Evaluation and Medical Management of Kidney Stones in Children

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Purpose: We review the current literature on the diagnostic evaluation and dietary and pharmacological management of children with nephrolithiasis.

Materials and Methods: We searched MEDLINE®, Embase® and the Cochrane Library from their inceptions to March 2014 for published articles in English on kidney stones and therapy in children 0 to 18 years old. Based on review of the titles and abstracts, 110 of the 1,014 articles (11%) were potentially relevant to the diagnostic evaluation and medical management of nephrolithiasis in children. We summarized this literature and drew on studies performed in adult populations to augment areas in which no studies of sufficient quality have been performed in children, and to highlight areas in need of research.

Results: During the last 25 years the incidence of nephrolithiasis in children has increased by approximately 6% to 10% annually and is now 50 per 100,000 adolescents. Kidney stones that form during childhood have a similar composition to those that form in adulthood. Approximately 75% to 80% of stones are composed of predominantly calcium oxalate, 5% to 10% are predominantly calcium phosphate, 10% to 20% are struvite and 5% are pure uric acid. The recurrence rate of nephrolithiasis in patients with stones that form during childhood is poorly defined. Ultrasound should be used as the initial imaging study to evaluate children with suspected nephrolithiasis, with noncontrast computerized tomography reserved for those in whom ultrasound is nondiagnostic and the suspicion of nephrolithiasis remains high. Current treatment strategies for children with kidney stone disease are based largely on extrapolation of studies performed in adult stone formers and single institution cohort or case series studies of children. Tamsulosin likely increases the spontaneous passage of ureteral stones in children. Increased water intake and reduction of salt consumption should be recommended for all children with a history of kidney stones. Potassium citrate is a potentially effective medication for children with calcium oxalate stones and concomitant hypocitraturia, as well as children with uric acid stones. However, long-term compliance with therapy and the effect on decreasing stone recurrence in children are unknown. Based largely on efficacy in adult populations, thiazide diuretics should be considered in the treatment of children with calcium based stones and persistent hypercalciuria refractory to reductions in salt intake.

Conclusions: The incidence of kidney stone disease in children is increasing, yet few randomized clinical trials or high quality observational studies have assessed whether dietary or pharmacological interventions decrease the recurrence of kidney stones in children. Collaborative efforts and randomized clinical trials are needed to determine the efficacy and effectiveness of alternative treatments for children with nephrolithiasis, particularly those with calcium oxalate stones and concomitant hypercalciuria and hypocitraturia. Additional

Abbreviations and Acronyms

CT = computerized tomography
MET = medical expulsive therapy
RTA = renal tubular acidosis

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areas in need of study are the optimal length of time for a trial of stone passage in children, the cost-effectiveness of medical expulsive therapy vs analgesics alone, and the size and location of stones for which medical expulsive therapy is most effective.

Key Words: child, diagnostic imaging, diet therapy, drug therapy, nephrolithiasis

NEPHROLITHIASIS is a major source of morbidity and health care expenditures in the United States. During the last 20 years the prevalence of nephrolithiasis has increased 70% in adults, and the gender gap between men and women is narrowing.[1] Furthermore, nephrolithiasis, once considered an adult disease, has become increasingly prevalent in children. In the last 25 years the incidence of nephrolithiasis in children has increased by approximately 6% to 10% annually and is now 50 per 100,000 adolescents.[2] In 2000 nephrolithiasis accounted for $2.1 billion in annual health care expenditures in the United States.[3] This increase in the incidence of nephrolithiasis in children has implications for future health care spending and health services allocation, and will increase the prevalence of what, for many, is a chronic condition associated with substantial pain and morbidity.[4] Most importantly the emergence of kidney stones as a pediatric disease necessitates that specialists who care for children with nephrolithiasis understand the optimal strategies to evaluate children with kidney stones and the effectiveness of nonsurgical interventions to decrease the risk of recurrence.

We reviewed the current literature on the diagnostic and metabolic evaluation, and dietary and pharmacological management of children with nephrolithiasis. A comprehensive review of the large number of, but rare, genetic diseases that cause kidney stones in childhood has been described elsewhere and is beyond the scope of this review. Similarly medical management for stones due to infectious causes, primary hyperoxaluria and cystinuria are not addressed. Finally, although this review focuses on the management of pediatric nephrolithiasis, it also draws on studies performed in adult populations to augment areas in which no studies of sufficient quality have been performed in children, and to highlight areas in need of research. Particular attention is given to the as yet unknown effectiveness of alternative treatment strategies in reducing the recurrence of kidney stone disease in childhood.

METHODS

In consultation with a reference librarian we searched MEDLINE, Embase and the Cochrane Library from their inceptions to March 2014 for published articles on kidney stones in children. Search terms and/or keywords included "kidney stone OR urolith* OR nephrolith*." The explosion feature of each database was used and the search was limited to studies on subjects 18 years or younger, English language publications and human studies. We excluded case reports, expert opinions and editorials. Abstracts were reviewed to identify articles on evaluation and medical treatment of pediatric nephrolithiasis. In addition, the bibliographies of all potentially relevant primary articles and review articles identified in the search were read to identify other relevant articles not detected in the database search. Full search terms are available on request.

SEARCH RESULTS

A total of 1,014 unique references were retrieved. No additional studies were identified from review of article references. A total of 18 previous systematic reviews were identified through search of the Cochrane Library, although these were based on studies of adults. Based on review of the titles and abstracts, 110 of 1,012 articles (11%) were potentially relevant to and within the scope of this review.

Acute Management

Diagnostic imaging. Clinical practice guidelines and evidence support using ultrasound for initial diagnostic imaging in children with suspected nephrolithiasis, and reserving CT for those with a nondiagnostic ultrasound in whom the clinical suspicion for stones remains high. Although ultrasound is less sensitive and specific than CT,[5,6] ultrasound accurately identifies clinically significant kidney stones in children. In a study of 50 patients younger than 18 years with suspected nephrolithiasis Passerotti et al determined the diagnostic performance of ultrasound in accurately localizing kidney stones.[6] Using CT as the gold standard, the sensitivity and specificity of ultrasound were 70% and 100%, respectively, when the radiologists interpreting the ultrasounds were blinded to CT results. In this population the positive predictive value of ultrasound was 96% and the negative predictive value was 62%. Of the 13 stones that were not visualized on ultrasound only 1 was larger than 5 mm. Three stones that were not visualized by ultrasound were in the ureter, and the remainder were nonobstructive stones in the kidney. The authors thus concluded that stones missed by ultrasound were likely of little