A Study of Percutaneous Nephrolithotomy (PCNL) and Grading of Complexity of PCNL procedures using "Guy's Stone Score"

Dissertation submitted in partial fulfillment of the requirements for the degree of

M.Ch (Urology) – Branch IV

STANLEY MEDICAL COLLEGE & HOSPITAL
THE TAMIL NADU DR. M.G.R. MEDICAL UNIVERSITY
CHENNAI, INDIA

AUGUST 2013

CERTIFICATE

This is to certify that this dissertation entitled **"A Study of Percutaneous Nephrolithotomy (PCNL) and Grading of Complexity of PCNL procedures using "Guy's Stone Score"** is a bonafide work done by **Dr. K.Karthikeyan** in partial fulfillment of the requirements of The TAMIL NADU DR.M.G.R. MEDICAL UNIVERSITY, Chennai for the award of M.Ch Urology Degree.

Prof. Dr.S.GEETHALAKSHMI.
M.D, Ph.D
DEAN
Stanley Medical College & Hospital,
Chennai - 600001

Prof. Dr. V. SELVARAJ,
M.S, M.Ch, (Urology)
Professor and Head of the
Department of Urology
Stanley Medical College & Hospital
Chennai - 600 001

DECLARATION

I, **Dr.K.Karthikeyan** solemnly declare that the dissertation titled "A Study of Percutaneous Nephrolithotomy (PCNL) and Grading of Complexity of PCNL procedures using "Guy's Stone Score" is a bonafide work done by me at Govt. Stanley Medical College & Hospital during February 2012 to March 2013 under the guidance and supervision of **Prof. Dr.V.Selvaraj, M.S., M.ch. (Urology)** Professor and Head Of The Department, Department of Urology.

The dissertation is submitted to Tamil Nadu, Dr.M.G.R University, towards partial fulfillment of requirement for the award of M.Ch. Degree(Branch-IV) in urology three years course

Place: Chennai

Date: **Dr. K. Karthikeyan**

GUIDE: Prof.Dr.P.Govindarajan. M.S., M.ch.(Urology)

Professor of Urology
Department of Urology
Stanley Medical College

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INSTITUTIONAL ETHICAL COMMITTEE, STANLEY MEDICAL COLLEGE, CHENNAI-1

Title of the Work : A Study of percutaneous Nephrolithotomy (PCNL) and Grading of complexity of PCNL procedures using 'Guy's Stone Score'

Principal Investigator : Dr.K. Karthikeyan

Designation : PG in M.Ch (Urology)

Department : Department of Urology
Government Stanley Medical College,
Chennai-1

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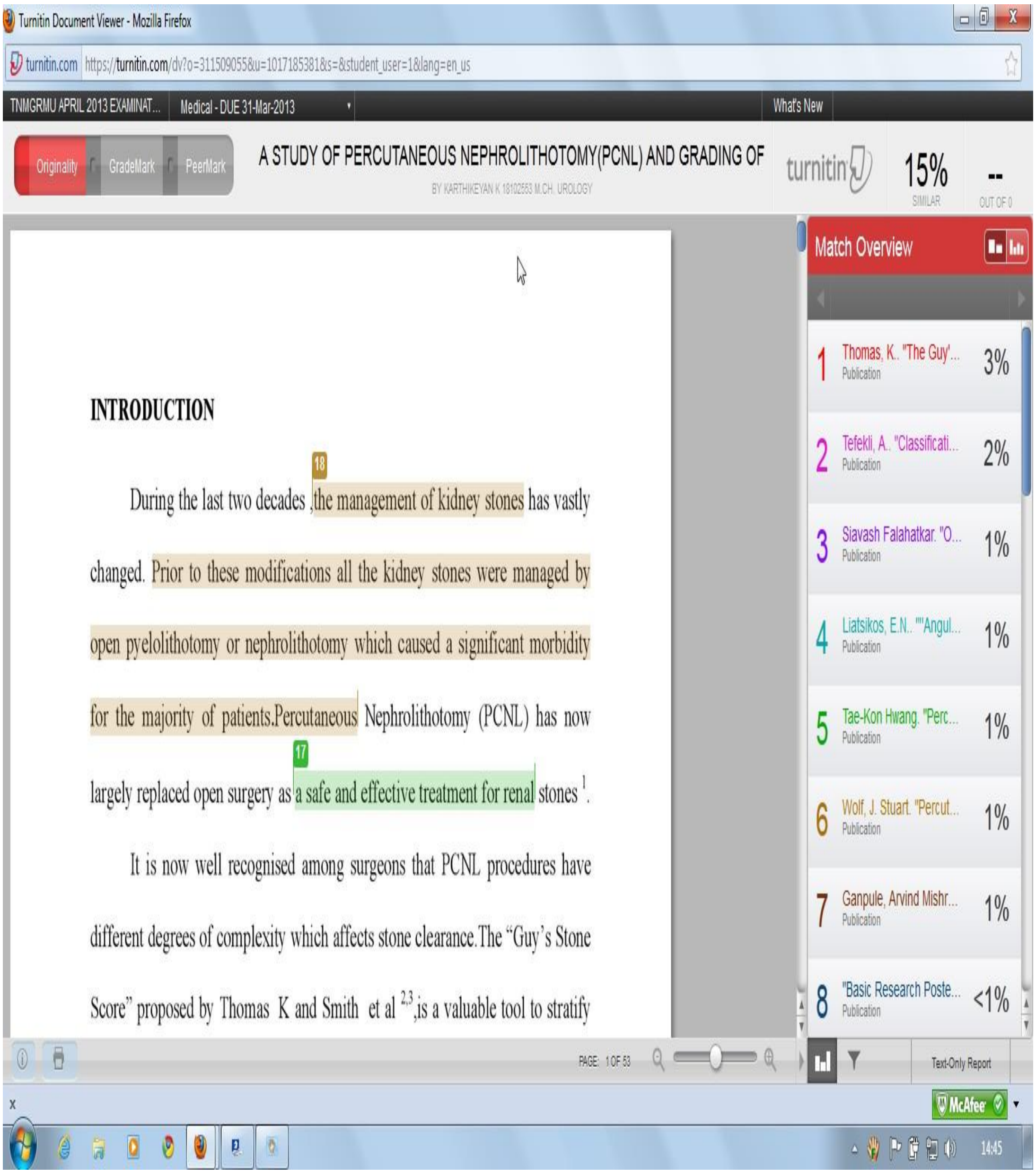
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INTRODUCTION
During the last two decades ,the management of kidney stones has vastly changed. Prior to these modifications all the kidney stones were managed by open pyelolithotomy or nephrolithotomy which caused a significant morbidity for the majority of patients.Percutaneous Nephrolithotomy (PCNL) has now largely replaced open surgery as a safe and effective treatment for renal stones 1.
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INTRODUCTION

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During the last two decades , the management of kidney stones has vastly changed. Prior to these modifications all the kidney stones were managed by open pyelolithotomy or nephrolithotomy which caused a significant morbidity for the majority of patient. Percutaneous Nephrolithotomy (PCNL) has now largely replaced open surgery as a safe and effective treatment for renal stones [1].

It is now well recognized among surgeons that PCNL procedures have different degrees of complexity which affects stone clearance. The "Guy's Stone Score" proposed by Thomas K and Smith et al [2,3], is a valuable tool to stratify the complexity of PCNL procedures into four groups based on the stone burden and the anatomy of both patient and renal tract.

Grade I : Solitary stone in mid / lower pole or solitary stone in pelvis with simple anatomy

Grade II : Solitary stone in upper pole or multiple stones in patient with simple anatomy or solitary stone in patient with abnormal anatomy

Grade III : Multiple stones in a patient with abnormal anatomy or stones in a caliceal diverticulum or partial Staghorn calculus

Grade IV : Staghorn calculus or any stone in a patient with spina bifida/spinal injury.

AIMS AND OBJECTIVES

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1) To evaluate patients with renal stones at our institution.

2) To study the indications for PCNL and to assess the outcome of procedure in patients with renal stones.

3) To study the grading and complexity of PCNL procedures using "Guy's Stone Score".

REVIEW OF LITERATURE

REVIEW OF LITERATURE

HISTORY

Dr Thomas Hillier MD was the first to publish a method of percutaneous nephrostomy in 1865, he repeatedly drained a congenitally obstructed kidney in a 4- year old boy. Goodwin and Casey in 1955 placed a trocar percutaneously in the collecting system. Later, the Seldinger method of nephrostomy placement was adopted. The first percutaneous nephrolithotomy (PCNL) via a nephrostomy tract created for the sole Purpose of stone removal was performed in 1976 by Fernstrom and Johansson[1] .

Untreated large staghorn calculi had a high 10 year mortality of (28%)in comparison with surgery(7.2%).In 2005, the clinical practice guideline report for the management of staghorn calculi by the American Urological Association guidelines[4] panel confirmed that percutaneous treatment of staghorn calculi should be first-line treatment for most patients.

RELEVANT ANATOMY

The kidneys are paired organs lying retroperitoneally on the posterior abdominal wall. Each kidney is of a reniform shape, having a upper and a lower pole, a convex border placed laterally, and a concave medial border. The medial border has a marked depression the hilum containing the renal vessels and the renal pelvis.

RENAL MORPHOMETRY

In adults, it is found that left kidney is larger than the right kidney, and this finding is in agreement with morphometric findings in fetal kidneys. The right kidney presented a mean length of 10.97 cm, while the left kidney presented a mean length of 11.21 cm. The right kidney presented 3.21 cm of mean thickness at the hilum, and the left kidney presented mean thickness of 3.37 cm.[1]

An interesting and worthwhile finding is that, in the same kidney, the superior pole has a greater width (mean = 6.48 cm) than the inferior pole (mean = 5.39 cm). They also found a statistically significant correlation between the kidney length and the stature of the individuals.

The anterior and the posterior renal arteries are the two main divisions of the renal artery. There are four segmental arteries arising from anterior division which supply the anterior and polar regions of kidney. The remainder of kidney is supplied by the posterior segmental artery. The segmental arteries give rise to the interlobar arteries beyond the renal sinus and form the arcuate arteries at the corticomedullary junction. The interlobular arteries branch from the arcuate arteries at right angles and run to the periphery giving rise to the afferent arterioles of the glomeruli. **Brödel's line separates an avascular plane between the anterior and posterior segmental blood supplies.**

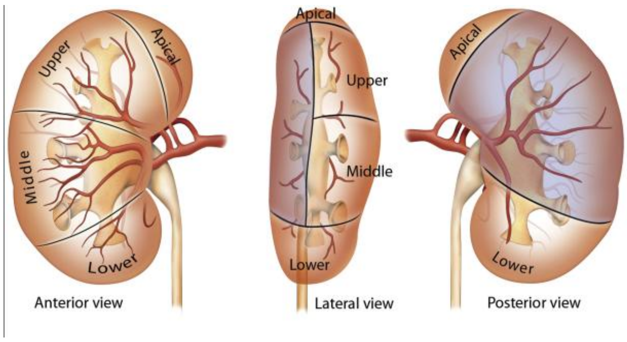


Figure: 1

Arterial supply to the kidney. The kidney is supplied by the anterior and posterior segmental branches of the main renal artery. The anterior segmental artery supplies both the anterior half of the kidney and the polar regions. The posterior segmental artery supplies only the posterior aspect of the kidney *(represented by the shaded region).* An avascular plane, known as Brödel's line, separates the anterior and posterior circulation

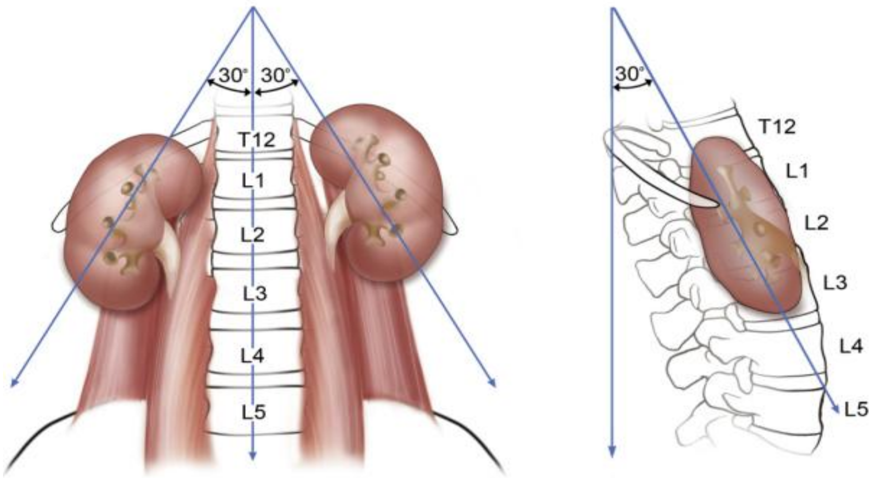


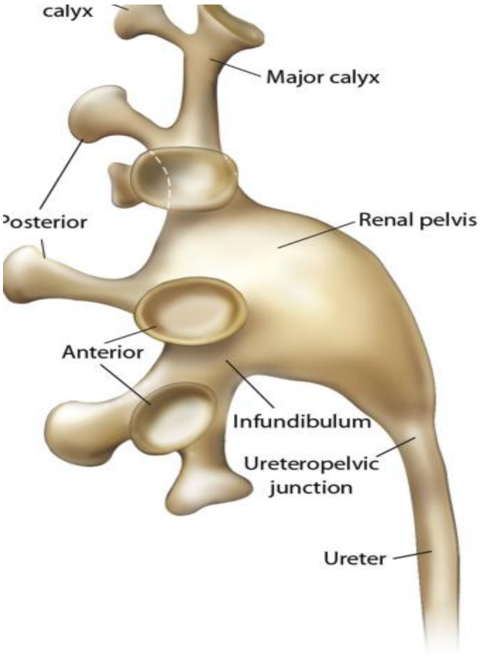
Figure:2

Location and orientation of kidneys in the retroperitoneum

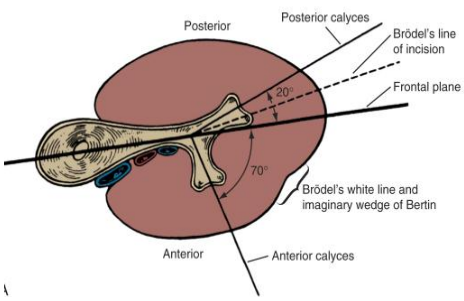
The intrarenal veins do not follow a segmental structure. Unlike the arteries, the venous system is freely interconnected. Multiple anastomotic arcades between the veins prevent parenchymal congestion and ischemia from venous injury.

Collecting System Anatomy

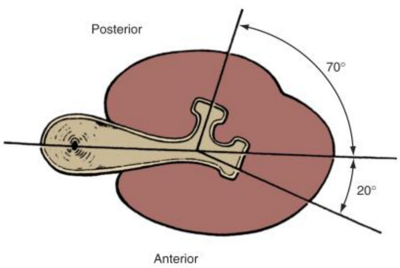
The anatomic landmarks dividing the renal parenchyma from the collecting system are the renal papilla. Calyces in direct apposition to the renal papilla are defined as minor calyces and vary in number from 5 to 14 (mean: 8). A minor calyx may be single (draining only one papilla) or compound (draining two or three papillae)[5]. Minor calyces may drain directly into an infundibulum or join to form major calyces, which then drain into an infundibulum (Fig. 3). The infundibula are the principal divisions of the pelvicalyceal system, draining directly into the renal pelvis. There are usually three renal calyceal groups: the superior, midzone, and inferior major calyces. Barcellos Sampaio and Mandarim-de-Lacerda[5] (1988) analyzed 140 three dimensional polyester resin corrosion endocasts of human kidneys and contributed significantly to our understanding of the intricate anatomy of the pelvicalyceal system. They observed that the superior and inferior major calyces usually consist of compound calyces that project toward the polar regions at various angles. The midzone calyces, on the other hand, are generally arranged in paired sets of anterior and posterior calyces. These paired calyces have been observed to display one of two configurations (Fig. 4). In the Brödel type configuration, the anterior calyx is short and medially directed (forming a 70-degree angle to the frontal plane of the kidney), whereas the posterior calyx is longer and more laterally directed (positioned only 20 degrees from the frontal plane of the kidney). The second configuration is the Hodson type in which the posterior calyx is shorter and more medially directed and the anterior calyx is longer and closer to the lateral edge of the kidney. It has been shown that 69% of right kidneys exhibit the Brödel configuration and 79% of left kidneys exhibit the Hodson configuration.



Basic pelvicalyceal anatomy   Figure:3



A Brodel configuration



B Hodson configuration

Figure : 4

Calyceal orientations in the Brödel and Hodson configurations. In the Brödel-type kidney (**A**), the longer posterior calyx is positioned 20 degrees from the frontal plane of the kidney and the shorter anterior calyx forms a 70-degree angle with the frontal plane. In the Hodson-type kidney (B), the shorter posterior calyx is positioned 70 degrees from the frontal plane of the kidney and the larger anterior calyx forms a 20-degree angle with the frontal plane. Figure: 4

In studying the pelvicalyceal endocasts, Barcellos Sampaio [5] (1988) noted significant variability in the drainage patterns of the three calyceal groups. The midzone calyceal group was variably found to have drainage dependent on one of the polar calyceal groups (62%) or to drain directly into the renal pelvis independent of either polar group (38%). In 18% of the endocasts studied, the kidney midzone was drained simultaneously by crossed calyces, one drains into the superior calyceal group and the other drains into the inferior calyceal group. In addition, a perpendicular minor calyx which drains directly to the pelvis was noted in 11% of the endocasts. The only consistently noted findings were that the superior calyceal group was drained by only one midline infundibulum in 99% of the endocasts and paired calyces drain the midzone. They are found to lie in two rows (anterior and posterior) in 96% [6].

Clinical Relevance of Intrarenal Anatomy

A thorough understanding of intrarenal anatomy is essential for a safe percutaneous puncture and minimize complications. Appreciation of the anterior and posterior segmental blood supply of the kidney can allow the urologist to utilize Brödel's line during percutaneous puncture. A needle traversing the renal parenchyma posterolaterally through this avascular plane avoids damage to any major blood vessels. More medial punctures in the superior calyx may injure the posterior segmental artery. The posterior segmental artery is the most commonly injured vessel in endourologic procedures. Knowledge of the Hodson and Brödel configurations of calyceal anatomy is crucial for precise preoperative localization of a stone or other lesion on intravenous pyelogram. Awareness of the great variability in calyceal drainage patterns can aid greatly during intraoperative decision making for appropriate puncture sites. The results of the Sampaio endocast studies imply that it is easy to puncture a polar region which is drained by a single infundibulum than a polar region drained by paired calyces. Furthermore, the anatomic relationships of the intrarenal vessels to the kidney collecting system predict a high rate of vascular injury for attempted puncture directly into any infundibulum. This suggests that percutaneous entry which is direct into the fornix of a calyx is the safest route. [6]

Preview of any renal access involves examination of the desired calyx. The calyx is inspected for three factors: relation to the 12th rib, extent of hydronephrosis, and presence of malrotation. Whether the desired calyx resides above or below the 12th rib has critical significance for the technique chosen for renal access and the possibility of pleural injury. The degree of dilatation influences the difficulty of renal puncture. Improper technique may still result in failure even in a well dilated system. Finally, the unusual case of the malrotated or ectopic kidney may necessitate minor adjustments in the access technique.

INDICATIONS FOR PCNL:

Percutaneous stone extraction is the primary modality to treat patients with large stones size more than 2 cms, obstructing kidney stones (e.g., staghorn calculi) or stones with composition resistant to fragmentation with extracorporeal lithotripsy [1]. In addition, for patients with concomitant renal stones and distal narrowing (e.g., infundibular stenoses and coexisting calyceal stones, stones in calyceal diverticula, or renal stones with ureteropelvic junction [UPJ] narrowing), the percutaneous route allows a convenient approach to address both problems simultaneously. For patients with UPJ obstruction (even in the absence of stones), percutaneous endopyelotomy provides an effective alternative to laparoscopic or open pyeloplasty with acceptable success rates.

IMAGING MODALITIES FOR PERCUTANEOUS ACCESS

Ultrasonography

Percutaneous ultrasound-guided nephrostomy[7] is perhaps the simplest and most direct technique to access and drain a hydronephrotic collecting system. It is most often utilized to place a temporary urinary diversion in the instances of an obstructing stone or pyonephrosis and has also been used successfully to relieve obstruction secondary to malignant compression. Although the technique has been especially popular among interventional radiologists, it has gained popularity among endourologists who are comfortable with ultrasonography. Allergies to topical or injectable local anesthetic and coagulopathy are the only relative contraindications to ultrasound-guided renal access. The ultrasound guided access has no radiation hazard and allows to image the structures across skin and kidney. Ultrasound access is safe in pregnancy and where retrograde catheter could not be placed[7].

Computed Tomography and Magnetic Resonance Imaging

CT-guided percutaneous access, is useful in special situations[8]. A CT- or MRI-guided approach is a time-consuming and expensive method that is not practical for most patients and needs to be considered only if the aforementioned techniques are not feasible or do not provide good results or if sophisticated preoperative planning is necessary. Patients with a retrorenal colon or a abnormal anatomy due to spinal anamoly predictably require cross-sectional imaging to facilitate safe access before percutaneous nephro lithotomy [9]. In addition, the CT guided approach may be useful in obtaining renal access in patients with ileal conduits, renal uric acid stones, or nephrolithiasis in the presence of angiomyolipomas at risk for bleeding . Three-dimensional CT has been described as a valuable tool for obtaining percutaneous access in the morbidly obese with malrotated kidneys and large staghorn calculi [8]. There are no specific indications for MRI-guided percutaneous nephrostomy, although the technique has been shown to be feasible and accurate in nondilated collecting systems.

FLUOROSCOPY

Endourologic procedures most often rely on fluoroscopy [10]. Although the risk is relatively small, everyone involved are exposed to radiation which includes the patient, surgeon and other staff. The endourologist, in particular, must undertake protective measures because he or she will have radiation exposure regularly. Likewise, children with nephrolithiasis secondary to cystinuria may be subjected to repeated fluoroscopy-based procedures. Children are more vulnerable to radiation. The two major risks associated with fluoroscopy are,[11]

- Radiation-induced injuries to the skin and underlying tissues ("burns"), and
- The small possibility of developing a radiation-induced cancer some time later in life.

Benefits outweigh the risks involved with fluoroscopy when one has a medical need. Time and exposure should be kept to a minimum required.

Skin injuries caused by fluoroscopy include the following [11]

Early transient erythema

Temporary epilation

Telangiectasis

Moist desquamation

Late erythema

Dermal necrosis and Secondary ulceration

Table 1 -- Radiation Safety for Urologists [12]

Put fluoroscopy beam under table.
Use lead apron and thyroid shields.
Use minimal fluoroscopic time: "Think before or after fluoroscopy, not during."
Collimate.
Wear radiation detection devices.
Wear lead-impregnated glasses.
Use lead gloves?

The principle for radiation safety is ALARA: as low as reasonably achievable. The maximum yearly whole-body exposure allowed by the National Council on Radiation Protection is 5000 mrem, or 5 rem[12]. Though the risk with radiation above standard limit is a small health risk ,it is substantial over lifetime of a surgeon (Castaneda,1996)[12]. Experimental data suggest that a mixture of dietary antioxidants and glutathione elevating agents may protect tissues from radiation's mutagenic effects. The use of such antioxidant preparations may soon extend the concept of ALARA from dose to biologic damage. Time, distance, and shielding are important factors for safe radiation. Reducing fluoroscopy time during endourologic procedures is of primary importance, because the exposure time determines the radiation dose to the operating room personnel. Newer fluoroscopic equipment features, including under-table fluoroscopic sources, timer alarms, collimated x-ray beam, and last-image-holding/memory capability help the urologist limit the fluoroscopy time. Grid-controlled fluoroscopic technique may also reduce overall radiation dose by decreasing the selected film frame rate[13]. Use of this technique, as opposed to continuous fluoroscopy, has led to substantial dose reduction for the patient and fluoroscopy operator without sacrificing image quality or diagnostic confidence. The major source of radiation to the endourologist is scatter from the patient's body [14]. Radiation is emitted from a source in all directions, and decreases with distance. Because scattered radiation follows the inverse square law, operators near the radiation beam can make significant reductions in exposure by increasing their distance from the patient [14]. For example, if one stands 3 feet from the fluoroscopy table during imaging, there is one ninth the radiation exposure, or an approximate 89% dose reduction. At a distance of 12 feet, however, the dose will approximate natural background levels, not registering on radiation monitoring devices (dosimeters). During fluoroscopy, the kilo voltage and milliamperage are adjusted automatically and the operator can control only the duration of the exposure. Exposure doses may be reduced significantly by minimizing the total "active" fluoroscopic time for a procedure through cautious use of the exposure switch to ensure that irradiation occurs only when there is a need for active viewing of the image. The use of a last-image-hold feature is of great importance in reducing the overall irradiation time[13]. With this feature, anatomic details can be scrutinized without a competing concern about additional radiation dose. Thus, all fluoroscopes used for percutaneous surgery should have a last-image-hold feature so the urologist does not need to "think with a foot on the pedal." The irradiated site of the patient affects the scatter rate to the endourologist. When the field is closer to the midline of the patient, less radiation is scattered to the operator because it is attenuated through a greater thickness of overlying tissue. When the field is more lateral, the radiation is less attenuated by the patient and thus there is more radiation scatter. Furthermore, in obesity there is a need for more radiation to form a quality image which leads to increased scatter. Protective surgical drapes composed primarily of bismuth, specialized urologic radiation shields, and special radioprotective gloves can be used to substantially reduce scattered radiation dose .Collimation narrows the beam and limits the imaging area to the exact position of interest, thus reducing the scattered radiation to and from the patient. Keeping the image receiver nearer the patient minimizes the distance between the focal spot and the image receptor, keeps beam intensity as low as possible, decreases image blur, and is useful as a scatter barrier between the operator and the patient. In addition, the direction of the beam significantly influences the amount of scattered radiation reaching the operator [12]. When the tube is above the operating table, there is a combination of leakage and scattered radiation. However, when the image intensifier is placed superiorly, radiation leakage is minimized, as an additional layer of material shields the emission tube. There is a reduction of scattered radiation to the operator. Shielding involves the use of flexible protective clothing such as aprons, skirts, thyroid shields, eyeglasses, and gloves. The basic protection for every urologist during percutaneous surgery is a lead apron, thyroid shield, and eyeglasses. The use of protective glasses is prudent, even though there is debate about their absolute necessity. Nevertheless, approximately 1100 mrem/hr may be deviated toward the urologist's upper extremities as a result of radiation scatter, which certainly suggests that the use of eye protection may be beneficial . The standard flexible material for protective clothing is lead-impregnated rubber. The goal is to provide a barrier between the radiation source and the operator so that radiation is attenuated by the shield. Lead aprons are heavy and can become uncomfortable when the operator is wearing them for a protracted period of time. The amount of lead required for efficacy has been established as 0.5 mm, and it has been estimated that the weight of aprons with this much lead ranges from 2.5 to 7 kg[13]. Today, however, some aprons are made of composites of lead with elements of lower atomic numbers so that the weight can be reduced but the efficacy maintained (Castaneda, 1996)[12].

Finally, **all personnel exposed to radiation should wear dosimeters** positioned where the operator receives the maximal radiation[15]. It has been estimated that the radiation exposure to the underlying body is as little as 1% of the measured value. In modern radiation protection practices, active personal dosimeters are absolutely essential operational tools for satisfying the ALARA principle.

Percutaneous Access without Imaging—"Blind Access"

Attempting percutaneous access without the aid of imaging is reserved for the rare instances when retrograde or intravenous opacification is precluded, the pelvicalyceal system cannot be opacified, or imaging machinery such as a fluoroscopic unit or sonography is inaccessible [16]. Poor renal function in the presence of ureteral obstruction, for example, may represent such a situation, especially if emergent collecting system decompression is required (i.e., urosepsis from pyonephrosis). Percutaneous access without imaging relies on anatomic landmarks and the assumption that anatomy is not aberrant. The lumbar notch, bounded medially by the sacrospinalis and the quadratus lumborum muscles, and laterally by the transversus abdominis and the external oblique muscles, superiorly by the latissimus dorsi muscle and the 12th rib, has been shown to be a useful anatomic window for successful blind percutaneous calyceal puncture. An 18-gauge access needle can be inserted into the notch at a 30-degree angle directed cephalad under the 12th rib to a depth of 3 to 4 cm

PREPARATION BEFORE PCNL

A good imaging is necessary. X ray KUB, IVU were used earlier .CT urograms[17] showed more details on anatomy of kidney and calculus, it will also show retrorenal colon. Urine should be sterile before PCNL. Bleeding tendencies should be corrected. Medications like aspirin ,NSAIDS should be stopped

DURING PCNL

Broad-spectrum parenteral antibiotics are given to all patients before surgery [18]. After inducing general anaesthesia, the patient is placed in lithotomy position, cystoscopy and retrograde catherisation done with 5fr ureteric catheter. Alternatively patient is placed in prone flexible cystoscopy can be used for RGC. With utmost care to the face and extremity pressure points, padding of all pressure points ensured.

Site Selection

It is necessary to select the percutaneous nephrostomy tract that is most suited for a particular procedure.Puncturing the posterior calyx is preffered because it is straight, gives stability with transparenchymal path and avoids major vascular structures. In addition, access from an anterior calyx to the renal pelvis is technically demanding because it requires directing the wire backward. Posterior segmental artery may be injured if the pelvis is punctured directly. In general, the risk of injuring larger branches of the renal artery increases with progressively more medial punctures. There is less stability with more medial punctures as it lacks parenchymal support. Collecting system is visualized by injecting contrast through ureteric catheter. Alternatively, a small amount of air may be injected to provide an air pyelogram [10]. The advantage of air is that it is lighter than urine or contrast material and therefore identifies the posterior calyces first, with the patient in the prone position. The typical appearance of air in a posterior calyx filled with contrast agent has been described as “Mickey Mouse ears.” With a single stone in the renal pelvis or when the anatomy is unclear, the use of contrast material is recommended to precisely delineate the intrarenal anatomy. However, in the case of multiple radiopaque calyceal or complete staghorn calculi, an air pyelogram outlines the collecting system satisfactorily and will not interfere with the evaluation of residual stones or fragments due to retained or extravasated contrast material. In general, anterior calyces are more laterally located and posterior calyces are more medially located (mnemonic LAMP: Lateral-Anterior, Medial-Posterior) [5].

Subcostal approach

With the C-arm in the vertical position, the collecting system is inspected and the appropriate calyx is identified. The ideal site provides the shortest tract to the calyx from below the 12th rib. With the C-arm at 90 degrees collecting system is examined which defines the medial vertical plane of the calyceal entry [10]. The C-arm is next moved 30 degrees towards the urologist. This places the axis of the C-arm in the same central posterior plane of the kidney, providing a straight end-on view of the posterior calyces. After the calyx is chosen, the overlying skin site is marked with a curved hemostat.

With the C-arm in the 30-degree position an 18-gauge translumbar angiography needle is advanced in the plane of the fluoroscope beam. The diamond tip prevents deflection by sharply cutting through muscle and fascia while causing minimal shearing . In general, the shorter the needle (11 to 15 cm) the easier it is to control. Longer needles are necessary for obese patients or when triangulation is utilized, because this latter technique may require a longer tract or more flexibility to “bend around” a rib. The appropriate direction for needle advancement is determined by obtaining a “bull's-eye sign” on the fluoroscopic screen [10]. This effect can be seen only when the needle hub is superimposed on the needle shaft and is evident when the plane of the needle is the same as that of the x-ray beam. If the axis of the needle advancement is not parallel to the axis of the C-arm beam, a segment of the needle shaft is visible. After determination of the appropriate plane the hemostat held needle is advanced in 1to 2cm increments. Use of hemostat minimizes exposure. The needle should approximate the avascular line of Brödel, because this provides the safest access to the posterior calyceal system. A transparenchymal route avoids the hilar vessels and seals the nephrostomy tract from urine leakage. The depth of needle penetration is monitored by moving the C-arm back to the vertical position. With the C-arm in the vertical position, the approximation of the tip of the needle to the predetermined calyx can be seen and guided fluoroscopically. For example, the needle is too deep if it appears to be past the calyx on the fluoroscopic screen. Periodically, it is important to evaluate the correct direction of needle advancement by rotating the C-arm 30 degrees toward the surgeon and observing for the bull's-eye effect. Both the appropriate axis and the needle depth are prerequisites for a successful percutaneous access. The needle has reached its intended target when its tip is in the desired calyx on both planes of fluoroscopy. When the needle seems to be in a calyx, the stylet can be removed and the correct needle position is verified by aspiration of urine or air, or both. A 0.038-inch floppy-tip J-shaped guide wire is inserted into the needle and either advanced across the UPJ or coiled within the renal pelvis. With the needle left in place, a 1-cm skin incision is made. The needle is then removed and the tract is dilated over the wire.

Intercostal Approach.

The risk of hydrothorax and hemothorax is increased when percutaneous access to the calyces is performed above the 12th rib. Various techniques to access the superior calyces while minimizing complications have been described. The direct intercostal approach, triangulation, indirect access by way of lower calyces, and retrograde percutaneous nephrostomy have all been described.

Access to an superior pole calyx can be difficult by a subcostal approach, and the endourologist needs to be familiar with the intercostal approach[6, 10]. Many urologists favor this approach for gaining access to the upper pole and suggest that it is straight and gives viable access to most staghorn calculi, even though it carries minimal increase in morbidity . Contemporary series, in contrast to older literature, indicate that with caution intercostal puncture may be safe and effective. In particular, care should always be taken to maintain that the access sheath is secure in the collecting system.

A technique for minimizing the potential morbidity of the intercostal approach by displacing the kidney caudally has been described. This is achieved by placing an Amplatz sheath through a central or lower pole calyx and rotating the back of the dilator cranially, which causes caudal displacement of the kidney that can be viewed fluoroscopically. A second distinct puncture or a Y-tract is created into the upper pole. This method was successful in majority of cases without complications . Also, an occlusion balloon catheter can be used to apply gentle caudal traction and displace the kidney downward and below the costal margin during the initial access approach. Alternatively, the needle can be advanced gradually only when the kidney is at its lowest excursion point, either incrementally during consecutive end-inspirations or while the patient is made to perform a Valsalva maneuver by the anesthesiologist.

Another frequently used technique for access to a superior calyx is triangulation. The C-arm is placed over the patient in the 90 degrees. A retrograde pyelogram is obtained, and the skin over the desired calyx is marked with a hemostat while the C-arm is maintained in the vertical position. Medial extent of needle penetration for access to the desired calyx is defined by this plane[8].Then end –on view of posterior calyx is seen with C-arm in 30 degrees. With the C-arm at 30 degrees, the skin site over the calyx is marked lateral to the first site. The surgeon uses this point on the skin surface to move in a vertical line inferiorly until a site 1 to 2 cm below the 12th rib is reached. This third site is marked and serves as the site of needle entry. From this point, the needle is advanced to the junction of the vertical plane and the 30-degree plane. Access is achieved at the junction of all three axes, hence the term triangulation . In the latter approach, the bull's-eye sign does not exist; and thus the axis for needle advancement is based on the surgeon's observation of the principles of two-plane fluoroscopic viewing, especially regarding the needle tip and calyceal position. It is also very important to be familiar with the orientation of the angle of advancement of the needle as it relates to the depth of puncture along the medially defined plane determined already. This approach is technically more demanding and requires more experience with percutaneous punctures. This procedure can place some torque on the renal parenchyma and should only be used when the normal renal excursion allows the superior calyces to be close to the level of the 12th rib.

Special Circumstances

Percutaneous access to anomalous kidneys for endourologic procedures requires excellent radiographic imaging for guidance. CT or MRI is imperative to properly define anatomy and guide puncture[19]. In some instances laparoscopic guidance may be needed .

Malrotated kidneys and horseshoe kidneys are relatively easy to access percutaneously . In these kidneys, the majority of the calyces are facing posteriorly while the renal pelvis is anterior. In general, the more medial the calyx, the more likely it is to be posterior. Because of the possible aberrant vasculature, however, preoperative CT is extremely helpful in deciding which calyx is best to access in terms of safety and efficacy (being able to reach the pathologic site). One advantage of horseshoe kidneys is that their embryologic ascent is limited by the inferior mesenteric artery, resulting in an inferior location compared with orthotopic kidneys. This results in a low incidence of pulmonary complications because the tract is almost always subcostal. The tract may be long, however, because these kidneys are more anterior; and in obese patients extra-long dilators and nephroscopes may be necessary. Also, these kidneys tend to have supernumerary calyces, making maneuvering from one calyx to another difficult. Access is more difficult with pelvic kidneys and cross-fused ectopic kidneys. The very anterior location of these kidneys with surrounding bowel often precludes safe access . Laparoscopic displacement of bowel with subsequent combined laparoscopic and fluoroscopically guided puncture has been used successfully. Cross-fused ectopic kidneys associated with UPJ obstruction may be able to be accessed through the anterior abdominal wall providing there are no intervening bowel segments. This can be ensured with a combination of a preoperative CT scan and intraoperative ultrasound and/or cross-table lateral fluoroscopy to guide the puncture.

Guide Wires and Catheters

In general, the wire preferred by most surgeons for initial access is the J-wire. This wire has the benefit of being nonperforating, because its distal end is in the shape of a soft J. It has a tendency to coil in the calyx of access or in the renal pelvis and can be maneuvered in the collecting system with low risk of injury. J-wires come in various lengths, coatings, and stiffness, each having distinct advantages and disadvantages. Hydrophilic coated wires are also commonly used for initial access, because they are very slippery and are most likely to find their way through a tight infundibulum, past an impacted stone, or through the UPJ. The major advantages of these wires are their ability to find their way through obstructions, to coil generously in the collecting system or bladder, and to have innate resistance to kinking. Their four disadvantages are their extreme slipperiness when wet, which can result in inadvertent loss of access; their blunt tip, which can cause perforation of the collecting system; their high coefficient of friction when dry, which can cause difficulty passing catheters over them; and their lack of memory, which can result in recoil if not physically held in position.

A third wire commonly used for access as well as for manipulating down the UPJ is the coaxial wire. This wire has an inner movable core, allowing the end of the wire to be flexible or stiff, depending on the desire of the surgeon and the particular situation. Once access is obtained to the collecting system with the distal end of the wire being flexible, the shaft of the wire leading into the collecting system can be stiffened, allowing for easier dilation and preventing kinking and loss of access.

Catheters are necessary once guide wire access has been obtained to the collecting system. The tract initially should be serially expanded to 10 to 12 Fr. This can be achieved using short fascial dilators [20]. These are tapered, Teflon-coated, and malleable but stiff enough to go over a guide wire and dilate through fascia, muscle, and renal capsule. If a guide wire gets kinked during passage of a dilator, the kinked portion can be pulled into the dilator and the dilator is then advanced with back tension on the wire. Once the dilating catheter is in the collecting system, the guide wire can be changed to a stiffer wire or an attempt can be made to maneuver a new wire down the UPJ. Other catheters, such as a coudé-tipped catheter, Kumpe catheter, or a Cobra catheter, can be used to manipulate the guide wire into desired locations. These catheters have tapered ends that are curved to varying degrees, allowing access around corners or tortuosities.

Previously operated patients or those who have scarring from infections, the fascia may be too fibrotic to dilate with a Teflon-coated catheter or a balloon. In these situations a fascial incising needle may be helpful. This device is a butterfly-shaped needle that goes over a guide wire. The wings have cutting surfaces that can slice through the scar, allowing subsequent catheter placement.

Dilation of the Nephrostomy Tract

Needle entry into the desired location of the pelvicalyceal system represents the first step of a successful percutaneous intervention. The tract also must be secured and dilated to allow for the passage of nephroscopic equipment or drainage catheters. In the early experience with percutaneous techniques, dilation of existing nephrostomy tracts was carried out gradually using sequentially larger telescopic dilators over a period of 8 days [20]. Acute dilatation of the nephrostomy tract in a single session with no untoward effects has been described. Since then, multiple techniques have been developed that allow for safe, rapid nephrostomy tract dilation so that percutaneous access and intrarenal surgery now can be routinely performed during the same setting.

Guide Wire Introduction

The main principle of acute tract dilation is that it must always be performed over a guide wire. After needle enters into the collecting system it is confirmed by return of urine after removal of the stylet, the Seldinger technique is used to advance a guide wire through the needle into the collecting system [21]. The wire should be stiff enough to support the subsequent dilation. Passage of the wire down the ureter into the bladder should be attempted to minimize the risk of wire dislodgement during fascial dilation. In situations in which this is not possible (e.g., impacted ureteral stone, narrow UPJ), the wire should be positioned in a calyx that is far from the initial puncture tract to prevent dislodgement during dilation. In patients with complete staghorn calculi, the guide wire may coil within the punctured calyx because it cannot pass into the renal pelvis. In this case, dilation must be performed very gently because the guide wire can be easily displaced. Its better to place a second safety guide wire. The safety wire is inserted immediately alongside the working wire and serves to protect access to the nephrostomy tract in case the working wire becomes kinked or displaced. Insertion of the safety guide wire requires the use of a double-lumen catheter or a coaxial system to accommodate two wires. This coaxial system consists of an inner dilator tapered to the size of the guide wire and an outer sheath. After the inner dilator is removed, the external sheath allows the safe insertion of the second guide wire, ensuring its correct positioning within the ureteral lumen. Various safety guide wire introducers are available .

Types of Dilators

A variety of techniques exist for acute dilation of the nephrostomy tract. The most commonly used systems include progressive fascial dilators, malleable dilators, metal coaxial dilators, and high-pressure balloon dilators [20]. The decision of which type of dilation system is used varies among urologists on the basis of personal preference and experience. Multiple investigators have found no differences in renal parenchymal damage among the various dilation methods. It should be noted, however, that when comparing balloon dilators and malleable dilators several groups of investigators observed lower renal hemorrhage rates and lower transfusion rates in patients undergoing balloon dilation (Davidoff and Bellman, 1997) [22].

Fascial Dilators

The fascial dilator system consists of progressively larger polytetrafluoroethylene (Teflon) tubes designed to slide over a 0.038-inch guide wire. They range in size from 8 to 36 Fr and are inserted in a rotating, screw-type fashion with the entire dilation procedure performed under fluoroscopic control. The main advantage of this system is that it is safe. Once the 8-Fr catheter is in place, subsequent dilation is unlikely to kink the guide wire. The stability conferred by the firm polytef composition also makes fascial dilators ideal for dilation of fibrous tracts such as may be seen in patients with a history of retroperitoneal surgery, percutaneous surgery, or inflammatory processes of the kidney. The main drawback of this system is its dependence on the integrity of the guide wire . In addition, despite their purported safety, caution must be exercised when introducing fascial dilators because their tips can perforate the renal pelvis medially, causing excessive blood loss or extravasation of irrigating fluid into the retroperitoneum.

Malleable Dilators

Malleable dilators were developed in 1982 by Kurt Amplatz to improve upon some of the weaknesses of the older fascial dilators and are now widely referred to as Amplatz dilators. A tapered 8-Fr angiographic catheter is initially inserted down the ureter over the working guide wire, and progressively larger polyurethane catheters are serially passed over the catheter/guide wire combination. The additional stability conferred by the tapered 8-Fr catheter facilitates the entire dilation process by preventing the guide wire from kinking and by allowing the larger dilating catheters to slide more easily. These dilating catheters range in diameter from 12 to 30 Fr in increments of 2 Fr. The nephrostomy tract either can be dilated in a stepwise fashion with the full set of dilators or some sizes can be skipped. The dilators must be advanced over the working guide wire until they enter the calyceal lumen. However, further insertion may damage the integrity of the pelvicalyceal system and should be avoided. Thus, to avoid collecting system tears, the distal end of the dilators should not be advanced across the UPJ. When nephrostomy tract dilation is performed to treat large renal stones, the dilators should be advanced only to the peripheral edge of the stone. Calyceal or infundibular lacerations have been reported when large dilators were forced past stones that were impacted in the pelvicalyceal system. Once the tract is adequately dilated, an outer sheath is passed in coaxial fashion over the polyurethane dilators. The external sheath secures access to the kidney and allows the repeated introduction and withdrawal of endourologic equipment. The sheaths range in size from 28 to 34 Fr, and the outer diameter exceeds the inner diameter by 4 Fr; thus, the 34-Fr sheath is designed to slide over the

30-Fr dilator. The sheaths are impregnated with polytef to reduce the coefficient of friction and to minimize buckling.

Complications that may occur with the malleable dilators include perforation of the pelvicalyceal system, hemorrhage, extravasation, and trauma to the renal capsule. Nephrostomy tract dilatation must always be done under fluoroscopic observation. If excessive force is used during the insertion of the dilators, the renal pelvis may be perforated despite the presence of the 8-Fr catheter. When the medial segment of the renal pelvis is perforated, there is the possibility of extravasation of irrigation fluid into the retroperitoneum. Trauma to the renal capsule with resultant perirenal hematoma can be caused by irregularities on the leading edge of the Amplatz dilator. The disposable dilator sets ensure a smooth leading edge on the sheath each time .

Metal Coaxial Dilators

Metal coaxial dilators are made of stainless steel and are mounted together in a telescopic fashion, mimicking a collapsible radio antenna. Progressively larger dilators are added until the tract is dilated to the desired size (Alken[20], 1981). The metal telescopic dilators consist of an 8-Fr hollow guide rod that slides over a guide wire and a set of six metal tubes ranging in diameter from 9 to 24 Fr. Each dilator adapts exactly to the lumen of the next dilator. A bulge at the end of the rod represents the endpoint for the progression of the dilators, ensuring that they cannot be advanced farther. After all dilators have been advanced, their tips are in the same horizontal plane, close to the tip of the guide rod. The metal coaxial dilation system is rigid and theoretically is excellent for patients with previous surgery and associated perirenal fibrous tissue. However, several notable drawbacks have limited its use. The main disadvantage is that it is difficult to control the pressure exerted during dilation. The central core of the apparatus must be held firmly while the outer dilator is advanced to avoid untoward events such as perforation of the renal pelvis and the resultant risks of extravasation and hemorrhage .

Balloon Dilation Catheters

For the fascial, malleable, and metal coaxial dilation systems, the major risk of injury stems from the uncontrolled repetitive passage of progressively larger dilators. In an attempt to minimize the morbidity of nephrostomy tract dilation, balloon dilation catheters capable of achieving tract dilation in a single step were developed. Before inserting the balloon catheter, a 30-Fr polytef working sheath is backloaded behind the uninflated balloon. The catheter is then inserted over the guide wire until the inflatable segment traverses the nephrostomy tract.

The tip of the balloon, indicated by the radiographic marker, is advanced just inside the calyx. Passing the balloon tip beyond the calyx or stone may result in infundibular tears or urothelial injury from the impaction of the stone. Once appropriately positioned, the balloon is inflated to acutely dilate the tract. Pressures of 15 to 20 atm can easily be reached with the balloon catheter. In patients with no previous renal surgery, pressures of 4 to 5 atm are usually enough to dilate a nephrostomy tract. In those who have had surgery, higher pressures are required to achieve the final dilatation. As the balloon is inflated, in areas of high resistance a characteristic "waist" appears, such as the renal capsule or a previous operative scar. With persistent inflation, the balloon expands fully and the waist disappears, allowing the backloaded sheath to be advanced into the collecting system in a rotating fashion. This sheath is advanced into the tract to the end of the balloon, not the end of the catheter. The balloon is then deflated and retrieved from the tract. The working sheath provides the access for further endourologic manipulations. The purpose of balloon dilation is to achieve tract formation in a single step, avoiding the need for serial dilation [22]. Among the major advantages of the balloon dilation system is its ease of use. Also, unlike serial dilators, which repetitively generate angular shearing forces, the balloons generate lateral compressive forces and are therefore less traumatic.

Theoretically, balloon dilation should generate less hemorrhage, but this has yet to be definitively proved. Among the drawbacks of the balloon dilation system are the relative inability to dilate dense fascial tissue or scar tissue and the greater expense compared with other dilation systems.

Novel Dilation Methods

Several groups have reported on alternative techniques of nephrostomy tract dilation to avoid the morbidity associated with repetitive insertion and withdrawal of malleable dilators. In contrast to the traditional method, which employs sequential insertion of dilators of increasing size, a "one-shot" method consisting of a single dilation of the tract with a 25- or 30-Fr Amplatz dilator has been described . Similar to the "one-shot" method,[21] single-step dilation using an expanding malleable sheath preloaded on a laparoscopic trocar has also been described (Goharderakhshan et al, 2001) [23]. Preliminary results using these novel methods suggest that they may be feasible and perhaps less time consuming than some of the traditional methods of tract dilation (Goharderakhshan et al, 2001) [23].

The indication for percutaneous access and the size of the endoscopic instruments that will be used dictate the final extent of tract dilation. With the access tract dilated, either endourologic equipment or a nephrostomy tube is introduced. When simple renal drainage is needed, a 10-Fr nephrostomy tube may be sufficient and there is no need for greater tract dilation. The final diameter of the tract should exceed the tube or instrument size by 2 to 4 Fr, to allow adequate flow of fluid around the instrument. When percutaneous access is needed for the management of stone disease, the tract is usually dilated to 30 Fr to accommodate a rigid nephroscope. Various authors have investigated the use of a “mini-perc” technique in which the tract is dilated between 13 and 20 Fr. The early literature suggests that a smaller volume of renal parenchyma is dilated, leading to a corresponding decrease in blood loss and postoperative pain . However, the only randomized study in the literature comparing the mini-perc and standard techniques showed no advantage with the mini-perc technique suggesting instead that poorer visualization and more difficult instrument handling may even place the mini-perc technique at a slight disadvantage.

COMPLICATIONS OF PERCUTANEOUS RENAL SURGERY

Eventhough PCNL is a minimal invasive procedure for renal stones its not without complications. Prompt recognition and management of complications are critical. Equally important are prevention and minimization of these complications.

KEY POINTS: COMPLICATIONS OF PERCUTANEOUS RENAL SURGERY [24]

- The risk of hemorrhage is increased by more medial punctures, multiple punctures, and punctures into kidneys with abnormal anatomy.
- A tamponading balloon catheter (Kaye catheter) should be readily available in the surgical suite in case brisk bleeding or bleeding refractory to a large-bore nephrostomy catheter is encountered.
- Delayed bleeding after percutaneous procedures usually indicates the presence of a pseudoaneurysm or an arteriovenous fistula.
- If the renal pelvis is perforated during percutaneous surgery, maximal decompression with a ureteral stent and a nephrostomy tube should be accomplished and the procedure should be discontinued.
- Because the risk of injury to the lungs or pleura increases with more superior punctures, a postoperative chest radiograph should be obtained for all patients in whom an intercostal puncture is performed.
- In the case of colonic perforation during percutaneous renal surgery, the gastrointestinal and urinary systems should be separated to avoid fistula formation. A double-pigtail stent should be placed in the ureter and a nephrostomy tube should be placed in the colon

Sepsis although rare can sometimes complicate PCNL even though the urine culture is negative. 25% of stones particularly staghorn calculi harbor bacteria [25].

Death is a very rare complication after PCNL mostly due to cardiovascular causes [26]

GUY's Stone Scoring (GSS) [2,3]

PCNL has a very good success rate open stone surgery is now rarely needed. Although a minimally invasive option, PCNL is a major operation and always cannot make a patient stone free. There is clear benefits in having a standardized protocol of predicting the stone free rate after PCNL. Patients could be informed before surgery about the possibility of being stone-free after PCNL. It would help to objectively assess the technical improvements. Surgeon can then compare their results with predicted Stone Free Rate.

A scoring system that is simple, reproducible, easy and has a good correlation with Stone Free Rate would be the ideal method of predicting the outcomes after PCNL

Previously a number of approaches were used to classify complexity. Tefekli et al.,[27] divided stones in to simple and complex (staghorn).

No consistent correlation between severities of the complications and complexity but did find a non-statistically significant greater success rate for “simple” stones compared with “complex” ones.. Progress in the field of technical refinements for PCNL would be easier to monitor with a reliable grading system. Thomas K et al proposed a scoring system **Guy’s Stone Score** which is validated and predicts stone free rates after PCNL.

Guy’s Stone Score [2,3]

Grade I : Solitary stone in mid / lower pole or solitary stone in pelvis with simple anatomy

Grade II : Solitary stone in upper pole or multiple stones in patient with simple anatomy or solitary stone in patient with abnormal anatomy

Grade III : Multiple stones in a patient with abnormal anatomy OR Stones in a caliceal diverticulum or partial Staghorn calculus

Grade IV : Staghorn calculus or any stone in a patient with spina bifida/spinal injury.

Stone Free Rates for grade I, II, III & IV were 81%, 72%, 35% & 29%, respectively [2,3]. Multivariate linear regression analysis (SPSS) revealed that the Guy's stone score was the only factor that significantly and independently predicted the Stone Free Rate (P=0.01)[2,3]. None of the other factors (i.e., stone burden, operating surgeon, patient's weight, age, comorbidity, and urine culture) correlated statistically significantly with the Stone Free Rate.

Modified Clavien Grading System [28]

Earlier there was no consensus on how to define complications and stratify them by severity. This hampered comparison of outcome data generated difficulties in informing patients about complications. A new classification (modified Clavien System) has been proposed to grade perioperative complications of general surgery and has been validated in a cohort of 6336 patients [28]. The same classification system has recently been used by urologists to grade perioperative complications following radical prostatectomy, laparoscopic live donor nephrectomy, laparoscopic pyeloplasty, laparoscopic and open partial nephrectomy[29] and most recently Transurethral Resection of Prostate.

Results of this new classification to grade complications after PCNL have also been described.

Classification of Surgical complications according to the Modified Clavien System [28]

Grade 1: Any deviation from the normal postoperative course without the need for pharmacologic treatment or surgical, endoscopic, and radiologic interventions. Allowed therapeutic regimens include drugs such as antiemetics, antipyretics, analgesics, diuretics, electrolytes, and physiotherapy.

Grade 2: Complications requiring pharmacologic treatment with drugs other than allowed for Grade 1 complications. Blood transfusions and total parenteral nutrition are also included.

Grade 3a: Intervention not under general anesthesia

Grade 3b: Intervention under general anesthesia

Grade 4: Life-threatening complications, urosepsis (including central nervous system complications) requiring intensive care unit stay

Grade 4a: Single-organ dysfunction (including dialysis)

Grade 4b: Multiorgan dysfunction

Grade 5: Death of the patient.

MATERIAL AND METHODS

MATERIAL AND METHODS

Study Design: Prospective study

Duration : February 2012 to March 2013

Setting: Govt. Stanley Medical College and Hospital,Chennai.

Inclusion Criteria:

1) Patients with renal stone undergoing surgery-Percutaneous nephrolithotomy

Exclusion Criteria:

1) Patients not fit for surgery – bleeding diathesis, high cardiac risk, infection/ sepsis

Methodology:

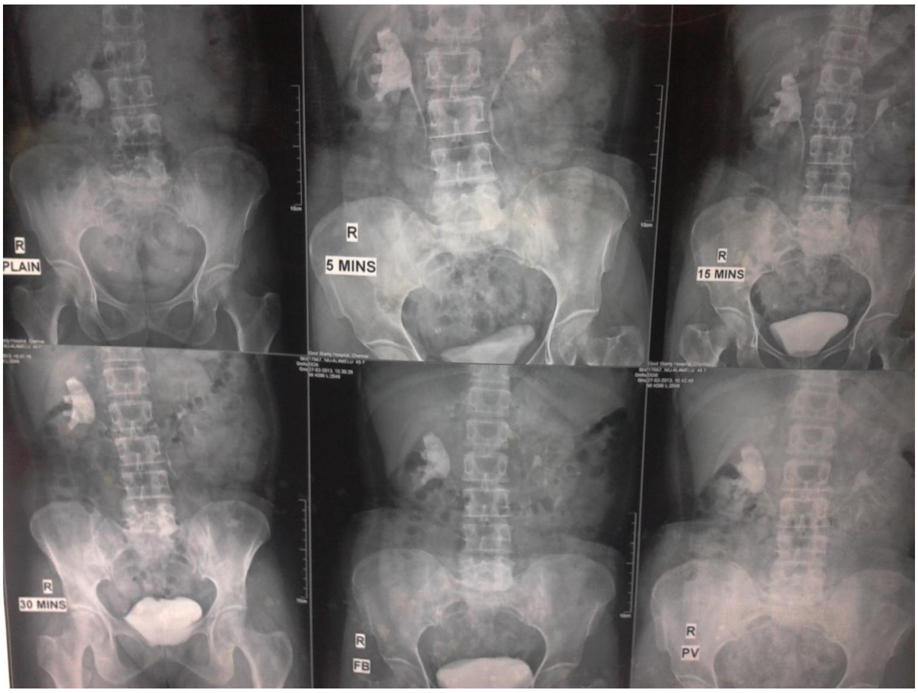
50 patients with symptomatic renal stones presenting to Urology OPD are evaluated and included in the study after informed consent. The indications for surgery are studied and patient is taken up for the same after anaesthetic fitness. PCNL is done using standard techniques. The complexity of procedure is graded using radiological studies and the outcome assessed based on “Guy’s Stone Score” and modified Clavien system.

PATIENTS AND METHODS:

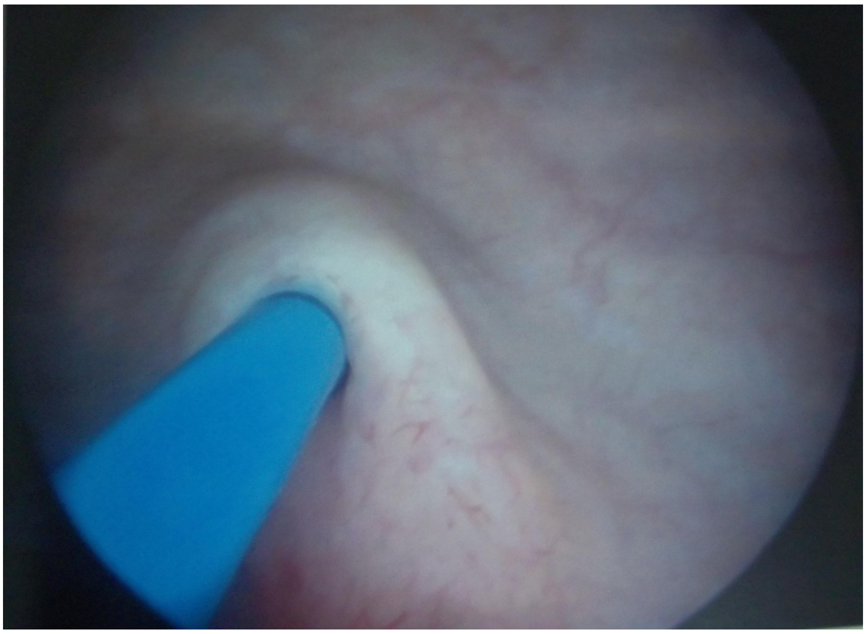
Our study included 50 patient who had symptomatic renal stones who underwent pcnl during the period between February 2012 to march 2013 All patients had basic investigations renal function test, urine cultures, xray KUB, ultrasound examination intravenous urogram and CT urogram in some All patients graded with Guy's stone score. Stone burden was defined as the maximum diameter of the stone on Kidney ureter bladder radiograph or CT urogram. Under general anesthesia, a 5F ureteral catheter was inserted in a retrograde fashion with cystoscope allowing the injection of saline or contrast media through a infant feeding tube attached to the ureteric catheter, no 16F foleys catheter was deployed. Patient is put in prone and PCNL is done. Puncture was done with 18 – gauge needle. A 0.035-inch terumo guide wire was then inserted. Then, skin incision of 10mm was made on the puncture site. This step was followed by multiple incremental Amplatz dilator set from 8F to 28 F dilators. Then, the dilators, were taken out and a 28F dilator was passed and a 30F Amplatz sheath was advanced over it, in some patients a single reusable 28F Amplatz dilator was advanced over an central guide rod after dilation with a 9F dilator. This single passage allowed the insertion of the 30F Amplatz working sheath. Amplatz dilator with the central guide rod was then removed after conforming that sheath is in the collecting system, terumo guide wire was retained in the system. Nephroscope was then introduced into the sheath, once the stone was seen,. Lithotripsy was done with the help of pneumatic lithoclast, fragments were retrieved out with the help of biopsy forceps or the water pressure itself. At any time if the amplatz sheath was displaced out of the system then methylene blue was injected into the ureteric catheter and it was followed. Once all the stone fragments are removed which we conform with fluoroscopy, 20fr percutaneous nephrostomy drain was deployed, amplatz sheath removed. In patients having residual stones a DJ stent was placed, PCN was removed on the post-operative day 1 and foleys catheter with the retrograde catheter removed on the second post op day.

At the end of the study demographic data, as well as intraoperative findings For each patient noted. Hemoglobin was done before the surgery *and* after surgery. Bleeding was considered a complication when it was severe enough to lead to procedural termination or requiring blood transfusion. All post operative complications like fever ,transient raise in creatinine, sepsis other organ injury, death due to procedure were noted and graded using modified clavien grading. Presence of significant residual calculus more than 4mm needing ancillary procedure was noted.

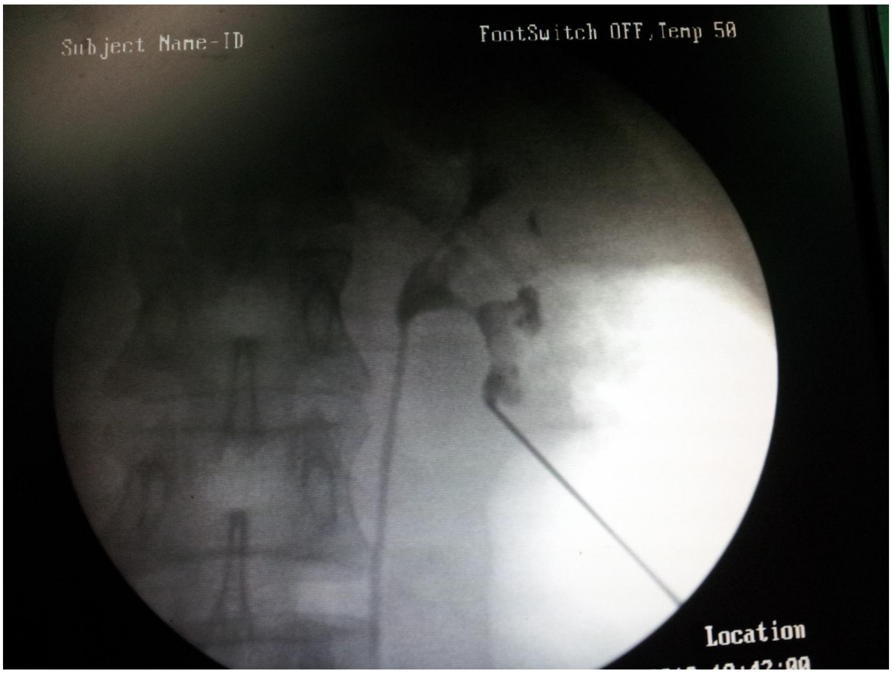
INTRAVENOUS UROGRAM OF A PATIENT WITH RIGHT STAGHORN CALCULUS.



URETERIC CATHETER PLACED IN URETERIC ORIFICE



PUNCTURE UNDER FLUOROSCOPY



AMPLATZ DILATORS

PCNL IN PROGRESS

RESULTS

RESULTS

50 patients underwent PCNL during the period February 2012 to March 2013. There were 25 males and 25 females, According to Guy's stone score grade I, II, III, IV there were 32 , 9, 6 & 3 patients respectively.

Grade I patients had solitary pelvic, lower or middle calyceal calculus.

In Grade II, 5 patients had multiple calculi, 3 patients had upper pole calculus and 1 patient had a horseshoe kidney with solitary calculus . All Grade III patients had partial staghorn calculus while Grade IV patients had a complete staghorn calculus.

Lowest Age of Patient was 11 years and highest was 70 years. The mean age was 42.48years.

There were a total of 25 complications noted in the 50 patients studied.

Residual stones that are defined as those of size more than 4 mm were noted in 19 patients. These patients had to undergo ancillary procedures for stone clearances.

We usually did only a single puncture which were mostly subcostal. We did supracostal puncture in one patient who developed pleural injury who needed intercostal drainage and intensive care for recovery.

The complications were graded and stratified using modified clavien grading. (Grade 4a and 4b that is life threatening complications sepsis, organ injury, intensive care are commonly Graded 4 in our study)

Fever was the presenting complaint in 8 patients; bleeding requiring only blood transfusion was seen in 11 patients and 2 patients needed open conversion for tackling the hemorrhage.

A transient raise in serum creatinine was noted in one patient, which recovered with conservative management.

Sepsis was seen in 2 patients who needed Intensive Care. 1 patient recovered after intensive care.

1 patient died of sepsis and associated cardiovascular condition (decreased Left ventricular function) in the whole series.

The mean operating time overall for all GUY grades was 88.4 min.

GRADE I: Mean 80.3 Min

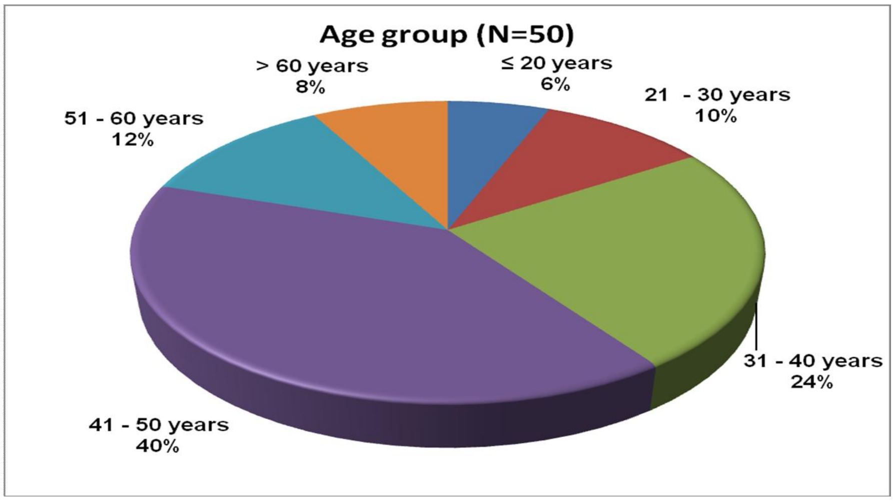
GRADE II : Mean 94.4 Min

GRADE III: Mean 111.67 Min

GRADE IV: Mean 110 Min

The mean stone burden according to the size was 2.8 cm.

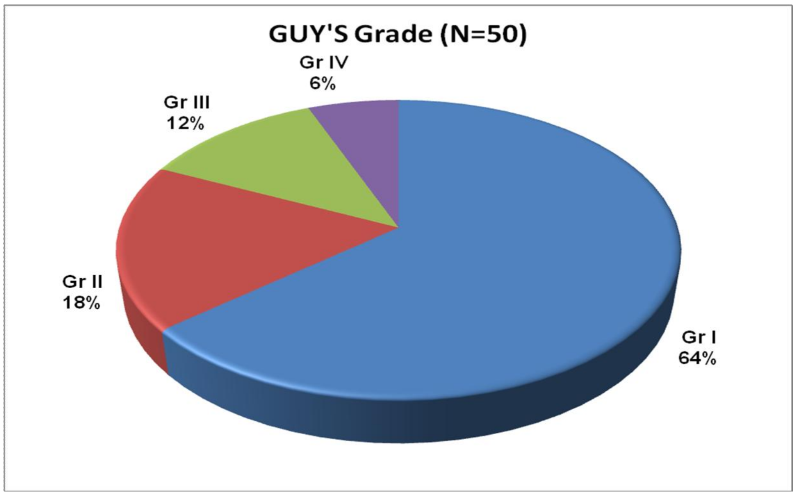
AGE DISTRIBUTION



Age group (years)	Frequency	Percent
<= 20	3	6.0
21 - 30	5	10.0
31 - 40	12	24.0
41 - 50	20	40.0
51 - 60	6	12.0
>60	4	8.0
Total	50	100.0

Gender was equally distributed in our series with 25 patients each noted in the male and female categories. Mean age of the study group was 42.48 years with a minimum of 11 years and maximum of 70 years.

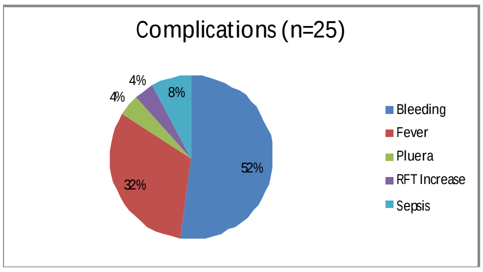
THE PATIENTS CLASSIFIED WITH GUY'S STONE SCORE



Guy Grade	Frequency	Percent
Gr I	32	64.0
Gr II	9	18.0
Gr III	6	12.0
Gr IV	3	6.0
Total	50	100.0

The commonest Guy's stone score grade noted in our study was Grade I (64%). This was followed by Grade II (18%) and Grade III (12%). The least number of patients in the study belonged to Grade IV (6%).

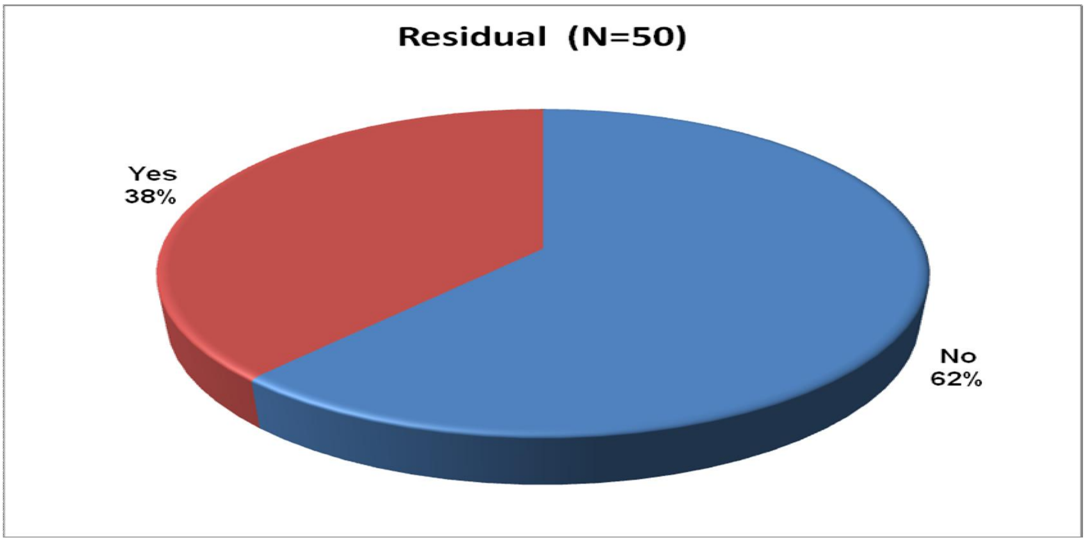
COMPLICATIONS AFTER PCNL



Complications	Percent
Bleeding	52
Fever	32
RFT Increase	4
Pleura injury	4
Sepsis	8

Complications were noted in 50% (25 patients) of the population studied. Among the complications, the most commonly noted one was bleeding (52%) followed by fever (32%). Sepsis was noted in 8% of the patients of which one person died in the post operative period in the whole series.

TOTAL NUMBER OF RESIDUAL CALCULUS AFTER PCNL

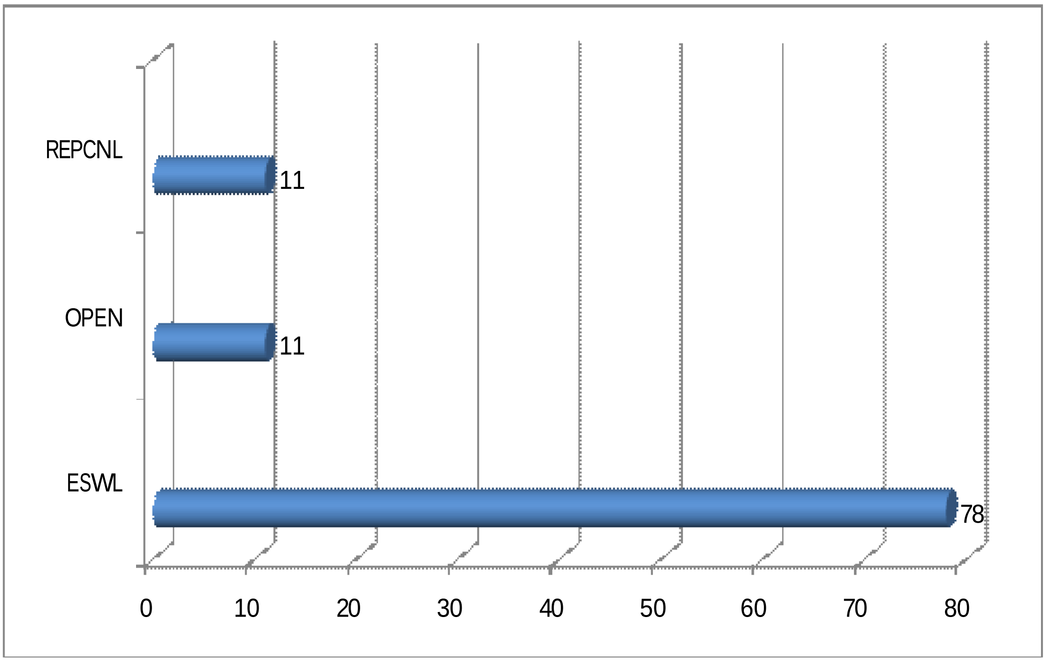


As there is increase in GUY's Grade Residual Stones Increase

		Guy Grade								Total	
		Gr I		Gr II		Gr III		Gr IV			
		N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Residual Stones	No	28	87.5	2	22.2	1	16.7	0	.0	31	62.0
	Yes	4	**12.5**	7	**77.8**	5	**83.3**	3	**100.0**	19	**38.0**
Total		32	100.0	9	100.0	6	100.0	3	100.0	50	100.0

Stone free rate (SFR) was 87.5% for patients with Guy's stone Grade I , 22.2% for Grade II, 16.7% for Grade III and O% for Grade IV. Hence it can be noted that as the Guy's stone grade increased the stone free rate decreased.

ANCILLARY PROCEDURES TO MANAGE RESIDUAL STONES



Ancillary	Frequency	Percentage
ESWL	14	78
Re look nephroscopy	2	11
Open	2	11

Ancillary procedure was required in 18 of the 19 patients with residual stones. One patient died of sepsis in the post operative period. Of the 18 patients , 14(78%) underwent ESWL as the fragments were deemed small (less than 1.5cm). Re look nephroscopy was required in two patients and in two patients conversion to open procedure was done.

THE MEAN AGE, STONE BURDEN, HOSPITAL STAY & OPERATING TIME

	Age	Hospital stay (days)	Stone burden	OP time (mins)
N	50	50	50	50
Mean	42.48	7.46	2.882	88.40
Std. Deviation	12.512	1.919	.4931	19.416
Minimum	11	6	2.5	70
Maximum	70	12	4.0	140
1st Quartile	33.75	6.00	2.500	77.50
Median	44.00	7.00	2.700	80.00
3rd Quartile	50.00	8.00	3.000	90.00

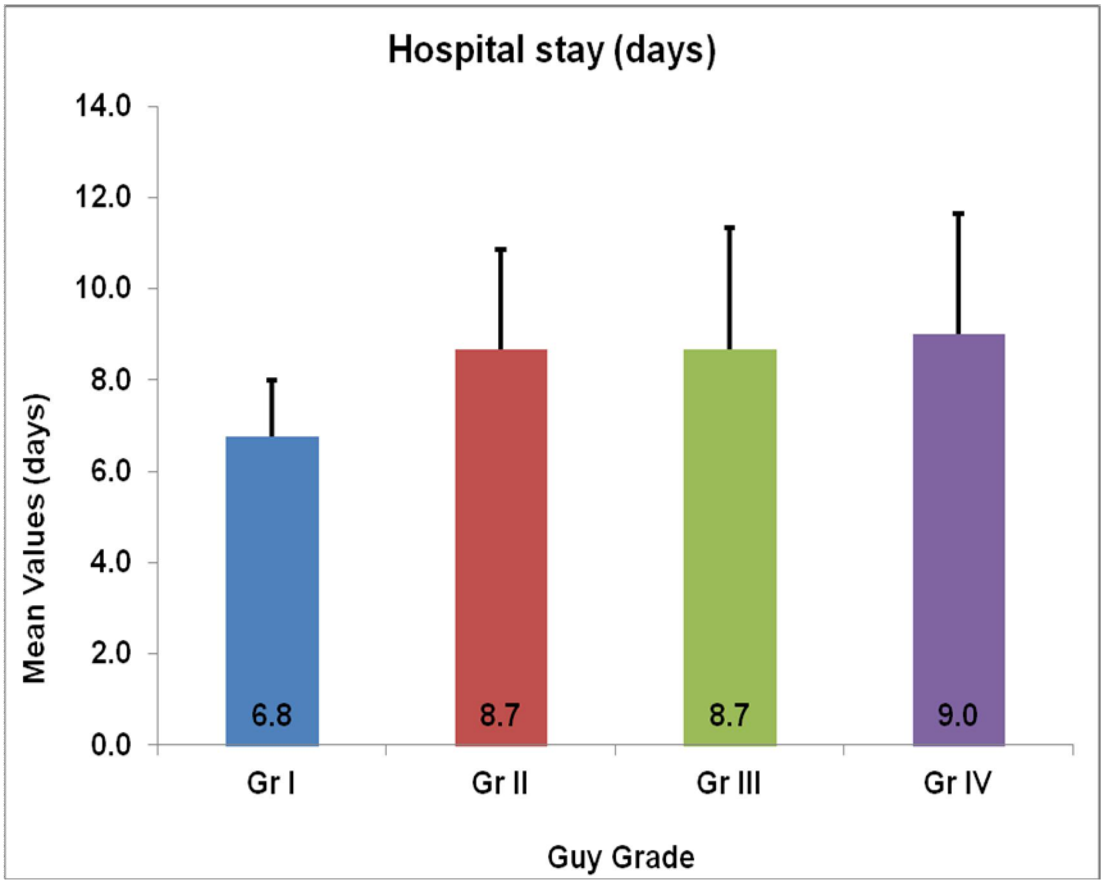
The mean age in the study group was 42.48 years.

The average duration of hospital stay was 7.46 days (range of 6 to 12 days).

The stone burden average was 2.882 cm with a minimum of 2.5 cm and a maximum of 4cm.

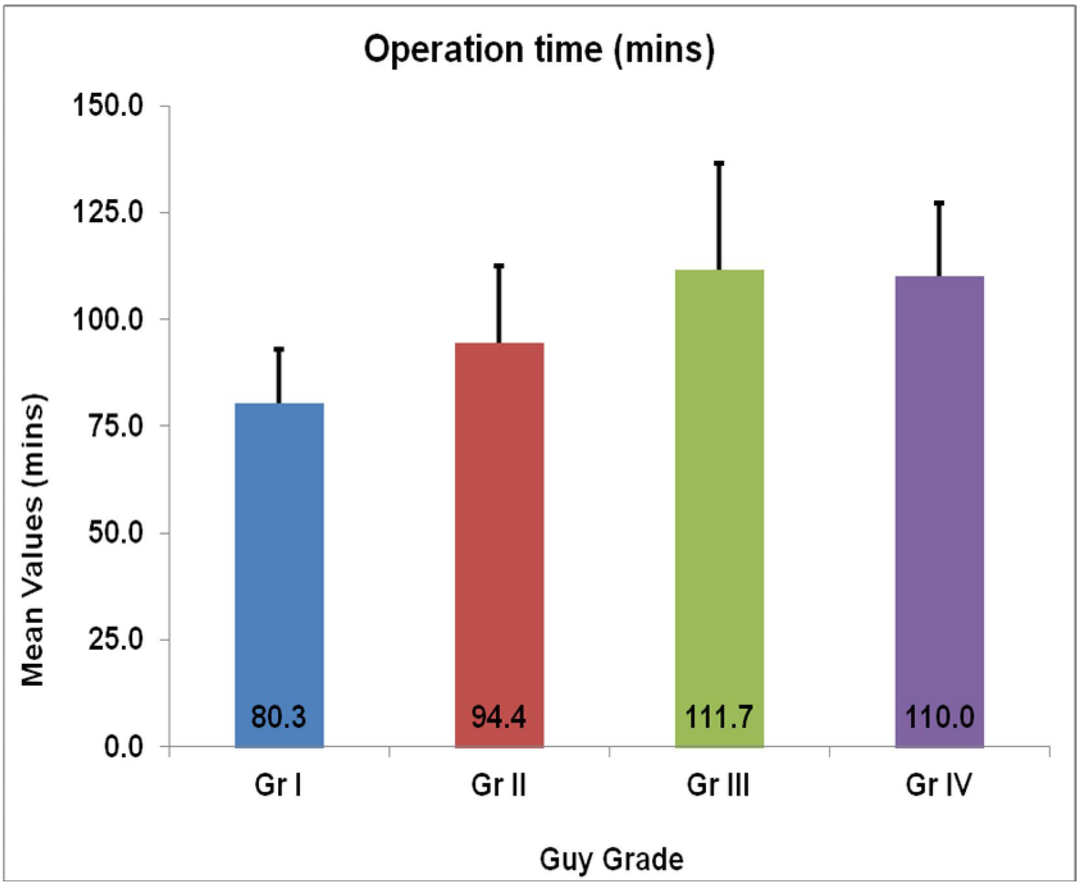
The mean operating time was 88.40 minutes (range of 70 to 140 minutes).

GUY'S GRADING AND MEAN HOSPITAL STAY



The mean hospital stay was 6.8 days for Guy's Gr I , it increased with Guy's Gr II 8.7 days and 9 days for Guy's Gr IV

GUY'S GRADING & OPERATING TIME



The mean operating times were 80.3 mins for Guy's Gr I

The mean operating times were 110 mins for Guy's Gr IV

Guy's Grading and Modified Clavien Grading Correlation

		Guy Grade								Total	
		Gr I		Gr II		Gr III		Gr IV			
		N	%	N	%	N	%	N	%	N	%
Clavien Grade	None	21	65.6	3	33.3	1	16.7	0	.0	25	50.0
	1	7	21.9	2	22.2	0	.0	0	.0	9	18.0
	2	3	9.4	1	11.1	3	50.0	2	66.7	9	18.0
	3b	1	3.1	2	22.2	0	.0	1	33.3	4	8.0
	4	0	.0	1	11.1	1	16.7	0	.0	2	4.0
	5	0	.0	0	.0	1	16.7	0	.0	1	2.0
Total		32	100.0	9	100.0	6	100.0	3	100.0	50	100.0

Minor Complications like fever & Bleeding Common in Guy's Gr I & II.

Major Complications like sepsis, Death was seen in Guy's Gr III & IV.

There is a trend towards major complications with increasing Guy's grades.

TEST FOR SIGNIFICANCE OF GUY’S GRADING WITH RESIDUAL STONES, COMPLICATIONS ANCILLARY PROCEDURES & CLAVIEN GRADES

Chi-Square Tests (Fisher's Exact Test)	Value	P-Value
Residual stone * Guy Grade	24.542	0.001
Complications * Guy Grade	30.930	0.001
Ancillary * Guy Grade	7.497	0.863
Clavien * Guy Grade	29.820	0.863

Guy’s Grading had significant impact on stone free rate & complication rate. Significant if $P<0.05$.

One way ANOVA to compare mean Operation times between Guy Grades

Variables	Guy Grade	N	Mean	Std. Dev	P-Value
OP time (mins)	Gr I	32	80.31	12.822	0.001 significant
	Gr II	9	94.44	18.105	
	Gr III	6	111.67	24.833	
	Gr IV	3	110.00	17.321	
	Total	50	88.40	19.416	

Operating Time were minimal in low grades and increased with higher grades it was significant with P is<0.05.

One way ANOVA to compare mean Hospital stay between Guy Grades

Variables	Guy Grade	N	Mean	Std. Dev	P-Value
Hospital stay (days)	Gr I	32	6.75	1.244	0.004 significant
	Gr II	9	8.67	2.179	
	Gr III	6	8.67	2.658	
	Gr IV	3	9.00	2.646	
	Total	50	7.46	1.919	

GUY's Grading had significant impact on the hospital stay with P value of 0.004. (significant since P < 0.05).

DISCUSSION

DISCUSSION

In spite of the high success rates, serious complications such as blood loss adjacent organ injuries and life threatening infections can occur during percutaneous renal surgery. In a large study [30] retrospective analysis of complications reported minor complications like fluid extravasation 7.2 % transfusion 11.2 – 17.5 % and fever 21.0 – 32.1 %, whereas major complications were septicaemia 0.3-4.7 % and colonic or pleural injury 0.03-3.1 % [30]. Modified Clavien grading system has been shown to be reliable tool for more objective outcome comparisons [31]. (Graefen M et al)

The overall complications rate of 50% was seen in our patients. Which is much higher than reported larger studies. That is 20.5 % (Rosette J et al) [32]. However in comparison to a similar prospective study by (Mandal S et al), [33] they had an overall complication rate of 41.7% which is comparable to our study.

One reason for this could be the procedures were performed during the learning curve of surgeons [34]. Another reason could be the prospective nature of study.

Complications of grade II severity was the most common. Bleeding requiring blood replacement was most common individual complication, observed in 26 % of patients.

This may be due to the poor body reserve of the low socio economic group of patients presenting to our hospital[35]. Blood transfusion was done if the haemoglobin level was below 8 gm percentage or as clinically assessed.[36,37]

Open conversion was done to manage bleeding in 2 patients.

Fever in the postoperative period was the second common complication seen in 16 % patients. Fever usually subsided with oral medication. Factors predisposing to fever after PCNL, include preexisting untreated urinary tract infection, infected urinary stones, duration of surgery[38].

Pleural injury was seen in one patient who had supracostal puncture which was managed by intercostal drainage and intensive care for few days.

Two patients had severe sepsis one recovered after intensive care, the other patient could not be revived. He died of sepsis superadded with cardiovascular complication. Septicemia can occur as a result of infection introduced via the access to the kidney or if the stones are infected [32,33].

Though the number of complications might seem to be high in our study however most of complications are minor, that is modified clavien grades 1 & 2 only, which were managed conservatively.

Stone free rate and Guy's stone score Grades (GSS)

As in previous study by Thomas et al.,[2,3] the GSS precisely predicted the Stone Free Rate after PCNL. The stone free rate for GSS Grade I is 87.5% for Grade II is 22.2 %, Grade III 16.7% and Grade IV 0 % . This was statistically significant with P = 0.001.

The complications rates were also minor, modified clavien grades 1 & 2 in majority of patients having low Guy's Stone score. There was a trend towards major complications as the GSS Grade increased.

The mean operating time for GSS Grade I 80 min and Grade IV is 110 min.

The mean hospital stay was also significantly low 6.8 days in GSS Grade I & 9 days in GSS Grade IV.

The main strength of the study is the prospective nature of the study.

The limitations of the present study is the small sample size.

CONCLUSION

CONCLUSION

In this study involving a relatively lesser number of cases from a tertiary care and resident training institute, the complication rates after PCNL was around 50 % mainly because of the learning curve in doing a new procedure. Most of the complications were minor which were treated conservatively.

The Guy’s stones score predicted the stone free rates correctly with higher Guy’s stones score needing ancillary procedures mainly in the form of extracorporeal shock wave lithotripsy for stone clearance.

Guy’s stones score correlated well with the modified clavien system of grading for perioperative complications.

The Guy’s stone score is easy to use and reproducible. It can be used as an objective and reliable method for describing the complexity of PCNL predicting the stone free rate, and stratifying cases between surgeons of different experience and reporting results.

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PROFORMA

PROFORMA

1) Name:

2) Age :

3) OP/ IP No:

4) Address and Phone No:

5) History :

- Loin pain : side, duration, nature
- Dysuria, hematuria, pyuria, calculuria
- Fever, vomiting, Decreased urine output
- H/O similar episodes in the past
- H/O previous surgery
- H/O DM/HTN/PT/IHD/COPD
- H/O prolonged drug intake/ alcohol/ smoking
- Any other significant history

6) General Physical Examination

- Pallor/Icterus/Cyanosis/GLA/Pedal edema

7) Systemic Examination :

- CVS :
- RS:
- CNS:
- P/A :
- Examination of Ext.Genitalia and Testes:
- DRE:

8) Investigations :

- CBC
- RBS,RFT
- Urine R/E and C/S
- Serum Calcium, Uric acid, Phosphorus
- Xray KUB
- USG KUB
- IVU/ CECT

- Guy’s Stone Grading

9) Surgery Details :

- Date : Type of Anesthesia:
- Completed/Converted (including reasons for conversion)
- Type of puncture:
- Number of Puncture:
- Intra op (Including complications)
- Operating time:
- Stent / Nephrostomy :
- Post op Period :

  Any complications:

  Modified clavien grading
- Post op Imaging to assess stone clearance:
- Ancillary procedures

MASTER CHART

MASTER CHART														
S. NO	**Patient Name**	**sex**	**Age**	**Stay**	**side**	**Location**	**stone burden cms**	**Guy Gr**	**Punture**	**Residual stone**	**OP time**	**Compli-cation**	**Modified clavien grade**	**Ancillary**
1	SUGANA	F	38 Y	12	RT	multiple	3	2	1	No	80			
2	MUTHULAKSHMI	F	40 Y	6	RT	middle	2.5	1	1	No	70			
3	ANJALI DEVI	F	49 Y	6	LT	lower	2.5	1	1	No	80			
4	JAYALAXMI	F	50 Y	6	LT	middle	2.8	1	1	No	70	fever	1	
5	KALA	F	27 Y	6	LT	lower	2.8	1	1	No	70			
6	RAJALAKSHMI	F	35 Y	8	LT	staghorn	4	4	1	Yes	120	bleed	2	eswl
7	VALLI	F	44 Y	6	RT.	pelvic	2.5	1	1	No	70			
8	RAJALAKSHMI	F	50 Y	7	LT	pelvic	2.8	1	1	No	80	fever	1	
9	SASIKALA	F	33 Y	6	RT	pelvic	2.5	1	1	No	80			
10	SADAIYAMMAL	F	50 Y	7	LT	multiple	3	2	1	Yes	90	fever	1	eswl
11	VIJAYA	F	23 Y	12	LTt	partial staghorn	3.5	3	1	Yes	90	bleed	2	eswl
12	PADMAVATHY	F	35 Y	7	LT	staghorn	4	4	1	Yes	90	bleed	2	eswl
13	LAKSHMI	F	29 Y	8	RT	horse shoe/single pelvic	3	2	1	Yes	90	bleed	2	eswl
14	CHELLAMMA	F	20 Y	7	RT	lower	2.5	1	1	No	70	fever	1	

15	KAMALA	F	38 Y	6	RT	multiple	2.5	2	1	No	80	sepsis	4	
16	INDIRA	F	55 Y	12	RT	staghorn	4	4	1	Yes	120	bleed	3b	open
17	SHANTHI	F	49 Y	12	LT	upper	2.5	2	1	Yes	140	bleed	3b	open
18	BABU	M	41 Y	8	LT	multiple	3	2	1	Yes	100	rft increas	1	eswl
19	VENISH	M	32 Y	8	LT	Partial staghorn	3.5	3	1	Yes	140			eswl
20	SARPUTHEN	M	54 Y	7	RT	partial staghorn	3	3	1	Yes	90	bleed	2	eswl
21	PALANI	M	47 Y	6	RT	pelvic	2.5	1	1	No	80			
22	BASKARAN	M	44 Y	6	LT	pelvic	2.5	1	1	Yes	80	fever	1	eswl
23	DHANASEKAR	M	38 Y	6	RT	pelvic	2.5	1	1	No	70			
24	BALAKRISHNA	M	50 Y	7	RT	Partial staghor	3.5	3	1	Yes	90	bleed	2	eswl
25	RAJASEKAR	M	31 Y	6	RT	lower	2.5	1	1	No	70			
26	CHANDRAPRAKASH	M	31 Y	7	LT	pelvic	2.6	1	1	No	80			
27	PRAKASH	M	11 Y	7	LT	middle	2.5	1	1	No	80			
28	SANTHANAM	M	62 Y	7	LT	pelvic	3	1	1	No	80			
29	SIVAKUMAR	M	42 Y	6	RT	partial staghorn	3.5	3	1	yes	120	Sepsis/death	5	
30	Pandurangan	M	50 Y	6	LT	pelvic	2.5	1	1	No	90	bleed	2	
31	BAKKIYANATHAN	M	48 Y	7	RT	lower	2.5	1	1	No	80			

32	Shantha kumar	M	50 Y	7	RT	pelvic	3	1	1	No	70			
33	BHAVANI	F	44 Y	7	RT	lower	2.5	1	1	Yes	80	fever	1	eswl
34	VELMURUGAN	M	24 Y	8	RT	upper	2.5	2	1	Yes	90			eswl
35	ANNAKILI	F	47 Y	6	LT	pelvic	2.8	1	1	No	80			
36	DINESH	M	28 Y	6	LT	lower	2.5	1	1	No	70			
37	SOLAI	M	44 Y	12	LT	lower	2.5	1	1	Yes	120	bleed	3b	relook
38	SAMUNDEESHWARI	F	34 Y	6	LT	pelvic	2.5	1	1	No	80			
39	PARTHIBAN	M	42 Y	6	RT	lower	2.8	1	1	No	70			
40	GANDHIMATHI	F	59 Y	7	RT	lower	2.5	1	1	No	80	fever	1	
41	MARIMUTHU	M	42 Y	7	LT	pelvic	2.5	1	1	No	90			
42	VINAYAGAM	M	61 Y	7	RT	pelvic	2.5	1	1	No	70	fever	1	
43	ALAMELU	F	55 Y	10	Rt	Pelvic	4	1	1	Yes	120	bleed	2	eswl
44	PRASANTH	m	20 Y	7	RT	multiple	3	2	1	No	90			
45	GOMATHI	F	58 Y	7	LT	lower	3.5	1	1	No	90			
46	JAKUBAI	F	70 Y	7	LT	pelvic	4	1	1	No	100	bleed	2	eswl
47	SELVARAJ	M	55 Y	7	RT	pelvic	2.5	1	1	No	70			
48	SEBASTIN	M	47 Y	6	RT	pelvic	2.5	1	1	No	80			
49	MARIMMAL	F	63y	12	RT	Partial staghor	3	3	1	Yes	140	Pleura inj/icu	4	
50	RAJENDRAN	M	35 Y	10	RT	upper	3	2	1	Yes	90	bleeding	3b	relook