Urolithiasis in Childhood: Aetiology and Management

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Urinary tract calculi remain a common pediatric problem in developing countries particularly those comprising the stone belt. In Pakistan one in 83 surgical admissions to a children's hospital are related to stone disease [1]; in Afghanistan suprapubic cystolithotomies account for approximately 20 percent of all surgical procedures performed on children [2]. In contrast, in industrialized countries the incidence of pediatric urolithiasis is low and responsible for only one in 1000 to 7000 pediatric admission per year [3,4]. The purpose of this article is to briefly review the aetiology of pediatric urolithiasis and discuss the current trends in the management of this entity.

Aetiology

Greek and Roman physicians recorded urolithiasis as an affliction of the human race as early as 4800 BC. However it has only recently been recognized that a stone within the urinary tract is a manifestation of complex underlying disorders with geographical variations. The formation of a stone requires precipitation of crystals which occurs when the urine is in a precipitating crystalline phase. In a complex solution such as urine, other factors in addition to solute concentration, are important in determining saturation to allow crystals to precipitate. Saturation is effected by the ionic strength and pH of the urine. Crystal formation and its progression to a stone within the urinary tract is a dynamic process which can be promoted or inhibited by various modifiers [5,6]. Besides the physico-chemical changes that occur in the urine, underlying metabolic disorders, anatomic abnormalities of the urinary tract and infections play an important role in the formation of stones [4,6].

The aetiology and location of urinary tract calculi in children varies in different parts of the world. In the West, stones tend to be located in the upper tract and are largely calcium oxalate or struvite in composition [7]. Infections and underlying genitourinary anomalies play a major role in the formation of these stones [8,9]. As many as 30 to 40 percent of children with stones are reported to have anatomical lesions that predispose to urinary stasis [3,4,9]. Metabolic abnormalities are common and often co-exist with anatomic abnormalities [3]. Among metabolic causes of pediatric urolithiasis idiopathic hypercalciuria is the most common. Up to 70-80 percent of patients in the industrialized countries have been reported to have this disorder [4,6,10].

In a series of 270 children reported from the United Kingdom, the cause of stone formation was urinary tract infection (60 %), idiopathic urolithiasis (27 %), anatomical (10 %) and metabolic abnormalities (3 %) [8]. In the idiopathic stone formers, stones were mostly calcium oxalate or of a mixed variety. Hypercalciuria (defined as >6 mg/kg/day calcium excretion) was present in 16 percent of these children. A more or less similar aetiology of urolithiasis in children has been reported in various series from the United States [3,9,11].

In the third world, urinary tract calculi in children are frequently located in the lower tract and the composition is predominantly ammonium acid urate and/or calcium oxalate [7]. Feeding patterns in young infants including diets high in oxalate precursors and depleted in phosphates have been implicated in the aetiology of bladder stones [4,6,7]. In studies from Thailand [12] supplementation of diet with phosphate buffers has been shown to correct crystalluria and may prevent stone formation. Other factors include recurrent infections, schistosomiasis, and dehydration secondary to high temperatures and recurrent gastroenteritis.

The aetiology of renal stones however may be changing in developing countries. Renal stones tend to become more frequent and bladder stones de-

crease as countries become affluent. In a largely historical review Sutor found that 89 % of renal stones from developing countries were composed of ammonium acid urate or calcium oxalate [13]. Recently, Cifuentes, et al have shown that the proportion of these stones has decreased to 48 % in Iran [14]. Similarly in South Africa, the incidence of renal stones in blacks appears to be increasing and the composition is changing to conform to that found in industrialized countries [15].

Management

The management of a child with urolithiasis should include identification and control of the acute presenting symptoms, followed by definition of any predisposing metabolic and anatomic abnormalities. Management must include a plan to eliminate the calculi, provide appropriate dietary and pharmacologic manipulation if needed, as well as correct any urinary tract anomaly to prevent stasis and future stone formation. Detailed investigations to permit long term management [4,6,16,17] should be undertaken after relief of acute symptoms, management of infection if present, and relief of acute urinary obstruction. Analysis of 24 hour urine is best done when the patient is asymptomatic and on a normal diet and fluid intake. Investigations should take the cost benefit ratio into account and laboratory evaluation should be appropriate keeping in mind the nature of the stone in the patient presenting for management. This is of particular importance in countries with limited resources and few third party payers.

The indications for stone removal in children are similar to those in adults. Stones producing obstruction, infection and renal damage need intervention. The options for treatment of stone disease in children have increased dramatically in the last decade. With the introduction of minimally invasive procedures like transurethral stone destruction, percutaneous nephrostolithotomy and extracorporeal shock wave lithotripsy (ESWL), traditional surgery in the treatment of stone disease has decreased to 2 to 4 % [6]. These new therapeutic modalities have their own indications and contraindications, and should be used in concert to achieve complete stone clearance. In children the choice of therapy is dependant on the patient size, the stone burden, composition and location of the stone, and the anatomy of the urinary tract. The availability of appropriate instruments and expertise in the use of these newer modalities in children is still restricted to relatively few centers. Traditional open surgery which can be done rapidly and also permits correction of associated anatomical abnormalities, still offers an excellent choice in the management of pediatric urolithiasis.

A major advance in the treatment of pediatric urolithiasis which is now widely available is ESWL. Introduction of third generation lithotriptors that use small focal points and the use of ultrasound for the detection and monitoring of stone fragmentation, make this a particularly attractive modality in children. By eliminating radiation hazards and reducing the pain associated with the procedure, lithotriptors have become popular for the elimination of a majority of the upper urinary tract stones in children and infants as young as 4 months of age [18]. Open surgery is now being restricted to management of large calcium oxalate and cystine stones.

Recent reports have raised concerns regarding the long term effects of ESWL on the developing kidney. An 8-10 % incidence of hypertension has been reported in adult patients following treatment with ESWL [19]. Intrarenal hemorrhage and reduction in renal function immediately after treatment has been reported in experimental as well as clinical studies [20]. In light of the uncertainties regarding long term effects of ESWL in children, its use should be restricted to stones that do not require an excessive number of high energy shock waves and in countries where long term follow up is possible [21].

The techniques of percutaneous nephrolithotomy and ureteroscopic retrieval of ureteric calculi have achieved a high success rate in adults. With the recent availability of small size instruments these options are also becoming available for management of pediatric urolithiasis to debulk large struvite stones [6,22,23,24]. Major advantages over the open surgical techniques include short hospital stay and a reduced convalescent period. With increase in expertise, simultaneous correction of coexisting anatomic abnormalities such as fulguration of calyceal diverticula and endopyeloplasty for pelviureteric junction obstruction are becoming possible. Reported complications include hemorrhage, extravasation of urine, vesicoureteric reflux and ureteric strictures

due to over dilatation of the ureter. Due to the size of the pediatric patient, mobility of the kidney and the smaller collecting system, the margin for error in children is much smaller than that in adults. Sufficient experience in the use of these techniques is a prerequisite to attempting these procedures in children.

After initial stone clearance, long term follow up, a (minimum of 5 years) is advised due to a recurrence rate of 8 to 44 % in the pediatric population [7,25]. The highest recurrence is reported among patients with metabolic disorders and underlying anatomic abnormalities [8]. Other factors contributing to recurrence include urinary tract infections, stasis secondary to anatomic and functional anomalies, multiple stones, incomplete stone clearance, malnutrition and dehydration. These lithogenic factors must be actively investigated and eradicated. Early evaluation and treatment of metabolic abnormalities, avoidance of stasis and infections, maintenance of adequate nutrition and hydration, management of obstructive conditions and judicious administration of medications are necessary to prevent recurrent urolithiasis in children.

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