INTRODUCTION

Urolithiasis in children is an important health issue. The optimal management for pediatric stone disease is still evolving. The treatment should not impair the growth and function of the young kidneys ***(Smaldone et al., 2010).***

Surgical management of urolithiasis in children has been changed dramatically in the last 2 decades. Before 1980, there was no role except for the open surgical procedures for pediatric renal stones that meet the indications of active intervention. During the 1980s, the advent of Extracorporeal Shock Wave Lithotripsy (ESWL) and endourological techniques revolutionized pediatric stone management and is currently the procedure of choice for treating most upper tract calculi in industrialized nations ***(Smaldone et al., 2009).***

Currently, the majority of stones in children can be managed either with Extracorporeal shock wave lithotripsy (ESWL), percutaneous nephrolithotomy (PNL) or ureteroscopy (URS), or a combination of these modalities, but open surgery is currently needed in a limited percentage of all cases ***(Tanrıverdi et al., 2011).***

Extracorporeal shock wave lithotripsy is the preferred treatment for small upper urinary tract calculi smaller than 20 mm in children because of its ease of application and efficacy. More effective disintegration of even larger stones, together with swifter and uncomplicated discharge of larger fragments, can be achieved in children by ESWL ***(Gnessin et al., 2012).***

Extracorporeal shock wave lithotripsy is often utilized as the first line treatment. However, the long term safety of ESWL has been questioned. Furthermore due to the higher incidence of metabolic and anatomical abnormalities in the pediatric stone patients, any residual stone after ESWL can more lead to recurrence. One of the goals in management of pediatric stones is to minimize the need for retreatment, and thus any possible treatment options to achieve a stone-free status in this age group are very important and should not be limited or precluded. The ideal treatment should therefore be minimally invasive with high stone free rate (SFR) and lower retreatment rate ***(Smaldone et al., 2010).***

Percutaneous nephrolithotomy consider one of the minimally invasive treatment strategies. PCNL can be performed safely and effectively to achieve a higher stone-free rate and allow a short treatment period in most patients, despite its well-known hazardous and serious complications ***(Sabnis et al., 2012).***

The slow acceptance of using this technique in children was due to concerns regarding long-term renal damage, small kidney size, relatively large instruments, radiation exposure, and the risk of major complications, including bleeding. However, as surgeons' experience increased in this field, the results of relatively large surgical series demonstrated that scarring and insignificant loss of renal function after this procedure were expected to be minimal ***(Samad et al., 2007).***

Initially, percutaneous renal surgery was recommended only for children over the ages of 5 to 8 years for fear of increased complications in younger children. However, others have suggested that complications encountered are not age dependent, and several major complications have been reported in the older children. It appears that these complications are more likely related to the size of the stone burden and not the age of the patient. Finally, results have clearly shown that younger children can safely undergo percutaneous nephrolithotomy by experienced endourologists ***(Desai et al., 2004)***.

However, PCNL can still be associated with significant morbidity, such as sepsis, bleeding, injury to surrounding viscera, or even loss of the kidney unit. Also, in real-life practice, the usual 26–30Fr tract size of PCNL may be too large in the pediatric system and in some adult undilated systems, and this has brought the need of using a smaller-size tract and also the idea that a small tract may further enhance the minimal invasiveness of the procedure ***(Shu et al., 2006).***

While earlier reports of performing PNL in children described the use of adult-size instruments, advancements in instrumentation have revolutionized the endourological management of stones in children ***(Tanrıverdi et al., 2011).***

Advancements in instrumentation (such as small nephroscopes) and availability of more efficient energy sources for intracorporeal lithotripsy (such as holmium:YAG laser) had enabled endourological procedures in children to be safely and effectively performed with mini-PCNL techniques ***(Guven et al., 2011)***.

Minimally invasive percutaneous nephrolithotomy (MPCNL), a modified standard PCNL with smaller percutaneous tract size (14– 20F), has been proven to be safe and efficacious in treating both pediatric and adult patients ***(Samad et al., 2006).***

The mini-PCNL technique is believed to have several advantages, including decreased blood loss and shorter hospital stays. As the risk for bleeding complications is related to the number and caliber of tracts used, limited transfusion rates have been reported with this technique ***(Guven et al., 2010).***

Aim of the Work

The aim of the work is to evaluate & compare the results of mini-percutaneous nephrolithotomy vs. extracorporeal shock wave lithotripsy in management of pediatric renal stones as regards effectiveness, safety, the need for retreatment, auxiliary treatment and any complication of both approaches.

Anatomy of the Kidney

The kidneys are paired organs lying retroperitoneally on the posterior abdominal wall. Each kidney is of a characteristic shape, having a superior and an inferior 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 ***(Sampaio et al., 2000).***

Position of the Kidneys:

Because the kidneys lie on the posterior abdominal wall, against the psoas major muscles, their longitudinal axis parallels the oblique course of the psoas. Moreover, since the psoas major muscle has a shape of a cone, the kidneys also are dorsal and inclined on the longitudinal axis. Therefore, the superior poles are more medial and more posterior than the inferior poles. Because the hilar region is rotated anteriorly on the psoas muscle, the lateral borders of both kidneys are posteriorly positioned. It means that the kidneys are angled 30 to 50° behind the frontal (coronal) plane (Figure 1) ***(Sampaio et al., 2000).***

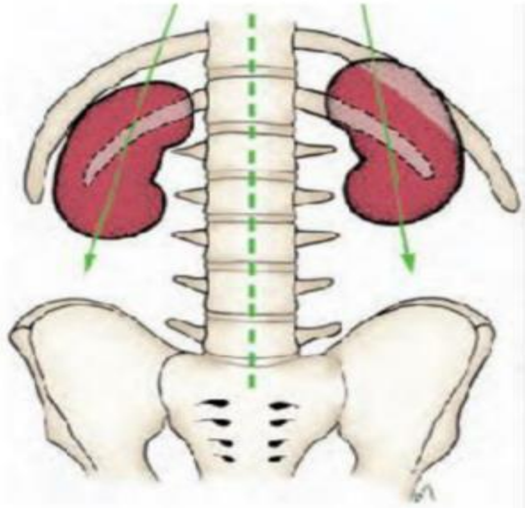


Figure (1): Anterior view of the kidneys in relation to the skeleton, shows that the longitudinal axes of the kidneys are oblique (arrows) ***(Sampaio et al., 2000).***

Kidney Relationships:

I. Kidney relationships with diaphragm, ribs, and pleura

The kidneys lie on the psoas and quadratus lumborum muscles. Usually, the left kidney is higher than the right kidney, being the posterior surface of the right kidney crossed by the 12th rib and the left kidney crossed by the 11th and 12th ribs ***(Hopper et al., 1990).***

The posterior surface of the diaphragm attaches to the extremities of the 11th and 12th ribs. Close to the spine, the diaphragm is attached over the posterior abdominal muscles and forms the medial and lateral arcuate ligaments on each side. In this way, the posterior aspect of the diaphragm (posterior leaves) arches as a dome above the superior pole of the kidneys, on each side. Therefore, when performing an intrarenal access by puncture, the endourologist may consider that the diaphragm is traversed by all intercostal punctures, and possibly by some punctures below the 12th rib. Also, it can be expected that the pleura is transversed without symptoms in most intercostal approaches ***(Hopper et al., 1990).***

Generally, the posterior reflection of the pleura extends inferiorly to the 12th rib; nevertheless, the lowermost lung edge lies above the 11th rib (at the 10th intercostal space). Regardless of the degree of respiration (mid- or full expiration), the risk of injury to the lung from a 10th intercostal percutaneous approach to the kidney is prohibitive (figure 2) ***(Hopper et al., 1990).***

Any intercostal puncture should be made in the lower half of the intercostal space, in order to avoid injury to the intercostal vessels above ***(Hopper et al., 1990).***

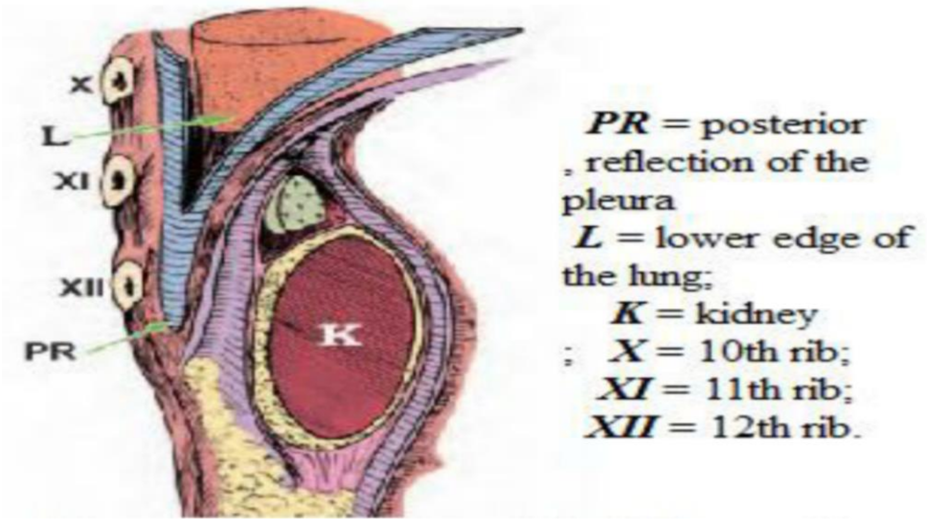
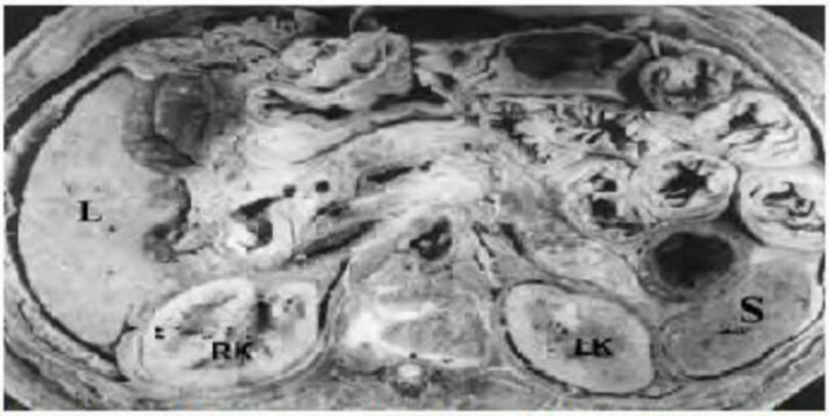


Figure (2): Lateral view of the kidney and its relationships with the diaphragm, ribs, pleura and lung ***(Hopper et al., 1990).***

II. Kidney relationships with liver and spleen

The liver on the right side and the spleen in the left may be posterolaterally positioned at the level of the suprahilar region of the kidney, because at this point, these organs have their larger dimensions. Therefore, one may remember that a kidney puncture performed high in the abdomen has little space for the needle entrance (Figure 3) ***(Sampaio et al., 2000).***

If the intrarenal puncture is performed when the patient is in mid - or full inspiration, the risk to the liver and spleen is increased. This knowledge is particularly important in patients with hepatomegaly or splenomegaly, on whom a computed tomography (CT) scan should be performed before puncturing the kidney ***(Sampaio et al., 2000).***



(L) the liver, (S) the spleen, (RK) right kidney, (LK) left kidney

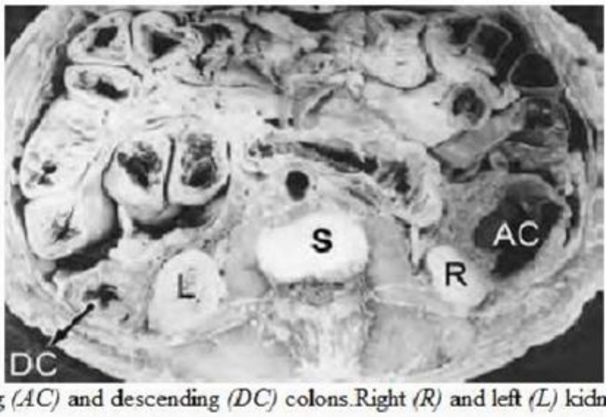
Figure (3): Inferior view of a transverse section of the kidney ***(Sampaio et al., 2000).***

III. Kidney relationships with ascending and descending colons

The ascending colon runs from the ileocolic valve to the right colic flexure (hepatic flexure), where it passes into the transverse colon. The hepatic colic flexure (hepatic angle), lies anteriorly to the inferior portion of the right kidney. The descending colon extends inferiorly from the left colic flexure (splenic flexure) to the level of the iliac crest. The left colic flexure lies anterolateral to the left kidney. It is important to consider the position of the retroperitoneal ascending and descending colons. Occasionally, it was observed in the course of routine abdominal CT scan examinations, that the retroperitoneal colon is lying in a posterolateral or even a post-renal position ***(Hopper et al., 1987).***

Hence, in these cases, it is at great risk of being injured during the intrarenal percutaneous approach. This event (retrorenal colon) more commonly occurs with regard to the inferior poles of the kidneys (Figure 4). In a controlled study, it was demonstrated by CT scan that, when the patient is in the supine position, the retrorenal colon was found in 1.9% of the cases. Nevertheless, when the patient assumes the prone position (the more frequent position used for percutaneous access to the kidney) the retrorenal colon was found in 10% of the cases ***(Anderson and Cadeddu, 2007).***

Therefore, special attention should be given, under fluoroscopy and with the patient in the prone position, to detecting patients with retrorenal colon prior any invasive percutaneous renal procedure. This examination is especially important in the area of the inferior poles of the kidneys ***(Anderson and Cadeddu, 2007).***



The ascending *(AC)* and descending *(DC)* colons. Right *(R)* and left *(L)* kidneys. *S* = spine.

Figure (4): Superior view of a transverse section at the level of the inferior poles of the kidney ***(Sampaio et al., 2000).***

Intrarenal Vessels:

Intrarenal Arteries

Generally, the main renal artery divides into an anterior and a posterior branch after giving off the inferior suprarenal artery. Whereas the posterior branch (retropelvic artery) proceeds as the posterior segmental artery to supply the homonymous segment without significant branching, the anterior branch of the renal artery provides three or four segmental arteries. The segmental arteries divide before entering the renal parenchyma into interlobar arteries (infundibular arteries), which progress adjacent to the calyceal infundibula and the minor calices, entering the renal columns between the renal pyramids (Figure 5) ***(Anderson and Cadeddu, 2007).***

As the interlobar arteries progress, near the base of the pyramids, they give origin to the arcuate arteries. The arcuate arteries give off the interlobular arteries, which run to the periphery giving off the afferent arterioles of the glomeruli ***(Sampaio et al., 2000).***

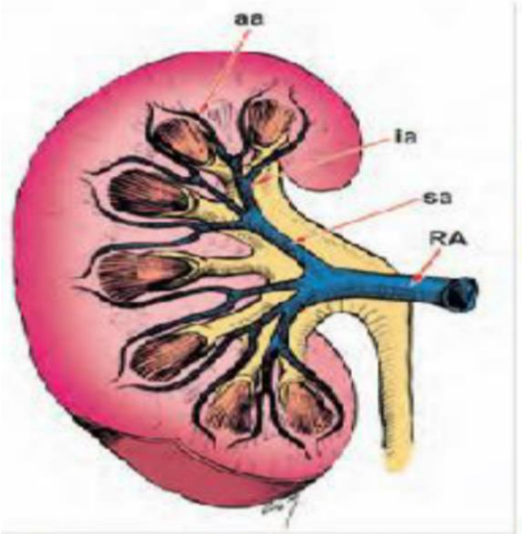


Figure (5): Intra renal arteries of the right kidney ***(Sampaio et al., 2000).***

Intrarenal Veins

The intrarenal veins, unlike the arteries, do not have a segmental model. Moreover, in contrast to the arteries, there is free circulation throughout the venous system, providing anastomoses between the veins. These anastomoses, therefore, prevent parenchymal congestion and ischemia in case of venous injury ***(Sampaio et al., 2000).***

The small veins of the cortex, called stellate veins, drain into the interlobular veins that form a series of arches (Figure 6). Within the kidney substance, these arches are arranged in arcades, which lie mainly in the longitudinal axis. There are usually three systems of longitudinal anastomotic arcades and the anastomosis occur in different levels between the stellate veins (more peripherally), between the arcuate veins (at the base of the pyramids) and between the interlobar (infundibular) veins (close to the renal sinus). This anastomosis was named as first order, second order, and third order, from periphery to center ***(Anderson and Cadeddu, 2007).***

Figure (6): The venous vascular tree of the left kidney ***(Sampaio et al., 1990).***

Pelvicalyceal System:

The renal Parenchyma consists basically of two kinds of tissue, the cortical tissue and the medullar tissue. On a longitudinal section, the cortex forms the external layer of renal parenchyma. The renal medulla is formed by several inverted cones, surrounded by a layer of cortical tissue on all sides (except at the apexes). As in longitudinal sections, a cone assumes the shape of a pyramid, and the established expression for the medullar tissue is renal pyramid; the apex of a pyramid is the renal papilla. The layers of cortical tissue between adjacent pyramids are named renal columns (cortical columns of Bertin) (Figure 7) ***(Sampaio et al., 2000).***

The cortical tissue comprises the glomeruli with proximal and distal convoluted tubules. The renal pyramids comprise the loops of Henle and collecting ducts; these ducts join to form the papillary ducts (about 20) which open at the papillary surface, draining urine into the collecting system into the fornix of a minor calix. A minor calix is defined as the calix that is in immediate apposition to a papilla. The renal minor calices drain the renal papillae and range in number from 5 to 14 (mean 8); although the number of minor calices is widely varied, we found 70% of the kidneys presenting 7 to 9 minor calices ***(Sampaio et al., 2000).***

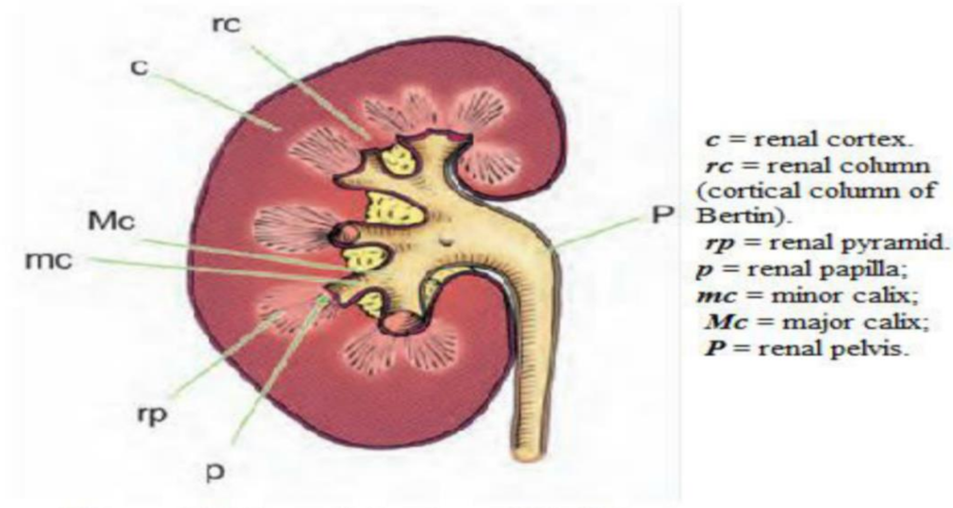


Figure (7): Intrarenal structure of the kidney ***(Sampaio et al., 2000).***