PERCUTANEOUS NEPHROLITHOTOMY (PCNL)
A Manual for the Urologist

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Acknowledgements

Prof. Francisco Sampaio for kind permission to use the photographs
and data from his endocast studies (Figs. 10–18 in this booklet).

Cook Urology for sponsoring workshops,
disposables and some photographs.

Mr. A. Sarkissian and Ms. A Law from KARL STORZ
for their support during this project.

Drs. K. du Toit and M. Fisher for taking many photographs.

Ms. C. Lochner for the artwork and drawings.
Figs. 14, 15 a–c, 17 a, b and Fig. 18 from *Smith’s Textbook of Endourology*, 2nd edition, ISBN 1-55009-365-7. Figs. 2, 3, 5 and 19 were remade based on drawings presented in the same source. Republishing permission granted by courtesy of People’s Medical Publishing House – USA (PMPH-USA, Ltd.)

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Foreword

Percutaneous Nephrolithotomy (PCNL) continues to challenge and fascinate. In order to achieve a good outcome for the patient while at the same time meeting the expectations of the urologist, it is of utmost importance that all members of the surgical team be excellent teamworkers. Since PCNL requires multiple key players to communicate and collaborate closely throughout the procedure, there are many things that can go wrong. For these reasons, the procedure is a good benchmark for the urologist’s organizational abilities, leadership skills and patience. The players in our team are the urologist, the scrub assistant, the anesthesiologist and the radiographer. Equally important is the equipment to visualize, disintegrate and remove the stones. The ‘opponents’ are the calculi with all kinds of ‘tricks up their sleeves’, such as being very hard or very soft or very elusive. The ‘playing field’ is the renal collecting system and calyceal anatomy. The stones have a ‘home-ground advantage’ which lies in the fact that the urologist will be ‘disqualified’ or ‘punished’ (with complications) for straying outside the borders of the playing field (renal cortex, hilum and peri-nephric areas). On the other hand, the surgeon will be rewarded for playing by the rules – a perfectly targeted puncture, atraumatic dilatation of the tract and rapid fragmentation of calculi. There is no greater satisfaction in urological surgery than complete removal of all calculi in the course of a PCNL procedure.

Introduction

Rupel and Brown extracted a calculus from an established nephrostomy tract after open surgery in 1941. Goodwin et al described the first percutaneous drainage of an acutely infected collecting system in 1955. However, removal of a calculus via a tract specifically created for that purpose was first performed in 1976 by Fernström and Johansson. Subsequently, several authors published articles describing successful outcomes in 1981, 1982 and 1984. Brannen and Bush reported on the removal of large stones in 1985 and held out the prospects that this approach will on a long-term basis supersede open surgery for renal stones.
**PCNL-Related Anatomy of the Kidney**

The left kidney is slightly larger than the right – this correlates with morphometric studies in fetal kidneys. The average length of the left kidney is 11.21 cm while that of the right is 10.97 cm. In the same kidney, the upper pole is wider than the lower pole (mean 6.48 cm upper, and 5.39 cm lower pole). As the psoas muscle has the shape of a cone, the upper pole of the kidney is more medial and posterior than the lower pole. The left kidney is slightly higher, and therefore supra-costal puncture is more likely\(^9\) (Fig. 1).

Since the longitudinal axis of the kidney is oriented in the sagittal plane, there is an inherent risk to go astray medially while using a puncture needle or any other instrument, because vital structures, such as the hilum and large vessels are in close proximity\(^10\) (Fig. 2).

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Anatomical axes / planes of the kidneys that need to be borne in mind while planning puncture access during PCNL.

Puncture access poses the risk of iatrogenic damage, as vessels are directly in line with the access trajectory.
The left kidney is crossed at the upper pole by the 11th and 12th ribs, but the right kidney is only crossed by the 12th. The diaphragm is traversed in all intercostal punctures and occasionally in punctures below the 12th rib as well. Medially, the posterior reflexion of the pleura extends below the 12th rib. It can be expected that the pleura is traversed in most intercostal punctures – most of the time with no adverse effect. The lung generally lies at the 10th intercostal space. Punctures that are placed above the 10th rib pose a high risk of iatrogenic damage to the lung (Fig. 3).

The liver and spleen lying in a postero-lateral position may be injured, especially with hepatosplenomegaly. In full inspiration, these organs are most vulnerable and the puncture site for access to the renal collecting system should be adjusted accordingly in patients with organomegaly. The colon can also be very close to the kidney. In the supine position, the colon is in retro-renal location in 1.9% of cases, but in the prone position it is retro-renal in 10% of cases (Figs. 4a, b).

With the intrarenal arteries and veins situated close to the infundibula, this is a major cause for bleeding and abandoning the PCNL procedure. This can be avoided by carefully selecting the calyces for access (Fig. 5).

The kidney has a segmental blood supply and the renal arteries are end-arteries. This means, that a segment of renal tissue will necrose distal to a significant proximal occlusion. It also means that an ‘avascular plane’ of Brödel may be found posterolaterally. This is the preferred plane of entry when defining the site of puncture (Figs. 6).

The pleura extends below the 12th rib and the lung lies at the level of the 10th intercostal space.

The loaded colon (left) may be close to the kidney and in the case of scoliosis (right), even the small bowel may be interposed between kidney and skin.

Renal interlobular (infundibular) arterial branches can be punctured if calyces are missed at puncture.

Brödel’s line: note that inadvertent damage to the posterior segmental artery (easily done at upper pole punctures) could render more than half of the kidney avascular.
In more than 50% of kidneys, the posterior segmental artery is situated in the middle or upper half of the organ and may therefore be easily damaged when the puncture needle travels too far – this mistake happens inter alia if the axis of the imaging modality is not aligned at exactly 90 degrees to the direction in which the needle is advanced during puncture. A parallax mistake is thus made, with possible dire consequences.\textsuperscript{15}

The calyceal anatomy continues to intrigue. The concept that the kidney consists of two rows of anterior and posterior calyces is possibly an over-simplification (Fig. 7).

Knowledge of the Hodson and Brödel arrangement of calyces is essential. The Brödel-type kidney has a longer posterior calyx which is only 20 degrees with respect to the frontal plane. The short anterior calyx maintains an angle of 70 degrees relative to the frontal plane. Approximately 69% of right kidneys have the Brödel-configuration\textsuperscript{16} (Fig. 8).

Hodson-type kidneys have posterior calyces at 70 degrees to the frontal plane and larger anterior calyces at 20 degrees to the frontal plane. About 79% of left kidneys have the Hodson configuration\textsuperscript{16} (Fig. 9).

\textbf{Hodson} and \textbf{Brödel} arrangements of calyces are illustrated in Figures 7, 8, and 9.
Sampaio and Mandarim-de-Lacerda performed detailed studies of calyceal endocasts and classified calyces into two main groups, irrespective of the side of the kidney.\textsuperscript{17}

**Sampaio Group A1:** (45%) The midzone is drained by minor calyces that are dependent on superior or inferior groups (Fig. 10).

**Sampaio Group A2:** (17%) The midzone is drained by minor calyces that cross and are dependent of superior and inferior major calyces (Fig. 11).

**Sampaio Group B1:** (21%) The midzone is drained by minor calyces draining into a midzone major calyx (Fig. 12).

**Sampaio Group B2:** (17%) The midzone has minor calyces that drain directly into the pelvis (Fig. 13).

A minor calyx situated perpendicular to the pelvis might pose difficulty when accommodating a stone which at first look gives the appearance of being in the pelvis, because the stone may not be found if entry is gained via a lower pole calyx. This can be suspected when the stone does not move on X-ray films taken with the patient in different positions, and renal function remains stable in a patient with a solitary kidney. In this case, lateral X-rays or CT scans may help in establishing the diagnosis (Fig. 14).
In the presence of crossed calyces it can be difficult to determine as to whether they are in anterior or posterior location. The interpelvio-calyceal region is normally oval and the inferior leg is ventral (anterior) in 87% of cases (Figs. 15a–c).

The anatomical-topographic relation of the calyces to the lateral border of the kidney has been erroneously simplified by the statement that posterior calyces are medial and lateral calyces are anterior. Out of 140 endocasts, Sampaio could not find any reliable correlation and suggested injecting a small volume of air into the collecting system to identify the posterior calyces (Figs. 16a, b).

The inferior leg of crossed calyces is ventral (anterior), therefore puncture has to be aimed at the superior leg which will be directed posteriorly.
The upper pole is drained mostly by one infundibulum (98%), the midzone by 2 rows of calyces (95%) and the inferior pole by 2 rows in about 60% of cases.\textsuperscript{18}

The relationship of vascular anatomy to calyces has been studied, and upper pole and infundibulum punctures are considered to be associated with an elevated risk of iatrogenic damage\textsuperscript{19} (Figs. 17a, b).

The posterior segmental artery is vulnerable and easily damaged (Fig. 18).

Inferior pole puncture is considered the safest, but Sampaio found large infundibular vessels in 38% of cases. Therefore, in principle, there is no safe region to puncture the kidney, except for the calyx itself.\textsuperscript{15} The blood vessels around the infundibulum lie anteriorly and posteriorly, which is why puncture of the infundibulum is best done from laterally, and should not traverse to the opposite side, as there will be vessels ‘lying in wait’ (Fig. 19) ...

Endocasts after calyceal puncture employing a safe technique. Note the rich peri-infundibular blood supply to the upper pole.\textsuperscript{17} Superior pole (s), mid-kidney (m), inferior pole (i). Renal artery (A) and vein (V), ureter (u).

Damage to the posterior segmental artery at upper pole puncture.\textsuperscript{17}

Possible sites for incising/puncturing an infundibulum in case no other option is available.
Anesthetic Considerations

An experienced and well-informed anesthesiologist is essential. PCNL in children requires an anesthesiologist well-versed in pediatric anesthesia. Ventilation of a patient in the prone position requires an armoured endotracheal (ET) tube to maintain the airway. Among the hazards that may arise during turning of the patient is dislodgement of intravenous (IV) lines and catheters, including the ureteric access catheter. Pressure on the eyeball during PCNL may render a patient blind at the end of the procedure. Cervical vertebrae can be damaged if the neck is hyper-extended during the procedure. On turning the patient over, his/her shoulder may dislocate. The patient must be kept warm during the procedure with the help of a hot air blanket and warm IV fluids as well as warm irrigation fluid (normal saline solution). If non-saline irrigation fluid (e.g. 5% mannitol) is used and enters the circulation, it may lead to dilutional hyponatremia, whereas non-isotonic fluid (e.g. sterile water) will cause haemolysis leading to acute renal failure ("transurethral resection (TUR) syndrome"). The anesthesiologist must pay due attention to blood pressure fluctuations that may indicate this. Last, but not least, the anesthesiologist must also be prepared for the unfortunate event of air embolism and cardiac arrest (Figs. 20–22).

Armoured endotracheal tube and band over forehead to protect the eyes from pressure.

No pressure should be exerted to the eyes with the patient in prone position. For core temperature monitoring, a probe is used via the nasal route.

The patient is kept warm during preoperative preparation of the procedure.
Patient Selection and Preparation

PCNL should only be performed on functioning kidneys! If any doubt exists, a scintigraphic study is indicated to assess differential or absolute renal function (glomerular filtration rate). The trend to do uncontrasted CT scans for renal calculi may lead to PCNL on non- or poorly functioning kidneys, which are best managed with nephrectomy. These kidneys may harbour resistant organisms or pus and the patient may suffer acute septic shock after puncture or tract dilatation – a scenario, that should be avoided under all circumstances.

Up-to-date X-rays should be available prior to starting. Contrast-enhanced CT to plan the target tract is only needed in the case of body habitus deformation or organomegaly. Colon distension or a suspected retro-renal colon (tall female patients who have lost weight or previous major bowel surgery) may also necessitate contrast-enhanced CT.16

To avoid sepsis, it is mandatory to have a negative urine culture before starting the procedure. Routine screening for coagulopathy is not indicated, but should be done if there is any suspicion, as bleeding tendency is an absolute contraindication to PCNL. Aspirin or other platelet inhibitors should be stopped well in advance. Blood group screening is advisable, in case blood transfusion is required.16

Indications for PCNL include large stone burden (calculi > 2 cm in diameter), failed ESWL, contra-indications to ESWL, known hard stones (e.g. cystine and calcium oxalate monohydrate), proximal ureteric stones, stones associated with foreign bodies, and pelvi-ureteric junction obstruction (PUJO).

Alternative treatments for renal stones suitable for PCNL are retrograde intrarenal surgery (e.g. laser lithotripsy) or laparoscopic pyelolithotomy, as well as open surgery.

Retrograde Study

The patient is placed in lithotomy positon, cleaned and draped. This is the beginning of the narrow PCNL path to walk on patiently to the end of the procedure – deviation may lead to damage and frustration. A balloon occlusion catheter is a “nice-to-have option”, but NOT essential. It may actually prove to be detrimental as the pressure created in the collecting system may increase to such a degree that extravasation occurs easily on needle entry to the collecting system. The floppy-tip guide wire of the balloon catheter is not as atraumatic as expected and may perforate the ureter, leading to early termination of the procedure.

Carefully place an open-ended ureteric catheter with the tip in the renal pelvis. Use a small amount of undiluted contrast medium and inject slowly (this should be done by the urologist). The heavy contrast fills the posterior calyces first – this may not be easy to see and one should exercise patience at this stage.

It is important to visualize the ureter during the retrograde study in order to diagnose unsuspected ureteric stones. These stones should be treated first, as distal obstruction will lead to persistent drainage from the nephrostomy tract (Fig. 23).

The ureteric catheter should be fixed to a urethral catheter in such a way that the port to inject contrast is freely accessible with the patient in prone position. An extension (IV type) to the ureteric catheter may be needed (Fig. 24).
Prone Positioning of the Patient

An “all-hands-on-deck” approach is needed to safely turn the patient until in prone position. Normally, it is easy enough to turn the patient on the operating table, but obese patients may benefit from being transferred back to the hospital bed and then carefully “log-rolled” prone from the bed to the operating table. The anesthesiologist must indicate when the patient may be moved at all, as ET-tube dislodgement can entail disastrous consequences.

The operating table must be stable and care must be taken to check that it is not the wrong way around – this may cause some tables to tip over with obese patients, an event to be avoided at all cost. Adequate extensions of the table should be available allowing the patient’s position to be readjusted in order to visualize the kidneys on X-ray screening. The C-arm of the image intensifier should be movable sideways and rotatable. The feet of the patient should be supported on the table. The arms must be in a neutral position in front of the patient.

The patient must be positioned on soft cushions under the chest and pelvis to take pressure off the abdominal organs. Some urologists advocate placement of an extra cushion or a 3-liter water bag under the patient’s stomach on the ipsilateral side of the targeted kidney in order to lift and stabilize the kidney. However, in our view the padding should be as flat as possible, as this makes the puncture easier, leaving more space for the C-arm to move freely around the kidney. A water bag under the kidney also promotes blurring of the screening pictures and makes puncture more difficult (Fig. 25).

Patient in prone position with soft padding under pelvis and chest.
Check List Before and After Cleaning and Draping the Prone Patient for Fluoroscopy-Guided Puncture – Making Life Easy

- Make sure, there is enough space for the C-arm to screen at right angles up to the superior and inferior poles of the kidney, and allow for tilting of the C-arm without clashing with the table pillar. For this reason, the patient’s kidney has to be far enough from the table pillar (Fig. 26).
- Make sure, there is enough space for the C-arm to move in a more horizontal plane, as this may be needed to follow the direction of an oblique calyx during puncture (Fig. 27).
- Make sure, it is possible to do a complete lateral view with the C-arm, as it is sometimes necessary to confirm the posterior position of a calyx (Fig. 28).
- Affix the extension of the retrograde catheter over the buttocks with adhesive tape to have it accessible throughout the procedure.
- Mark the posterior axillary line – punctures should not be above (posterior) to that.

Screening to the upper and lower pole at right angles should be possible.

‘A’ may clash with ‘B’ when screening at angles (e.g., around a rib).

Complete lateral view screening is very helpful in selecting the posterior calyx.
Have dilute (50:50) contrast available in 60 ml syringes for the contrast studies – to have a continuous infusion with contrast controlled by a wheeled tap may lead to poor control, with extravasation of contrast – this increases the difficulty of the procedure.

Make sure, all disposable and non-disposable equipment is available and in working order – before making the skin incision.

Talk through all the steps of the procedure with the scrub assistant to ascertain that all aspects of equipment and consumables have been covered (Fig. 29).

Connect the nephroscope, camera and irrigation before the initial puncture is made. Any delay in irrigating the collecting system after dilatation of the nephrostomy tract will allow a troublesome blood clot to form, which may impede localizing the stone, as clots adhere tightly to calculi.

Make sure, there is a double irrigation administration set attached to the nephroscope, with warmed irrigation fluid in standby. Use sterile normal saline solution, not sterile water (which will cause dilutional hyponatremia and haemolysis if it enters the circulation). Dedicate a person to keep an eye on the irrigation fluid level and to change the bag before it is empty.

Make sure, the receptacle collecting the drain-off water is not in the way of the rotating C-arm.

Make sure, the height of the table and C-arm relative to each other is so that the C-arm can be moved freely from vertical to horizontal (true lateral). It is very frustrating if the C-arm gets stuck during rotation and adjustments then have to be made by bending down to look under the sterile drapes (wearing a heavy lead apron) making the procedure unsterile (Fig. 30).

Communicate to the radiographer what your expectations are. It is very important to lock the wheels of the C-arm image intensifier once the ‘bull’s-eye position’ has been achieved – clear instructions should be given as to what ‘sagittal rotation’ of the C-arm means and what ‘oblique rotation’ means. A true lateral view may be needed to precisely identify the posterior calyces. As one essentially works with coordinates, the wheels must be locked at all times and lateral movements of the C-arm must be avoided, as that will protract puncture time.
■ Have a flexible cystoscope on standby to extract stones that cannot be accessed with the rigid nephroscope – a laser lithotripter is also useful to have available in addition to the standard ultrasonic lithotripter.
■ Make sure, the ultrasonic lithotripter is working and that the irrigation fluid pump is set up correctly, creating suction and not blowing air into the patient (this may cause air embolism and is a known cause of intra-operative death during PCNL). The hand-piece and working ultrasonic lithotripsy probe must be coupled to each other applying moderate tension with a spanner – the urologist should preferably do this on his/her own.
■ A nephrostomy balloon device should be available in case of severe hemorrhage. Alternatively, a balloon dilator set or Foley’s catheter can be used in an emergency.

Fluoroscopy

The radiation exposure of the patient, urologist and staff is relatively small, but should nevertheless be minimized as far as possible. Cumulative absorbed doses have been linked to malignancies such as leukemia and thyroid cancer. The main principle concerning radiation exposure is contained in the acronym ALARA: As Low As Reasonably Achievable. The maximum permissible exposure per year recommended by the National Council on Radiation Protection in the USA is 5000 mrem or 5 rem.20

Duration of exposure and distance from the X-ray source as well as passive shielding are critical factors. The major contribution to the cumulative radiation dose for urologist and staff is scatter from the patient. Intensity decreases proportionally to the square of the distance from the source. Short-term consequences are few, but long-term risks are significant if exposure continues over a person’s professional lifespan.21 Modern equipment has advantages such as under-table sources, collimation of the beam, last picture-freeze function and memory capability (Fig. 31).

Passive shielding includes a lead apron, thyroid shield and lead glasses. Some aprons are very heavy (up to 7 kg) but newer lead composite aprons can weigh as little as 2.5 kg. All personnel should wear dosimeters.21

The X-ray generating tube should be placed under the table to minimize radiation exposure to the urologist and staff.
Establishing Fluoroscopic-Guided Access to the Collecting System (and Keeping It ...)

Accurate puncturing of the collecting system may appear difficult. However, by adhering to two basic principles (and two procedural steps to make them work) it is possible to perform accurate puncturing in nearly all cases. Be sure to select a posterior calyx – if necessary, do a complete lateral view screening or inject a small volume (2–3 ml) of carbon dioxide or air into a correctly placed ureteric catheter. The time spent to select an appropriate calyx is a good investment in an expeditious procedure. Rushing in to puncture any calyx that seems accessible is not sensible.

**Principle 1:** Get a ‘bull’s-eye view’ on the tip of the targeted calyx (and keep this view for the first few centimetres of needle advancement)

**Principle 2:** Advance the needle to as close as possible to a 90 degree angle to the X-ray bundle (not 90 degrees to the calyx or the X-ray bundle merely in the vertical position).

**Make Principle I Work:**

It is easier to drop a bomb accurately into a target from a low altitude than from high above. A skin incision to get the needle tip closer to the kidney will shorten the distance between the tip and the kidney, which is why a bull’s-eye view can be obtained more easily and accurate entry to the targeted calyx is gained. If the needle needs to bend around a rib, the bull’s-eye position can be considered achieved when the tip of the needle lines up with the hub of the needle. It is probably better to tilt the C-arm sideways, so that a perfect bull’s-eye position can be viewed past the rib – either below or just above the rib. For fluoroscopy-guided puncture, a rigid needle with unbevelled tip should be used to prevent it from going astray, which may occur if a needle with bevelled tip is used, posing the risk of inadvertent damage to vessels encountered along the aberrant trajectory. Once the bull’s-eye view has been created, it may be difficult to maintain due to renal movement during breathing. Two options are available to cope with this situation:

1. The anesthesiologist may control breathing to assist in establishing the puncture – unfortunately a valsalva maneuver displaces the pleura caudally, increasing the risk of iatrogenic puncture.
2. Advance the needle slowly when in the bull’s-eye position, until both the needle and kidney move together during respiration. It is now very important to readjust the orientation of the C-arm until approximately perpendicular to the needle to avoid traversing the calyx and damaging the infundibular vessels. Once the bull’s-eye view has been created properly, an accurate mental note of the direction of the needle should be made – this alignment must be maintained exactly when advancing the needle in the “perpendicular-to-needle view” to avoid missing the calyx in the antero-posterior plane.
Make Principle II Work:

A parallax mistake is the enemy of successful PCNL. Make sure the screening axis is aligned at an angle approximately perpendicular to the needle when advancing it towards the kidney, so as to show the penetration depth of the advancing needle accurately. Often, the needle tip can be seen to indent/bulge the calyx before entering it. The needle should be advanced 2–3 mm into the calyx, but not beyond the calyx. Clear fluid (contrast medium or urine) will drain from the needle, but this may not always be the case in low pressure punctures, so if one is absolutely sure the needle tip is in the correct position, a floppy-tip guide wire may be advanced carefully. If a pelvi-ureteric occlusion balloon catheter is used correctly, clear fluid should always be seen draining from the needle on entry to the collecting system.

The rigid needle with unbevelled tip is suitable for PCNL puncture. A bevelled tip may cause the needle to adopt an aberrant course during advancement.

The bull's eye position can be simulated with the tip of a no. 11 scalpel blade to make an accurate skin incision (a).

The skin incision is made deep enough (through subcutaneous fat, but not through the sheath or muscles) to allow the tip of the puncture needle to be closer to the kidney when the bull's eye view is created (b).

The anesthesiologist can assist the urologist by controlling breathing and the stationary position of the kidney.
Feeding the guide wire is a critical step and it is important not to hold on to the needle when it is in a calyx before the guide wire has been inserted, as movement of the kidney during respiration will cause the needle to become dislodged. A hydrophilic guide wire may be used initially, as it slips more easily into the ureter, but due care must be taken to prevent it from slipping out of the patient just as easily. A second, stiffer working guide wire is placed after preliminary dilatation with a non-disposable nail-type dilator, or a disposable two-lumen hydrophilic 8 French dilator. All possible efforts should be made to have two guide wires in place before dilatation starts – preferably one going down the ureter.

A simple trick to create the bull’s-eye view without using the grasper is to hold the needle with a plastic tube in position (c). Under controlled respiration, the needle is preliminarily advanced for a short distance while staying parallel with the X-ray beam (d, e).
As soon as the kidney and needle move together on the fluoroscopic image, the needle has entered the kidney and the direction of screening must be rotated away to permit accurate control of the penetration depth until the collecting system has been entered.

A nail-type metal dilator is inserted to facilitate subsequent placement of the second guide wire.
Two guide wires are in place, ideally going across the ureteropelvic junction and down the ureter.

A fascia needle (if needed) with the bevel orientated parallel to the ribs to avoid injury to subcostal or intercostal vessels.

Taking time to secure the safety guide wire in place with suture can help to save much time.

Once access to the target calyx has been created, the previously assembled nephroscope should instantly be passed with full irrigation to prevent troublesome blood clots from forming in the collecting system which may obscure vision of the kidney stone.
Ultrasound-Guided Puncture

Percutaneous renal access under fluoroscopy was initially described in 1955, prior to the advent of ultrasound.² It took another twenty years to use this approach for renal stone treatment. Today, many punctures are performed under fluoroscopic control, only. In some countries, this maneuver is considered to be a radiological procedure and therefore relegated to radiologists. A 2003 review revealed that only 11% of urologists obtain renal access for PCNL on their own.²² Since involving a radiologist for the puncture might cause logistical issues, many urologists around the world prefer an ultrasound-guided puncture, which can be done by them in the operating room. In addition, exposure to radiation during fluoroscopy is becoming an increasing concern.²³

Ultrasound probes with puncture attachments are available from various companies. Care should be taken to ensure that adequate percutaneous needle-guidewire equipment be used. In the authors’ experience, metallic devices with a long channel are suited best for that purpose, providing adequate coaxial stability and reducing the risk of an aberrant trajectory. The needle follows the dotted line marking the puncture path on the ultrasound screen and consequently will reach its target. Plastic and self-opening puncture attachments can lead to flawed punctures, which may cause severe bleeding.

The procedure begins with the placement of a ureteric catheter into the renal pelvis. Alternatively, a double-J stent plus a Foley bladder catheter can be inserted. The ureteric catheter or Foley catheter is connected to irrigation fluid to establish and maintain dilated calyces. If the upper urinary tract is already dilated by an obstructing stone, this step is not necessary. The patient is placed in the prone or supine position, depending on the urologist’s preference. If prone, the patient needs some bolstering under the lower chest and at the level of the Iliac crest. Thus, the bowels and viscera tend to fall away and the risk of bowel injury is reduced.

If possible, the table is flexed 30° to 40° to open the space between the 12th rib and the posterior iliac crest. Thereafter the flank area is cleaned and draped. To prepare for the percutaneous access, ultrasound scanning commences posteriorly and proceeds up to the posterior axillary line. Doing this, the first calyx to be seen will be the posterior calyx.⁵ In an orthotopic kidney, the renal pelvis and the lower calyx should be located when scanning parallel to the 12th rib. The dotted line of the scanner focuses the intended puncture line and its target: the renal pelvis behind the calyx to be accessed.

Puncture is accomplished with an 18-gauge needle. Following the dotted line carefully on the screen, its penetration into the collecting system through a papilla can be observed in real time.²⁴ Once the needle and the guide wire are in proper position, the skin is incised with a scalpel to allow dilatation, which follows the same steps as in the other methods to gain access to the collecting system.
Dilating the Access Tract Safely

It is a great advantage if the tip of the guide wire can be advanced across the PUJ to the ureter. Occasionally, this is not possible because the guide wire lodge in the upper pole or has curled up in the calyx punctured, as an impacted stone prevents it from entering into the renal pelvis. It is important that the assistant hold the “tail” of the guide wire in line, because it may twist or flick out in a fraction of a second, wasting minutes or hours.

Extra-renal kinking of the guide wire may render a puncture site unmanageable. This is especially common in lower pole punctures. It is therefore important to keep the tract as straight as possible, and the wire as stiff as possible. A kink in the extra-renal guide wire could indicate that the guide wire has moved out of the collecting system. The C-arm must be used from various angles to confirm the position.

Fascial dilators (not the Amplatz type) were widely used, but as all dilators have to be advanced over a single guide wire, buckling is virtually inevitable. The Amplatz dilators use a long 8 French dilator (over a guide wire) over which all the other dilators are inserted. This is a big advantage compared with fascia dilators, as the 8-French dilator gives more rigidity to the guide wire. A possible disadvantage of these dilators is that shearing forces may cause renal tears if depth is not judged accurately (X-ray beam not perpendicular to the axis of advancement). An advantage of fascia dilators over balloon dilators is that they tear through scar tissue from previous surgery (Fig. 44).

Metal dilators are very efficient in dilating the tract – even when scar tissue is present. The last dilator is often the sheath accommodating the nephroscope which, in turn, unfortunately makes intra-renal pressures higher during the procedure. The tip of the metal dilators is quite sharp, so care must be taken during tract dilatation to prevent iatrogenic damage to the kidney.
Less bleeding may occur with balloon dilators, as the only dilating force is radial expansion. Most probably, less bleeding is also correlated with the level of experience the urologist has gained in the procedure. Amplatz dilators can be used in different sizes, but balloon dilators only in one size (F32). This may become important in cases where multiple punctures have to be done for stones in calyces difficult to access via the pelvis or with a flexible nephroscope. Balloon dilators have the disadvantage that they are not suited to dilate dense scar tissue. A fascia incising needle has shown to be of great value in cutting through scar tissue and facilitating balloon dilatation.

A balloon dilator is passed over the working guide wire and inflated until 16 atmospheres pressure and the access sheath placed with twisting movements under screening to make sure it is not advanced too far, posing the risk of iatrogenic damage to the renal hilum. It is very important to stabilize the balloon while advancing the sheath over it, making sure that the balloon is not dislocated or pulled out of the collecting system.
Removing the Stones

The stones should be fragmented to as few pieces as possible to facilitate removal and minimize migration of fragments which may become trapped in other calyces. Care should be taken not to torque the nephroscope unduly, as this may tear the kidney and cause bleeding – rather use a flexible nephroscope or perform another puncture.

Intracorporeal lithotripters use different energy sources to fragment the stones:

- Ultrasonic lithotripsy is by far the best treatment modality for large and soft stones. The inherent property of the system to fragment calculi while using suction improves vision dramatically and facilitates clearing of blood clots from the collecting system as well. A possible disadvantage is the somewhat complicated set-up. If the pump tubing is not connected properly, insufflation of air rather than suction may be caused, leading to air embolism.
- Electromagnetic-, electrohydraulic or pneumohydraulic devices are useful for small and fairly hard stones.
- Laser lithotripsy is a valuable modality for fragmenting remote lower or upper pole stones via a flexible nephroscope.

The irrigation fluid must be controlled to reduce fragment migration to inaccessible calyces. During stone extraction particular care must be taken to prevent the guide wire from being pulled out inadvertently (Figs. 48–50).
PCNL in Supine Position

This technique was first described in Spanish by Valdivia Uria et al. in 1987 and has not until recently been used more widely. Keeping the patient in the supine position may be more favourable for airway protection, less time-consuming in set-up and is supposed to facilitate establishing a ureteroscopic access. To have ureteroscopic access can help to reduce the number of punctures needed because calyceal stones can be manipulated with relative ease.

Other purported advantages of supine PCL seem to be reduced occupational loads because there is scarcely a need to lift or turn the patient, less risk of pressure damage to, e.g., the eyes, and reduced costs as only one draping is required with a normal (un-armoured) less expensive endotracheal tube. The surgeon is in the sitting position next to the patient. There may be less radiation to the surgeons hands. For patients with cardiac risk factors, the supine position seems to be ‘first choice’ as venous return is impeded in the prone position involving the potential risk of lethal outcomes in case a sudden cardiac arrest emergency occurs.

Renal stones can clear under gravity via the puncture tract as access is gained from below the kidney. The intra-renal pressures obtained may be less than in prone PCNL. The risk of colonic injury should be similar if renal access is from posterior to the posterior axillary line.

However, if pure fluoroscopic puncture is used, a bull's-eye sign cannot be created in the supine position. This will lead to multiple passes in one dimension which involves known complications. The use of ultrasound in addition to fluoroscopy is mandatory to perform safe punctures in the supine position. Another drawback is that the kidney may also be excessively mobile in this position migrating medially under the force of dilators. This can dramatically reduce the angles accessible by the nephroscope making ureteroscopic access or extra punctures necessary. The nephroscope may also clash with the bottom part of the operating table making the procedure more difficult. Air bubbles accumulating in the kidney may also become a source of trouble that needs to be dealt with.

The prone position may not be as easy as it appears. Whichever position the surgeon choose for PCNL, it is important that he/she becomes an expert for that position.

Complications of PCNL

Despite the much smaller scar compared with open nephrolithotomy, complications of PCNL occur in more than 25% of cases. However, with increased experience, a steep decline in the complication rate has been reported – in one study falling from 61% to 3.7%. The question is whether formal training for PCNL is adequate in the centers across the world implementing this procedure.

Hemorrhage

The incidence of severe hemorrhage requiring blood transfusion after PCNL varies from 0.04% to 11%. Blood loss is a common occurrence during PCNL as the kidney is a highly vascular organ. Especially, puncture sites located far medial, multiple punctures and abnormal renal anatomy are risk factors for increased bleeding. Around 1% of cases need angiographic embolization after PCNL. The cause is usually arteriovenous fistulae or pseudoaneurysms breaking through into the collecting system. Renal vein injury can be treated with tamponade by an open-ended Foley-type balloon catheter. Most mild forms of bleeding will settle after routine placement of a
20–24 Fr. nephrostomy tube. If this fails, a Kaye balloon device can be inflated in the tract. This has a larger-bore nephrostomy lumen and allows drainage of urine. If this is not available, the used balloon dilator can be re-inflated in the tract over a guide wire. The balloon can be carefully deflated after 24 hours, and re-inflated, if needed. Persistent bleeding (acute or delayed) will necessitate angiography and superselective renal artery embolization.

Prevention of bleeding is most important: Balloon dilators have been shown to cause less bleeding than telescopic dilators or fascia dilators. However, this may also be related to experience, as medial encroachment during repeated tract dilatation can be avoided with careful and correctly angled fluoroscopy. Balloon dilators become less effective when used for multiple punctures and to use a new balloon for each puncture is costly. In these situations, Amplatz dilators are very useful, as they come with three working sheaths that can be rotated as necessary during PCNL for large stones (Fig. 51).

**Injury to the Renal Pelvis**

This usually stems from pushing the stone into and through the renal pelvis during lithotripsy, or aggressive passage of dilators with incorrect X-ray beam angulation, making a parallax mistake on advancement of the dilators. If dilatation occurs on a misguided wire, the tear in the pelvis can be large. Tears can also occur due to kinking of the guide wire leading the dilator away from the tract. The incidence of kinks and tears is higher in lower pole punctures, as the kidney is rotated upwards and inwards when the dilator makes contact with the renal capsule. If a perforation occurs, the operator must have a low threshold to stop the procedure.

**Fluid Absorption**

Patients with venous or collecting system injury must be carefully monitored for volume overload. TUR syndrome during PCNL presents in the same way as in other situations. Early recognition of the problem is important, because convulsions or cardiac arrest are difficult to manage with the patient in the prone position. Signs of volume overload and dilutional hyponatremia must be sought actively and serum sodium checked in prolonged cases.

**Injury to Pleural Cavity**

Subcostal punctures have the lowest rate of pleural complications and intercostal punctures the highest. Pneumothorax rates vary from 0 to 4%. Pleural effusion rates vary from 0–8% for intercostal punctures. An intercostal chest drain can easily be placed intra-operatively, if needed. Post-operative chest X-ray is deemed necessary in all patients who had intercostal punctures.

The following recommendations can help to reduce the risk of pleural injury:

- Puncture during expiration.
- Anesthesiologist must keep the lung in expiration and ventilate gently with small tidal volumes.
- Tracts planned in the 10th or 11th intercostal space, should always be lateral to the midscapular line - established in expiration.
- Tracts should be kept to the minimum needed size.
- Use of an Amplatz sheath in all patients reduces the risk of pleural effusion.
- A sharp costophrenic angle on fluoroscopy at the end of the procedure is indicative of no significant injury.
- Early diagnosis and treatment (intercostal chest drain) may prevent complications such as empyema.
Bowel Perforation

Colonic perforation occurs in less than 1% of cases.\textsuperscript{34} A retro-renal colon is present in 0.6% of patients lying supine and 1.9% of patients lying prone.\textsuperscript{13, 35} A retro-renal colon can be expected in thin females, renal fusion abnormalities and those with extensive bowel surgery, specifically jejuno-ileal surgery and horseshoe kidney.\textsuperscript{12, 36} If the perforation is extraperitoneal, it can be treated conservatively. Care must be taken to separate the urinary and faecal streams, therefore a double-J ureteric stent is needed in all cases and the nephrostomy tube is retracted under fluoroscopic guidance into the colon.

Duodenal perforation has been described and diagnosed on nephrostogram. Conservative management is advocated, with parenteral feeding.\textsuperscript{37}

Injury to the Liver or Spleen

This type of injury is uncommon given the absence of organomegaly. In cases of splenomegaly CT-guided nephrostomy may be needed. Splenic injury usually requires surgical exploration and splenectomy. Liver injuries are less common than splenic injuries.\textsuperscript{11}

Sepsis

Severe urinary sepsis after PCNL has a low incidence (0.3% to 1%) but a high mortality (66%–80%).\textsuperscript{38, 39} Post-operative fever occurs in about 33% of cases and has to be observed carefully to exclude urosepsis.\textsuperscript{39}

The majority of patients managed with PCNL have infection stones, which make up 15% of renal calculi in industrialized countries.\textsuperscript{40} Bacteria are inherently part of these stones, as they protect themselves from antibiotic eradication by producing biofilms.\textsuperscript{41}

Risk factors contributing to urosepsis after PCNL are:

- Infected stones
- Indwelling catheters
- Urinary tract obstruction
- Immunosuppression
- Renal failure
- Voiding dysfunction
- Urine diversion
- Extreme age
- Female gender

Patients should have urine cultured pre-operatively, and in the case of non-eradication culture-specific antibiotics should be started a week before surgery.\textsuperscript{42} Septic complications have a significantly lower rate in patients receiving a week of wide spectrum antibiotic treatment prior to PCNL compared with those subjected only to perioperative antibiotic prophylaxis at the start of the procedure.\textsuperscript{43}
Appendix

Operating Room Setup for Left and Right PCNL

Right Prone PCNL

- Dripstand for nephroscope
- Camera unit
- C-arm
- C-arm monitor

Anesthesiologist (as far as possible)

(Assistant)

Surgeon

Scrub Assistance

Tray Tray Tray

Ultrasonic lithotripter unit

Left Prone PCNL

- Dripstand for nephroscope
- Camera unit
- C-arm
- C-arm monitor

Ultrasonic lithotripter unit

Anesthesiologist (as far as possible)

(Assistant)

Surgeon

Scrub Assistance

Tray Tray Tray
References

1. RUPEL E, BROWN R: Nephroscopy with removal of stone following nephrostomy for obstructive calculous anuria. J Urol. 1941 (46); 177 – 82.


Percutaneous Nephroscopes
with Continuous Irrigation and Suction

Length 19 cm

ALKEN-HOHENFELLNER Recommended Set

- **27092 AMA**  
  **HOPKINS® Wide-Angle Straight Forward Telescope 6°,**  
  with parallel eyepiece, **autoclavable,**  
  fiber optic light transmission incorporated with working channel,  
  with Luer-Lock connection for inflow,  
  color code: green-yellow  
  or  

- **27093 AA**  
  **HOPKINS® Wide-Angle Straight Forward Telescope 6°,**  
  with angled eyepiece, **autoclavable,**  
  fiber optic light transmission incorporated with working channel,  
  with Luer-Lock connection for inflow,  
  color code: green-yellow

- **27090 A**  
  **Telescope Bougie Set,** including 6 dilation sleeves  
  9, 12, 15, 18, 21 and 24 Fr.,  
  with 2 rigid guide wires and 2 flexible guide wires

- **27090 AH**  
  **Dilator,** 27 Fr., for use with telescope bougie set

- **27090 AJ**  
  **Same,** 30 Fr.

It is recommended to check the suitability of the product for the intended procedure prior to use.
Percutaneous Nephroscope
with Continuous Irrigation and Suction

Length 19 cm

Sheaths for continuous irrigation and suction

27093 BD Operating Sheath, 26 Fr., for continuous irrigation and suction, with Luer-Lock stopcock, rotating, color code: black-yellow

27093 ON Hollow Obturator and Fascial Dilator, color code: black

27093 CD Operating Sheath, 24 Fr., for continuous irrigation and suction, with Luer-Lock stopcock, rotating, color code: white-yellow

27093 OC Hollow Obturator and Fascial Dilator, color code: white

27093 GM Adaptor, for use with PCN sheaths, for introducing flexible cysto-urethroscopes through a PCN sheath

27093 GN Adaptor, for use with resectoscope outer sheaths and PCN sheaths in conjunction with evacuators and bladder syringes
**Percutaneous Nephroscopes**

*with Continuous Irrigation and Suction*

Length 25 cm

**ALKEN-HOHENFELLNER Recommended Set**

- **27292 AMA**
  - **HOPKINS® Wide-Angle Straight Forward Telescope 6°,** with parallel eyepiece, **autoclavable,** fiber optic light transmission incorporated with working channel, with Luer-Lock connection for inflow, color code: green-red
  - or

- **27293 AA**
  - **HOPKINS® Wide-Angle Straight Forward Telescope 6°,** with angled eyepiece, **autoclavable,** fiber optic light transmission incorporated with working channel, with Luer-Lock connection for inflow, color code: green-red

- **27290 A**
  - **Telescope Bougie Set,** including 6 dilation sleeves 9, 12, 15, 18, 21 and 24 Fr., with 2 rigid guide wires and 2 flexible guide wires

- **27290 AH**
  - **Dilator,** 27 Fr., for use with Telescope Bougie Set 27290 A

- **27290 AJ**
  - **Same,** 30 Fr.
Percutaneous Nephroscope
with Continuous Irrigation and Suction

Length 25 cm
Sheaths for continuous irrigation and suction

27293 BD  Operating Sheath, 26 Fr., for continuous irrigation and suction, with Luer-Lock stopcock, rotating, color code: black-red

27293 BL  Hollow Obturator and Fascial Dilator, color code: black-red

27293 BD  Operating Sheath, 24 Fr., for continuous irrigation and suction, with Luer-Lock stopcock, rotating, color code: white-red

27293 CL  Hollow Obturator and Fascial Dilator, color code: white-red

27093 GM  Adaptor, for use with PCN sheaths, for introducing flexible cysto-urethoscopes through a PCN sheath

27093 GN  Adaptor, for use with resectoscope outer sheaths and PCN sheaths in conjunction with evacuators and bladder syringes

27040 LB  Adaptor, for use with Telescopes 27293 AA and 27292 AMA with resectoscope outer sheaths of 27040 SL/SD and 27050 SL

27040 SC  Adaptor, for use with Telescopes 27293 AA and 27292 AMA with resectoscope outer sheaths of 27050 SC/SD
Operating Instruments
for Percutaneous Removal of Kidney Stones,
with Continuous Low Pressure Irrigation and Suction

ALKEN-HOHENFELLNER Recommended Set

Length 38 cm, color code: red-black,
for use with Percutaneous Nephroscopes 27292 AMA, 27293 AA, 27092 AMA and 27093 AA

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 DL  Biopsy Forceps, single action jaws,
with ring handle, 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,
double action jaws, 10.5 Fr., length 38 cm,
color code: red-black

27290 SA  Scissors, single 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

27294 Y  Suction Tube, 12 Fr., length 38 cm,
color code: red-black

27290 LL  LASER Suction Tube, with micro manipulator for precise positioning
of the LASER fiber, 12 Fr., length 40 cm

including:
27290 LA  Outer Sheath
27290 LI  Micromanipulator, with LASER guidance
Percutaneous Nephroscopes, “Slender” Model
for Percutaneous Removal of Kidney Stones

18/22 Fr., length 24 cm

- **HOPKINS® Wide-Angle Straight Forward Telescope 6°**
  - 18 Fr., with parallel eyepiece, autoclavable,
  - fiber optic light transmission incorporated with 13.7 Fr. working channel,
  - with Luer-Lock connector for inflow,
  - color code: green-blue

- **HOPKINS® Wide-Angle Straight Forward Telescope 6°**
  - 18 Fr., with angled eyepiece, autoclavable,
  - fiber optic light transmission incorporated with 13.7 Fr. working channel,
  - with Luer-Lock connector for inflow,
  - color code: green-blue

- **Telescope Bougie Set**, including 5 dilation sleeves
  - 9, 12, 15, 18 and 20 Fr., 2 rigid guide wires,
  - 2 flexible guide wires and 1 protective tube

- **Operating Sheath**, 22 Fr., for continuous irrigation and suction,
  - with Luer-Lock stopcock, rotating,
  - color code: blue

- **Hollow Obturator and Fascial Dilator**, color code: blue

- **Adaptor**, for use with PCN sheaths,
  - for introducing flexible cysto-urethroscopes through a PCN sheath

- **Adaptor**, for use with resectoscope outer sheaths and PCN sheaths in conjunction with evacuators and bladder syringes

- **Adaptor**, for use with Telescopes 27294 AA, 27295 AA with standard 24/26 Fr. resectoscope sheaths
Operating Instruments
for Percutaneous Removal of Kidney Stones

7 Fr., length 40 cm, to be used through the working channel with simultaneous irrigation with HOPKINS® Telescopes 27294 AA/27295 AA

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<th>Item</th>
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<td>27035 L</td>
<td>Biopsy Forceps, semirigid, double action jaws, 7 Fr., length 40 cm</td>
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<tr>
<td>27035 F</td>
<td>Grasping Forceps, semirigid, double action jaws, 7 Fr., length 40 cm</td>
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Length 38 cm, color code: red-black, for use through the working channel with HOPKINS® Telescopes 27294 AA/27295 AA

<table>
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<td>27290 K</td>
<td>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</td>
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<tr>
<td>27290 M</td>
<td>Forceps, for grasping larger stones and stone fragments, with serrated jaws and ring handle, double action jaws, 10.5 Fr., length 38 cm, color code: red-black</td>
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<tr>
<td>27290 SA</td>
<td>Scissors, single action jaws, 10.5 Fr., length 38 cm, color code: red-black</td>
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<td>27294 S</td>
<td>Knife, straight, with 3-ring-handle, 10.5 Fr., length 38 cm, color code: red-black</td>
</tr>
<tr>
<td>27294 SK</td>
<td>Knife only</td>
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<tr>
<td>27294 SH</td>
<td>Knife, sickle-shaped, with 3-ring handle, 10.5 Fr., length 38 cm, color code: red-black</td>
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<td>27294 SB</td>
<td>Knife only</td>
</tr>
</tbody>
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Video Cysto-Urethroscopes
with CCD chip technology

Special Features:
- 6.5 Fr. working channel
- Sterilizable via EtO and FO gas, Steris® and Sterrad®
- Easy to handle without requiring an additional light cable and camera head

Expanded PDD version 11272 VPI/VNIU:
- Equipped with special PDD filter for use in white light mode as well as photodynamic diagnosis
- Early recognition of tumors due to better visualization of, among others, carcinoma in situ
- Integrated suction unit drains the bladder faster
- For use with the high-performance light source D-LIGHT C/AF
Video Cysto-Urethroscopes
with CCD chip technology

16 Fr.

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Expanded PDD version

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Following accessories are included in delivery:

- 27677 VC  **Case**
- 27023 FE  **Grasping Forceps for small fragments**, single action jaws, flexible, 5 Fr., length 73 cm
- 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
- 20213070  **Video Connecting Cable**

Optional accessories:

- 27023 VK  **Stone Basket**, 5 Fr., length 60 cm
- 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**
CALCULASE II SCB
LASER System for Endoscopic Stone Therapy and Soft Tissue Treatment

20 Watt LASER Power
The brand CALCULASE II SCB stands for a cost-effective and efficient Holmium: YAG LASER system for endoscopic LASER lithotripsy.

Soft Tissue Treatment
The system can be used for, among others, soft tissue treatment such as ureteropelvic junction stenosis and ablation of urethral carcinoma.

Diverse LASER Fibers and Instruments
KARL STORZ offers LASER fibers in various sizes (230, 365 and 600 µm) for both single and multiple use. Together with its wide range of rigid and flexible uretero-renoscopes equipped with fiber optic and sensor technology, KARL STORZ offers the ideal complete solution for stone therapy and soft tissue treatment.

Automatic Fiber Detection
This feature enables automatic adjustment of energy settings to the fiber sizes and, consequently, prevents damage to the fibers or the unit itself.

Mobility
Its compact design makes CALCULASE II SCB a very versatile and mobile system. Thanks to its innovative handles, the LASER system can easily be placed on the urological equipment cart and moved from one OR to the next.
Alternatively, the LASER system can be placed on an equipment cart specially designed for this purpose and transported as required.
CALCULASE II SCB
LASER System for Endoscopic Stone Therapy and Soft Tissue Treatment

LASER System for the Treatment of Bladder, Ureter and Kidney Stones and for opening stenoses/strictures as well as tumor ablations

Special Features:
- Extremely fast lithotripsy
  - High success rate independent of stone composition
  - Rapid stone destruction
  - Lithotripsy under endoscopic control
- 20 Watt for effective and precise treatment:
  Precise cutting effect in the case of stenoses:
  - Individually selectable parameters (pulse frequency and intensity)
  - Least possible tissue damage
- Automatic fiber detection:
  - High user-friendliness
  - Automatically controlled energy output
  - Increased safety

Special design:
- Mobile desktop housing
- Integrated low-noise cooling system
- For use on endoscopic equipment carts
- Green pilot laser: Good visibility even in challenging situations
- For use with rigid, semiflexible and flexible endoscopes
- With connection possibilities to the KARL STORZ Communication Bus (KARL STORZ-SCB)
**CALCULASE II SCB**
Holmium LASER System for Endoscopic Stone Therapy
and Soft Tissue Treatment, Recommended System Configuration

Please note: Each lithotripsy system requires a separate basic fiber set: 27 7502 87 or 27 7502 86.

### Parameters for 230 µm Fibers

<table>
<thead>
<tr>
<th>Energy (J)</th>
<th>4 Hz (W)</th>
<th>6 Hz (W)</th>
<th>8 Hz (W)</th>
<th>10 Hz (W)</th>
<th>15 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 J</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>–</td>
</tr>
<tr>
<td>0.8 J</td>
<td>3.2</td>
<td>4.8</td>
<td>6.4</td>
<td>8</td>
<td>–</td>
</tr>
<tr>
<td>1.2 J</td>
<td>4.8</td>
<td>7.2</td>
<td>9.6</td>
<td>12</td>
<td>–</td>
</tr>
<tr>
<td>1.7 J</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>2 J</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

### Parameters for 365 µm and 600 µm Fibers

<table>
<thead>
<tr>
<th>Energy (J)</th>
<th>4 Hz (W)</th>
<th>6 Hz (W)</th>
<th>8 Hz (W)</th>
<th>10 Hz (W)</th>
<th>15 Hz (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 J</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>7.5</td>
</tr>
<tr>
<td>0.8 J</td>
<td>3.2</td>
<td>4.8</td>
<td>6.4</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>1.2 J</td>
<td>4.8</td>
<td>7.2</td>
<td>9.6</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>1.7 J</td>
<td>6.8</td>
<td>10.2</td>
<td>13.6</td>
<td>17</td>
<td>–</td>
</tr>
<tr>
<td>2 J</td>
<td>8</td>
<td>12</td>
<td>16</td>
<td>20</td>
<td>–</td>
</tr>
</tbody>
</table>

Parameter settings are selected via the LASER fiber code.
CALCULATE II SCB
System Components

UNIT SIDE

PATIENT SIDE

Video Uretero-Renoscopes FLEX-Xc IMAGE1 S/FLEX-Xc

CALCULATE II Fiber

Uretero-Renoscope

LASER Suction Tube

Percutaneous Nephroscope

One-Pedal Footswitch

27750124

27750271

27290 LL

27292 AMA/27293 AA/27092 AMA/27093 AA

11278 VS/VSU/VSU

27001 L/K
CALCULASE II SCB
Accessories

**Fiber Sets, reusable**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>277502 71-P6</td>
<td>CALCULASE II Fiber 230 µm, reusable, sterile, length 300 cm, package of 6</td>
</tr>
<tr>
<td>277502 72-P6</td>
<td>CALCULASE II Fiber 365 µm, reusable, sterile, length 300 cm, package of 6</td>
</tr>
<tr>
<td>277502 73-P6</td>
<td>CALCULASE II Fiber 600 µm, reusable, sterile, length 300 cm, package of 6</td>
</tr>
</tbody>
</table>

**Fiber Sets, for single use**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>277502 77-P6</td>
<td>CALCULASE II Fiber 230 µm, for single use, sterile, length 300 cm, package of 6</td>
</tr>
<tr>
<td>277502 78-P6</td>
<td>CALCULASE II Fiber 365 µm, for single use, sterile, length 300 cm, package of 6</td>
</tr>
<tr>
<td>277502 79-P6</td>
<td>CALCULASE II Fiber 600 µm, for single use, sterile, length 300 cm, package of 6</td>
</tr>
</tbody>
</table>

**CALCULASE II Fiber Kit**

- Including:
  - 3x CALCULASE II Fiber 230 µm, reusable
  - 3x CALCULASE II Fiber 365 µm, reusable
  - 3x CALCULASE II Fiber 600 µm, reusable

**Additional Accessories**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>277500 82</td>
<td>Fiber Cutter</td>
</tr>
<tr>
<td>277500 81</td>
<td>Fiber Stripper</td>
</tr>
<tr>
<td>277502 80</td>
<td>Fiber Stripper Set, sterilizable, for use with CALCULASE II fibers</td>
</tr>
<tr>
<td></td>
<td>including: Holder, Ceramic Knife, Fiber Stripper 230, 365 and 600 nm</td>
</tr>
<tr>
<td>277500 95</td>
<td>Safety Goggles Ho:YAG Laser, 2080 nm</td>
</tr>
</tbody>
</table>

The CALCULASE II fibers above are compatible with the previous model CALCULASE (277501 20-1).
CALCULASE II SCB Equipment Cart

Special Features:
- Flexible use of CALCULASE II SCB 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, smooth-running and antistatic dual wheels
- Powder-coated panels and shelves meet the most stringent quality and hygiene standards

Equipment Cart, wide, small, rides on 4 antistatic dual wheels equipped with locking brakes, mains switch on cover, energy beam with integrated electrical subdistributors with 6 sockets, grounding plugs,
Dimensions: Equipment cart: 830 x 1265 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, small
- Shelf, wide
- 2x Drawer Unit with Lock, wide
- 2x Equipment Rail, long
CALCUSON
Ultrasonic Lithotripsy System,
Recommended Standard Set Configuration

Special Features:
- Ultrasonic lithotripsy system with automatically controlled generator for maximum power output, working frequency approx. 26,000 Hz
- Enhanced patient safety

- Easy to use
- Optimal power output
- High effectiveness

27 610001 CALCUSON Ultrasonic Generator Set,
power supply 100 – 120 VAC/200 – 240 VAC, 50/60 Hz
including:
Mains Cord
One-Pedal Footswitch
Transducer
Connecting Cable (transducer/generator)
Protection Sleeve, for storage and sterilization of probes
Cleaning Rod, for probes
Wrench, for probes

Specifications:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working frequency</td>
<td>approx. 26,000 Hz</td>
</tr>
<tr>
<td>Power supply</td>
<td>110-120 VAC/200-240 VAC, 50/60 Hz</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
<td>305 x 110 x 260 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>3.7 kg</td>
</tr>
<tr>
<td>Certified to</td>
<td>IEC 60601-1, CE acc. to MDD</td>
</tr>
</tbody>
</table>
## Accessories for CALCUSON

### Ultrasonic Lithotripsy Probes for use with Transducer 27610030

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Diameter</th>
<th>Length</th>
<th>Further Details</th>
<th>for use with</th>
</tr>
</thead>
<tbody>
<tr>
<td>27425 NK</td>
<td>1.5 mm</td>
<td>47 cm</td>
<td>without oscillating tip, with suction channel</td>
<td>Ureteroscope 27002 K</td>
</tr>
<tr>
<td>27425 NL</td>
<td>1.5 mm</td>
<td>57 cm</td>
<td>without oscillating tip, with suction channel</td>
<td>Uretero-Renoscope 27002 L</td>
</tr>
<tr>
<td>27830 KN</td>
<td>1.5 mm</td>
<td>37 cm</td>
<td></td>
<td>Nephroscope for MIP M 27830 KA</td>
</tr>
<tr>
<td>27095 LK</td>
<td>1.8 mm</td>
<td>32 cm</td>
<td>with oscillating tip and suction channel</td>
<td>HOPKINS® Telescope 27095 AA in combination with Operating Sheath 27095 B</td>
</tr>
<tr>
<td>27093 LM</td>
<td>3 mm</td>
<td>40 cm</td>
<td>with oscillating tip and suction channel</td>
<td>HOPKINS® Telescopes 27294 AA, 27295 AA and Operating Sheath 27294 B and Nephroscope for MIP L 27840 KA</td>
</tr>
<tr>
<td>27093 OM</td>
<td>3 mm</td>
<td>40 cm</td>
<td>without oscillating tip, with suction channel</td>
<td></td>
</tr>
<tr>
<td>27093 LL</td>
<td>3.5 mm</td>
<td>40 cm</td>
<td>with oscillating tip and suction channel</td>
<td>HOPKINS® Telescopes 27292 AMA, 27293 AA and Operating Sheaths 27293 BD/CD</td>
</tr>
<tr>
<td>27093 OL</td>
<td>3.5 mm</td>
<td>40 cm</td>
<td>without oscillating tip, with suction channel</td>
<td></td>
</tr>
<tr>
<td>27093 LK</td>
<td>3.5 mm</td>
<td>30 cm</td>
<td>with oscillating tip and suction channel</td>
<td>HOPKINS® Telescopes 27092 AMA, 27093 AA and Operating Sheaths 27093 BD/CD</td>
</tr>
<tr>
<td>27093 OK</td>
<td>3.5 mm</td>
<td>30 cm</td>
<td>without oscillating tip, with suction channel</td>
<td></td>
</tr>
</tbody>
</table>
ENDOMAT® LC SCB
Roller Pump – Suction System,
Recommended Standard Set Configuration,
for use with CALCUSON

Special Features:
- Simple roller pump system, flow-regulated, for suction. To improve visibility during suction, the second level of Footswitch 20 0142 30 can be used to activate a flow between 500 and 1000 ml/min.
- SCB model with connections to the KARL STORZ Communication Bus (KARL STORZ-SCB)

27330301-1 ENDOMAT® LC SCB,
suction pump, power supply 100 – 240 VAC, 50/60 Hz
including:
- SCB Connecting Cable, length 100 cm
- Suction Bottle, 0.5 l, sterilizable
- Silicone Tubing Set, for suction, sterilizable, for use with suction bottle
- Bottle Cap, for suction bottle
- Bottle Stand, for suction bottle
- Connecting Cable

Optional accessory
for use with ENDOMAT® LC SCB with CALCUSON:
031247-10* Tubing Set, for suction, for single use, sterile, package of 10

Specifications:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suction flow</td>
<td>regulated: 0-1000 (ml/min)</td>
</tr>
<tr>
<td>Suction pressure</td>
<td>non-regulated: -0.46 (-46 kPa) bar</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
<td>305 x 110 x 260</td>
</tr>
<tr>
<td>Weight</td>
<td>4.5 kg</td>
</tr>
<tr>
<td>Power supply</td>
<td>100-240 VAC, 50/60 Hz</td>
</tr>
<tr>
<td>Certified to</td>
<td>IEC 601-1, CE acc. to MDD</td>
</tr>
</tbody>
</table>

*mtp medical technical promotion gmbh,
Take-Off GewerbePark 46, 78579 Neuhausen ob Eck, Germany
### Accessories for ENDOMAT® LC SCB

<table>
<thead>
<tr>
<th>Code</th>
<th>Item Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20300482</td>
<td>Connector Set, for ENDOMAT® LC, for use with Silicone Tubing Sets 20330340, 20330341 and 20330343</td>
</tr>
<tr>
<td>20330393</td>
<td>Pump Tube, sterilizable, package of 25</td>
</tr>
<tr>
<td>20014230</td>
<td>One-Pedal Footswitch, digital, two-stage</td>
</tr>
<tr>
<td>20090370</td>
<td>SCB Connecting Cable, length 60 cm</td>
</tr>
<tr>
<td>20300051</td>
<td>Suction Bottle, 0.5 l, sterilizable</td>
</tr>
<tr>
<td>20300039</td>
<td>Bottle Cap, for Suction Bottle 20300051</td>
</tr>
<tr>
<td>20300231</td>
<td>Bottle Stand, for Suction Bottle 20300051</td>
</tr>
<tr>
<td>20330342</td>
<td>Silicone Tubing Set, for suction, sterilizable, for use with Suction Bottle 20300051</td>
</tr>
</tbody>
</table>
UROMAT E.A.S.I.® SCB

Special Features:
- Effective suction of tissue fragments
- Control/activation of both units via a one-pedal footswitch
  1. step = pump activation; suctioning of tissue fragments
  2. step = activation of morcellator while pump is activated
- Adjustable constant pressure inside the bladder during morcellation for greater patient safety
- With connection possibilities to KARL STORZ Communication Bus (KARL STORZ-SCB)

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

**Specifications:**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow-regulated</td>
<td>depending on mode</td>
</tr>
<tr>
<td>Irrigation pressure</td>
<td>adjustable 20-200 mmHg</td>
</tr>
<tr>
<td>Suction</td>
<td>100-1800 ml/min suction power</td>
</tr>
<tr>
<td>Power supply</td>
<td>100-240 VAC, 50/60 Hz</td>
</tr>
<tr>
<td>Dimensions</td>
<td>447 x 155 x 313 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>8.8 kg</td>
</tr>
<tr>
<td>Certified to</td>
<td>IEC 60601-1, CE acc. to MDD</td>
</tr>
</tbody>
</table>

* mtp medical technical promotion gmbh,
  Take-Off GewerbePark 46, 78579 Neuhausen ob Eck, Germany
The combined use of CALCUSON and ENDOMAT® LC SCB as a suction pump and UROMAT E.A.S.I.® as a suction/irrigation pump is recommended.
## Accessories for use with CALCUSON

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>UP 003</td>
<td><strong>Silicone Tubing Set</strong>, for suction, sterilizable, for use with UROMAT E.A.S.I.* SCB and CALCUSON</td>
</tr>
<tr>
<td>20014230</td>
<td><strong>One-Pedal Footswitch</strong>, digital, two-stage</td>
</tr>
<tr>
<td>20300051</td>
<td><strong>Suction Bottle</strong>, 0.5 l, sterilizable</td>
</tr>
<tr>
<td>20300039</td>
<td><strong>Bottle Cap</strong>, for Suction Bottle 20300051</td>
</tr>
<tr>
<td>UP 011</td>
<td><strong>Bottle Holder</strong>, for Suction Bottle 20300051</td>
</tr>
</tbody>
</table>
With its new FULL HD camera platform IMAGE1 S, KARL STORZ once again sets a new milestone in endoscopic imaging, consolidating their reputation as an innovation leader in minimally invasive surgery. IMAGE1 S provides users with versatile visualization options for surgery and diagnosis.

Special Features:
- Dashboard: Overview with intuitive user guidance
- Live menu: User-friendly and customizable menu bar
- Intelligent icons: The graphic representation changes as soon as settings are modified in the connected units
- Automatic light source control
- Side-by-side view: Parallel display of standard image and the Visualization mode
- Multiple source control: Picture-in-Picture function enables the simultaneous display of image information from two connected image sources, e.g., for hybrid procedures

**IMAGE1 S Camera System**

**Modular camera control system**

**IMAGE1 S camera heads**

**Dashboard**

**Live menu**

**Intelligent icons**

**Renal collecting system in side-by-side view**
Brilliant Imaging in FULL HD
IMAGE1 S delivers excellent imaging for both flexible and rigid endoscopy. The IMAGE1 S system provides true-to-life color reproduction and impresses with a natural color rendition.

CLARA and CHROMA
IMAGE1 S offers the possibility of combining both the CLARA and CHROMA technologies. In this mode, the image is uniformly illuminated by CLARA and the tissue structures are clearly defined by CHROMA.

SPECTRA A*
In SPECTRA A*, spectral filtering of the red hues takes place. The resulting color change is due to spectral color shifts. The contrast of structures, such as blood vessels in mucosa, is seen with a green-blue tint.

SPECTRA B**
SPECTRA B** reduces reds and intensifies the green-blue spectral component. The background appears greenish so that blood vessels and capillaries are highlighted. The user maintains a large amount of the natural color perception.

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

<table>
<thead>
<tr>
<th>Feature</th>
<th>TC 200EN*</th>
</tr>
</thead>
<tbody>
<tr>
<td>HD video outputs</td>
<td>- 2x DVI-D</td>
</tr>
<tr>
<td></td>
<td>- 1x 3G-SDI</td>
</tr>
<tr>
<td>Format signal outputs</td>
<td>1920 x 1080p, 50/60 Hz</td>
</tr>
<tr>
<td>LINK video inputs</td>
<td>3x</td>
</tr>
<tr>
<td>USB interface</td>
<td>4x USB, (2x front, 2x rear)</td>
</tr>
<tr>
<td></td>
<td>2x 6-pin mini-DIN</td>
</tr>
<tr>
<td>Power supply</td>
<td>100–120 VAC/200–240 VAC</td>
</tr>
<tr>
<td>Power frequency</td>
<td>50/60 Hz</td>
</tr>
<tr>
<td>Protection class</td>
<td>I, CF-Defib</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
<td>305 x 54 x 320 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>2.1 kg</td>
</tr>
</tbody>
</table>

**For use with IMAGE1 S**

**IMAGE1 S CONNECT Module TC 200EN**

TC 300

**IMAGE1 S H3-LINK**, link module, for use with IMAGE1 FULL HD three-chip camera heads, 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:**

<table>
<thead>
<tr>
<th>Feature</th>
<th>TC 300 (H3-Link)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supported camera heads/video endoscopes</td>
<td>TH 100, TH 101, TH 102, TH 103, TH 104, TH 106 (fully compatible with IMAGE1 S)</td>
</tr>
<tr>
<td></td>
<td>22220055-3, 22220056-3, 22220053-3, 22220060-3, 22220061-3, 22220054-3, 22220055-3 (compatible without IMAGE1 S technologies CLARA, CHROMA, SPECTRA*)</td>
</tr>
<tr>
<td>LINK video outputs</td>
<td>1x</td>
</tr>
<tr>
<td>Power supply</td>
<td>100–120 VAC/200–240 VAC</td>
</tr>
<tr>
<td>Power frequency</td>
<td>50/60 Hz</td>
</tr>
<tr>
<td>Protection class</td>
<td>I, CF-Defib</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
<td>305 x 54 x 320 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>1.86 kg</td>
</tr>
</tbody>
</table>

* **SPECTRA A**: Not for sale in the U.S.
** **SPECTRA B**: Not for sale in the U.S.
**IMAGE1 S Camera Heads**

For use with IMAGE1 S Camera System
IMAGE1 S CONNECT Module TC 200EN, IMAGE1 S H3-LINK Module TC 300
and with all IMAGE1 HUB™ HD Camera Control Units

**TH 100**

**IMAGE1 S H3-Z Three-Chip FULL HD Camera Head**, 50/60 Hz, IMAGE1 S compatible, progressive scan, soakable, gas- and plasma-sterilizable, with integrated Parfocal Zoom Lens, focal length f = 15–31 mm (2x), 2 freely programmable camera head buttons, for use with IMAGE1 S and IMAGE1 HUB™ HD/HD

**TH 103**

**IMAGE1 S H3-P Three-Chip FULL HD Pendulum Camera Head**, 50/60 Hz, IMAGE1 S compatible, 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 and IMAGE1 HUB™ HD/HD

**Specifications:**

<table>
<thead>
<tr>
<th>IMAGE1 FULL HD Camera Heads</th>
<th>IMAGE1 S H3-Z</th>
<th>IMAGE1 S H3-P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product no.</td>
<td>TH 100</td>
<td>TH 103</td>
</tr>
<tr>
<td>Image sensor</td>
<td>3x 1/3&quot; CCD chip</td>
<td>3x 1/3&quot; CCD chip</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
<td>39 x 49 x 114 mm</td>
<td>35 x 47 x 88 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>270 g</td>
<td>226 g</td>
</tr>
<tr>
<td>Optical interface</td>
<td>integrated Parfocal Zoom Lens, f = 15–31 mm (2x)</td>
<td>pendulum system, fixed focus f = 16 mm</td>
</tr>
<tr>
<td>Min. sensitivity</td>
<td>F 1.4/1.17 Lux</td>
<td>F 1.4/1.17 Lux</td>
</tr>
<tr>
<td>Grip mechanism</td>
<td>standard eyepiece adaptor</td>
<td>standard eyepiece adaptor</td>
</tr>
<tr>
<td>Cable</td>
<td>non-detachable</td>
<td>non-detachable</td>
</tr>
<tr>
<td>Cable length</td>
<td>300 cm</td>
<td>300 cm</td>
</tr>
</tbody>
</table>
Monitors

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

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
Monitors

<table>
<thead>
<tr>
<th>KARL STORZ HD and FULL HD Monitors</th>
<th>19&quot;</th>
<th>26&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall-mounted with VESA 100 adaption</td>
<td>9619 NB</td>
<td>9826 NB</td>
</tr>
<tr>
<td>Inputs:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DVI-D</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Fibre Optic</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>3G-SDI</td>
<td>–</td>
<td>●</td>
</tr>
<tr>
<td>RGBS (VGA)</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>S-Video</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Composite/FBAS</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Outputs:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DVI-D</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>S-Video</td>
<td>●</td>
<td>–</td>
</tr>
<tr>
<td>Composite/FBAS</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>RGBS (VGA)</td>
<td>●</td>
<td>–</td>
</tr>
<tr>
<td>3G-SDI</td>
<td>–</td>
<td>●</td>
</tr>
<tr>
<td>Signal Format Display:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4:3</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>5:4</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>16:9</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Picture-in-Picture</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>PAL/NTSC compatible</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

Optional accessories:
9826 SF  Pedestal, for monitor 9826 NB
9619 SF  Pedestal, for monitor 9619 NB

Specifications:

<table>
<thead>
<tr>
<th>KARL STORZ HD and FULL HD Monitors</th>
<th>19&quot;</th>
<th>26&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desktop with pedestal</td>
<td>optional</td>
<td>optional</td>
</tr>
<tr>
<td>Product no.</td>
<td>9619 NB</td>
<td>9826 NB</td>
</tr>
<tr>
<td>Brightness</td>
<td>200 cd/m² (typ)</td>
<td>500 cd/m² (typ)</td>
</tr>
<tr>
<td>Max. viewing angle</td>
<td>178° vertical</td>
<td>178° vertical</td>
</tr>
<tr>
<td>Pixel distance</td>
<td>0.29 mm</td>
<td>0.3 mm</td>
</tr>
<tr>
<td>Reaction time</td>
<td>5 ms</td>
<td>8 ms</td>
</tr>
<tr>
<td>Contrast ratio</td>
<td>700:1</td>
<td>1400:1</td>
</tr>
<tr>
<td>Mount</td>
<td>100 mm VESA</td>
<td>100 mm VESA</td>
</tr>
<tr>
<td>Weight</td>
<td>7.6 kg</td>
<td>7.7 kg</td>
</tr>
<tr>
<td>Rated power</td>
<td>28 W</td>
<td>72 W</td>
</tr>
<tr>
<td>Operating conditions</td>
<td>0–40°C</td>
<td>5–35°C</td>
</tr>
<tr>
<td>Storage</td>
<td>-20–60°C</td>
<td>-20–60°C</td>
</tr>
<tr>
<td>Rel. humidity</td>
<td>max. 85%</td>
<td>max. 85%</td>
</tr>
<tr>
<td>Dimensions w x h x d</td>
<td>469.5 x 416 x 75.5 mm</td>
<td>643 x 396 x 87 mm</td>
</tr>
<tr>
<td>Power supply</td>
<td>100–240 VAC</td>
<td>100–240 VAC</td>
</tr>
<tr>
<td>Certified to</td>
<td>EN 60601-1, protection class IPX0</td>
<td>EN 60601-1, UL 60601-1, MDD93/42/EEC, protection class IPX2</td>
</tr>
</tbody>
</table>
Data Management and Documentation

KARL STORZ AIDA® – Exceptional documentation

The name AIDA stands for the comprehensive implementation of all documentation requirements arising in surgical procedures: A tailored solution that flexibly adapts to the needs of every specialty and thereby allows for the greatest degree of customization.

This customization is achieved in accordance with existing clinical standards to guarantee a reliable and safe solution. Proven functionalities merge with the latest trends and developments in medicine to create a fully new documentation experience – AIDA.

AIDA seamlessly integrates into existing infrastructures and exchanges data with other systems using common standard interfaces.

WD 200-XX*  
**AIDA Documentation System**, for recording still images and videos, dual channel up to FULL HD, 2D/3D, power supply 100-240 VAC, 50/60 Hz

including:
- **USB Silicone Keyboard**, with touchpad
- **ACC Connecting Cable**
- **DVI Connecting Cable**, length 200 cm
- **HDMI-DVI Cable**, length 200 cm
- **Mains Cord**, length 300 cm

WD 250-XX*  
**AIDA Documentation System**, for recording still images and videos, dual channel up to FULL HD, 2D/3D, including SMARTSCREEN® (touch screen), power supply 100-240 VAC, 50/60 Hz

including:
- **USB Silicone Keyboard**, with touchpad
- **ACC Connecting Cable**
- **DVI Connecting Cable**, length 200 cm
- **HDMI-DVI Cable**, length 200 cm
- **Mains Cord**, length 300 cm

*XX Please indicate the relevant country code (DE, EN, ES, FR, IT, PT, RU) when placing your order.
Workflow-oriented use

**Patient**
Entering patient data has never been this easy. AIDA seamlessly integrates into the existing infrastructure such as HIS and PACS. Data can be entered manually or via a DICOM worklist. All important patient information is just a click away.

**Checklist**
Central administration and documentation of time-out. The checklist simplifies the documentation of all critical steps in accordance with clinical standards. All checklists can be adapted to individual needs for sustainably increasing patient safety.

**Record**
High-quality documentation, with still images and videos being recorded in FULL HD and 3D. The Dual Capture function allows for the parallel (synchronous or independent) recording of two sources. All recorded media can be marked for further processing with just one click.

**Edit**
With the Edit module, simple adjustments to recorded still images and videos can be very rapidly completed. Recordings can be quickly optimized and then directly placed in the report. In addition, freeze frames can be cut out of videos and edited and saved. Existing markings from the Record module can be used for quick selection.

**Complete**
Completing a procedure has never been easier. AIDA offers a large selection of storage locations. The data exported to each storage location can be defined. The Intelligent Export Manager (IEM) then carries out the export in the background. To prevent data loss, the system keeps the data until they have been successfully exported.

**Reference**
All important patient information is always available and easy to access. Completed procedures including all information, still images, videos, and the checklist report can be easily retrieved from the Reference module.
Fiber Optic Light Cable

495 NAC
NEW

Fiber Optic Light Cable,
with straight connector,
extremely heat-resistant,
with safety lock,
diameter 3.5 mm, length 230 cm

495 NA

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

Cold Light Fountain XENON NOVA® 300

20134001
Cold Light Fountain XENON NOVA® 300,
power supply: 100–125 VCA/220–240 VAC, 50/60 Hz
including:
Mains Cord

20133028
XENON Spare Lamp, only,
300 watt, 15 volt

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:
Cold Light Fountain Power LED
Mains Cord
SCB Connecting Cable, length 100 cm

20132026
Xenon-Spare-Lamp, 175 Watt, 15 Volt
Notes:
Notes: