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Recent Advances in the Surgical Treatment of Pediatric Stone Disease Management

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Abstract

The advances in technological equipments in the last decade for the treatment of pediatric stone disease has significantly improved outcomes. A variety of nephroscopes of different sizes which can be used for different age groups are available on the market to treat kidney stones. Flexible ureteroscopes, ultrathin ureteroscopes, and other sizes of semirigid ureteroscopes are also available for the treatment of ureteral and upper urinary tract calculi in children. In addition to the advancement of the finer instruments, laser technology with different powers has improved fragmentation of the stones. The advancement of stone retrival devices and baskets facilitated the procedures by decreasing the complications. Open stone surgery has almost disappeared and together with laparoscopy, it is only reserved for stones in children with anatomical abnormalities (pelvic kidneys, spinal deformities, etc.). Beyond surgical alternatives, although its use has proportionally decreased over time, shock wave lithotripsy is here to stay as a valuable option. Nevertheless, *personalized management* is the key to treat pediatric stone disease and it is the task of the surgeons to find out the best alternative according to the size and location of the stone, and age and body size of the child. Future technical improvements are also awaited and will soon improve the efficiency of the current endourological procedures.

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1. Introduction

The incidence of pediatric stone disease is increasing not only in the east but also in the western world [1]. Due to the recurrent nature of pediatric stones, new strategies to achieve stone-free status in children have emerged. The most important strategy within the last decade has been the technical advances of the instruments which are suitable for use in the pediatric population. Various types and sizes of novel instruments including different nephroscopes (mini, ultramini, micro, etc.), different sizes, and characteristics of ureteroscopes (flexible ureteroscopy [fURS], ultrathin ureteroscope [URS], etc.), and many other advancements in supplementary equipments (laser devices, stone retrieval baskets, etc.) changed the course of outcomes in pediatric calculi [2]. It is obvious that open stone surgery has now almost disappeared and the vast majority of pediatric stone disease can be managed with endoscopic treatment options.

The advancements in technical equipments changed the recommendations of the European Association of Urology/Euroepan Society for Paediatric Urology guidelines over the years. Although shock wave lithotripsy (SWL) is still the first choice in many stone cases, mini-percutaneous nephrolithotomy (mini-PNL), micro-PNL, and retrograde intrarenal

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surgery (RIRS) are listed as potential alternatives in pediatric kidney stone management [2]. However, in clinical practice, the popularity of endoscopic treatment options surpassed the performance of SWL in both the USA and Europe, and there is a proportionally decreased rate of SWL use worldwide [3].

Having all the technical equipments in hand, the surgeon needs to find out the best treatment option for the patient and personalized management is the key to the success of each procedure. In this review, we aim to provide the recent advances in the surgical treatment of pediatric stone disease in the era of new technology.

2. PNL

Historically, the treatment of renal stones in children with PNL lagged behind several years after the adult procedures. This may be attributed to the safety concerns regarding new technology. The first adult PNL was reported in 1976, whereas the first pediatric percutaneous stone removal was reported in 1987 [4,5]. Since then, the global experience with PNL in different age groups has increased and it is now accepted as one of the most effective treatment options in the management of kidney stones with stone-free rates of more than 90% in the pediatric population.

Standard or conventional PNL is the starting point of this minimally invasive surgery and is performed through a 24–30-F amplatz sheath. Adult-size instruments were used in the initial reports of PNL in children [6]. Those initial series did not include children under the age of 5 yr due to general concerns about using large instruments in small kidneys. The outcomes of standard PNL in children were satisfactory in the majority of the series with success rates between 90% and 100%. However, the concerns over its invasiveness and the risks of bleeding and parenchymal damage are still questioned. In one of the largest multicenter studies of PNL in 1205 children, large tract size (> 20 F) was found to be an independent predictor of bleeding complications necessitating transfusion [7].

Therefore, miniaturization of the instruments has brought us mini, ultramini, and micro PNL as a result of safety concerns in children (Fig. 1). In order to standardize the nomenclature, in this review the following tract sizes describing different procedures will be as follow: standard PNL: 24–30 F, mini-PNL: 15–24 F, and ultramini-PNL: 11–15 F, micro-PNL: below 11 F.

2.1. *Technique of the procedure*

The author's technique is described as the following. A computed tomography scan with good anatomical vision is always available in order to decide the access and procedure type. After confirming sterile urine of the patient by negative urine culture, surgical antibiotic prohylaxis is given by cephalosporins. A 4-F or 5-F open-end ureteral catheter is placed in the ipsilateral kidney with the aid of cystoscopy. As a general practice, PNL is performed in prone position. The gonads are always covered by radiation-protective shields (Fig. 2). An 18-G needle is used for access and the access can be obtained by two different techniques, namely "eye of the needle" and "triangulation." The opted access technique is generally "eye of the needle," but due to the high mobility of the kidney in infants and toddlers "triangulation technique" is reserved for smaller children. During access to the kidney, the renal pelvis is distended by contrast-medium administered through a ureteral catheter.

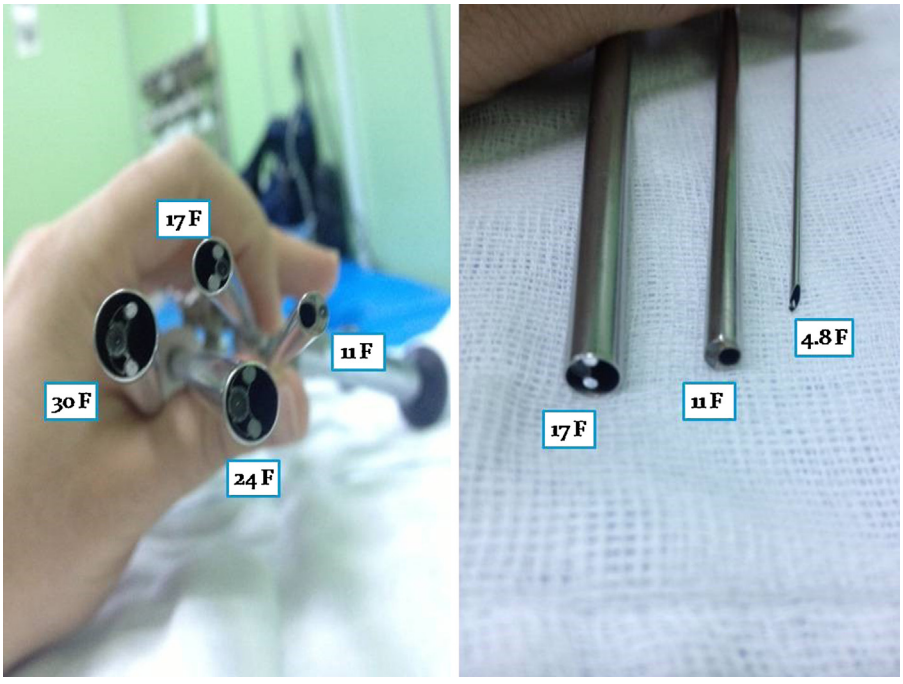

Fig. 1 – Different sizes of nephroscopes used for percutaneous nephrolithotomy in children.