KARL STORZ once again sets a new milestone in endoscopic imaging, consolidating their reputation as an innovative leader in minimally invasive surgery.

The IMAGE1 S™ camera platform offers surgeons a single system for all applications. As a modular camera platform, IMAGE1 S™ combines various technologies (e.g., rigid, flexible and 3D endoscopy) in one system and can therefore be adapted to individual customer needs. Furthermore, near infrared (NIR/ICG) for fluorescence imaging, the integration of operating microscopes and the use of VITOM® 3D exoscopes is possible via the camera platform.

Brilliant imaging

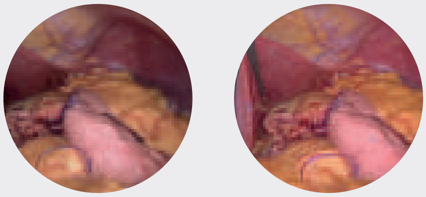
- Versatile visualization options for diagnosis and therapy
- Innovative S-Technologies for easy differentiation of tissue structures
- Clear and razor-sharp imaging
- Natural color rendition
- Automatic light source control

CLARA + CHROMA: Homogeneous illumination + contrast enhancement



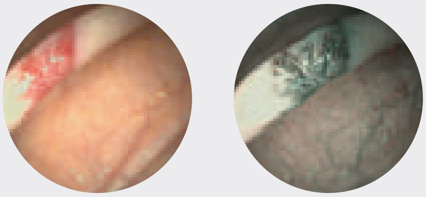
Standard Image | CLARA + CHROMA

CLARA: Homogeneous illumination



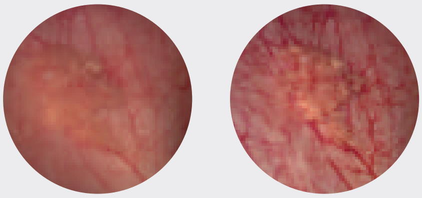
Standard Image | CLARA

***SPECTRA A:** Color hue shift and exchange (filtering reds)



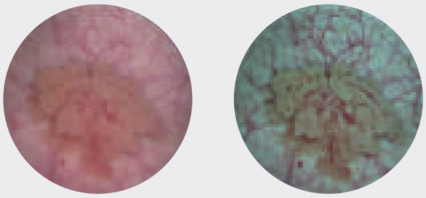
Standard Image | *SPECTRA A

CHROMA: Contrast enhancement



Standard Image | CHROMA

***SPECTRA B:** Spectral color shift (intensification of greens and blues)

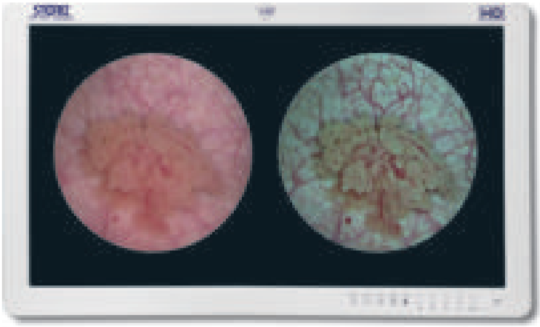


Standard Image | *SPECTRA B

* SPECTRA A**: Not for sale in the U.S.**
* SPECTRA B**: Not for sale in the U.S.**

IMAGE1 S™

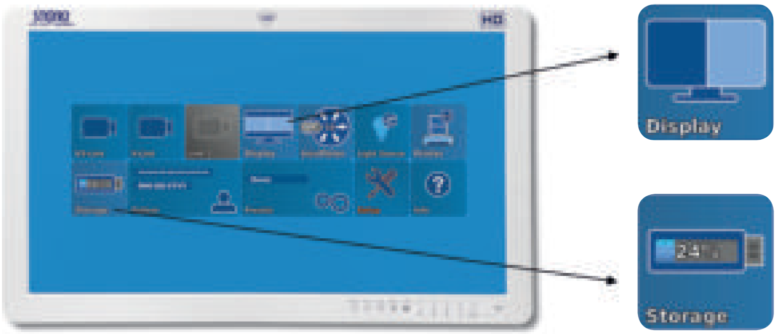
As individual as your requirements



Side-by-side View:
Parallel display of standard image and *SPECTRA B

Innovative Design

- Side-by-side View: Parallel display of standard image and visualization mode possible
- Multiple source management: Simultaneous control, display and documentation of two image sources possible (e.g., hybrid procedures)
- Intuitive user guidance (dashboard, live menu and setup menu)
- Intelligent icons display settings and status
- Individual presets possible
- 50 patient data records can be archived



Status indication icons

Dashboard

Economical and futureproof

- Modular platform: Rigid, flexible and 3D technology can be selected according to individual preferences
- Easy integration of new technologies
- Forward and backward compatibility
- No additional equipment (e.g., special light sources) required for S-Technologies

* SPECTRA A: **Not for sale in the U.S.**
* SPECTRA B: **Not for sale in the U.S.**

IMAGE1 S™ Camera System

TC 200EN* — **IMAGE1 S CONNECT™**, connect module, for use with up to 3 link modules, resolution 1920 x 1080 pixels, with integrated KARL STORZ-SCB and digital Image Processing Module, power supply 100–120 VAC/200–240 VAC, 50/60 Hz
including:
Mains Cord, length 300 cm
DVI-D Connecting Cable, length 300 cm
SCB Connecting Cable, length 100 cm
USB Flash Drive, 32 GB, USB silicone keyboard, with touchpad, US

***Available in the following languages:** DE, ES, FR, IT, PT, RU

Specifications:

HD video outputs	- 2x DVI-D - 1x 3G-SDI
Format signal outputs	1920 x 1080p, 50/60 Hz
LINK video inputs	3x
USB interface SCB interface	4x USB, (2x front, 2x rear) 2x 6-pin mini-DIN

Power supply	100–120 VAC/200–240 VAC
Power frequency	50/60 Hz
Protection class	I, CF-Defib
Dimensions w x h x d	305 x 54 x 320 mm
Weight	2.1 kg

For use with IMAGE1 S™
IMAGE1 S CONNECT™ Module TC 200EN

TC 301

TC 301 — **IMAGE1 S™ X-LINK,** link module, for use with flexible video endoscopes, power supply 100–120 VAC/200–240 VAC, 50/60 Hz, **for use with IMAGE1 S CONNECT™ TC 200EN**
including:
Mains Cord, length 300 cm
Link Cable, length 20 cm

Specifications:

Camera System	TC 301 (X-LINK)
Supported camera heads/video endoscopes	11900 AP/AN, 11900 BP/BN, 11101 VP/VN, 13820 PKS/NKS, 13821 PKS/NKS, 13885 PKS/NKS, 13924 PKS/NKS, 13925 PKS/NKS, 11272 VPI/VNI, 11272 VPIU/VNIU, 11272 VPU/VNU, 11272 VP/VN, 11278 V, 11278 VU (IMAGE1 S™ modes available)
LINK video outputs	1x
Power supply	100–120 VAC/200–240 VAC
Power frequency	50/60 Hz
Protection class	I, CF-Defib
Dimensions w x h x d	305 x 54 x 320 mm
Weight	1.86 kg

IMAGE1 S™ Camera Heads

For use with IMAGE1 S™ Camera System
IMAGE1 S CONNECT™ Module TC 200EN, IMAGE1 S™ X-LINK Module TC 301

TH 110 **IMAGE1 S™ HX One-Chip FULL HD Camera Head,**
50/60 Hz, fixed focus, progressive scan, soakable,
gas- and plasma-sterilizable, focal length f = 16 mm,
2 freely programmable camera head buttons,
for use with IMAGE1 S™

TH 111 **IMAGE1 S™ HX-P One-Chip FULL HD Pendulum Camera Head,**
50/60 Hz, with pendulum system and fixed focus,
progressive scan, soakable, gas- and plasma-sterilizable,
focal length f = 16 mm, 2 freely programmable camera head buttons,
for use with IMAGE1 S™

TH 112 **IMAGE1 S™ HX FI One-Chip FULL HD Camera Head,**
S-Technologies (CHROMA, SPECTRA A and B) **available,**
OPAL1-Technologies (PDD, AF) in conjunction with light source
D-LIGHT C for PDD or D-Light C/AF for PDD and AF, fixed focus,
progressive scan, soakable, gas- and plasma-sterilizable,
focal length f = 16 mm, 2 freely programmable camera head buttons,
for use with IMAGE1 S™ (X-LINK)

TH 113 **IMAGE1 S™ HX FI One-Chip FULL HD Camera Head,**
S-Technologies (CHROMA, SPECTRA A and B) **available,**
OPAL1-Technologies (PDD, AF) in conjunction with light source
D-LIGHT C for PDD or D-Light C/AF for PDD and AF, fixed focus,
progressive scan, soakable, gas- and plasma-sterilizable,
focal length f = 16 mm, 2 freely programmable camera head buttons,
for use with IMAGE1 S™ (X-LINK)

Monitors

9826 NB

9826 NB **26" FULL HD Monitor,**
wall-mounted with VESA 100 adaption,
color systems **PAL/NTSC,**
max. screen resolution 1920 x 1080,
image format 16:9,
power supply 100 – 240 VAC, 50/60 Hz
including:
External 24 VDC Power Supply
Mains Cord

9619 NB

9619 NB **19" HD Monitor,**
color systems **PAL/NTSC,** max. screen
resolution 1280 x 1024, image format 4:3,
power supply 100–240 VAC, 50/60 Hz,
wall-mounted with VESA 100 adaption,
including:
External 24 VDC Power Supply
Mains Cord

Cold Light Fountain Power LED 175 SCB

20161401-1 **Cold Light Fountain Power LED 175 SCB,**
with integrated SCB, high-performance LED
and one KARL STORZ light outlet,
power supply 110–240 VAC, 50/60 Hz
including:
Mains Cord
SCB Connecting Cable, length 100 cm

20132026 **Xenon-Spare-Lamp,** 175 watt, 15 volt

Fiber Optic Light Cables
for Cold Light Fountains

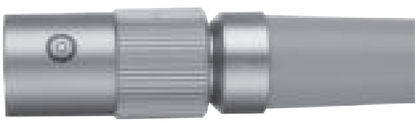
495 NA **Fiber Optic Light Cable,**
with straight connector, diameter 3.5 mm, length 230 cm

495 NAC **Fiber Optic Light Cable,**
with straight connector, extremely heat-resistant, with safety lock, enhanced light transmission, can be used for ICG applications, diameter 3.5 mm, length 230 cm

495 NL **Fiber Optic Light Cable,**
with straight connector, diameter 3.5 mm, length 180 cm

495 NTA **Fiber Optic Light Cable,**
with straight connector, diameter 2.5 mm, length 230 cm

495 NT **Fiber Optic Light Cable,**
with straight connector, diameter 2.5 mm, length 180 cm



495 NCSC **Fiber Optic Light Cable,**
safety lock

Recommended combination*

Light Cable Diameter	Endoscope Diameter
4.8 – 5.0 mm	6.6 – 12.0 mm
3.0 – 3.5 mm	3.0 – 6.5 mm
2.0 – 2.5 mm	0.8 – 2.9 mm

* Special endoscope may deviate

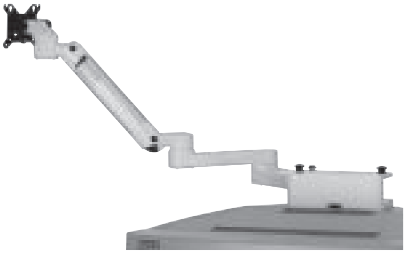
Equipment Cart

UG 220

UG 220 **Equipment Cart,**
wide, high, rides on 4 antistatic dual wheels equipped with locking brakes,
mains switch on cover, energy beam with integrated electrical subdistributors with 12 sockets, grounding plugs,

Dimensions:
Equipment cart: 830 x 1474 x 730 mm (w x h x d),
Shelf: 630 x 25 x 510 mm (w x h x d),
Caster diameter: 150 mm

including:
Base Module, equipment cart, wide
Cover, equipment cart, wide
Beam Package, equipment cart, high
3x **Shelf,** wide
Drawer Unit with Lock, wide
2x **Equipment Rail,** long
Camera Holder



UG 540 **Monitor Swifel Arm,**
height and side adjustable,
can be positioned on the left or on the right side,
swivel range 180°, reach 780 mm,
from center 1170 mm, loading capacity max. 15 kg,
with monitor mount VESA 75/100,
for use with Equipment Carts UGxxx

UG 530 **Swivel Arm,**
for navigation camera, height and side adjustable,
can be mounted on the left or on the right side,
swivel range 180°, reach 880 mm,
from center 1270 mm, loading capacity max. 1.5 kg,
for use with Equipment Carts UGxxx and navigation camera