African Journal of Urology (2016) **22**, 141–148

African Journal of Urology

Official journal of the Pan African Urological Surgeon's Association
web page of the journal

www.ees.elsevier.com/afju
www.sciencedirect.com

Stones and Endourology
Review

New developments in percutaneous stone surgery

S. Derisavifard *, C. Hartman , N. Gupta , D. Hoenig , Z. Okeke , A. Smith

Smith Institute for Urology, Northwell Health, 450 Lakeville Road, New Hyde Park, NY, USA

Received 3 March 2016; received in revised form 14 April 2016; accepted 16 April 2016
Available online 1 August 2016

KEYWORDS
Nephrolithiasis;
Kidney calculi;
Percutaneous nephrolithotomy;
New techniques

Abstract
Percutaneous stone surgery is the gold standard in removing large renal calculi. In light of the increase in prevalence and size of renal stones being addressed in recent years, numerous advances have been made in attempts of improving the morbidity, efficacy, and technical ease of stone clearance. In this review article, we assess new advancements in percutaneous stone surgery including diagnosis and surgical planning, methods of renal access, patient positioning, tract dilation, nephroscopes, lithotripsy, and post-operative drainage and antibiotic prophylaxis.

Introduction

Nephrolithiasis is an increasingly common condition that is the global cause of a significant amount of morbidity. Burgeoning rates of conditions such as hypertension, obesity, and diabetes mellitus have contributed to the rise in incidence of new stones. Within the past two decades, for instance, the prevalence of diabetes has increased two fold; along with it, the frequency of stone-related Emergency Department visits has also risen from 178 in 100,000 visits to 340 in 100,000, nearly doubling in number [1,2]. Over time, an increase in the absolute size of stones diagnosed has increased as well.

In addition to medical comorbidities and genetic factors, environmental factors have been suggested to affect rates of nephrolithiasis as well. It has been demonstrated that the development and composition of stones within the in Chinese-American community differs from those of the Chinese. Chi et al. [3] has found that Chinese-Americans are more likely to have higher body mass indices (BMIs) and develop stones an average of 9 years earlier than individuals in China.

Percutaneous nephrolithotomy (PCNL) became a standard technique to address complex, large renal stones during the last two

* Corresponding author.
E-mail addresses: sderisav13@northwell.edu (S. Derisavifard), chartman@northwell.edu (C. Hartman), ngupta1@northwell.edu (N. Gupta), dhoenig@northwell.edu (D. Hoenig), zoekek@northwell.edu (Z. Okeke), asmith1@northwell.edu (A. Smith).

Peer review under responsibility of Pan African Urological Surgeons' Association.

http://dx.doi.org/10.1016/j.afju.2016.04.002

decades of the twentieth century [4]. Given its decreased morbidity, lower cost, and shorter duration of hospitalization compared to open nephrolithotomy, PCNL has rendered open stone extraction obsolete [5]. In an era when the demographics of the general populace are leading to the production of larger stones in unhealthier patients, PCNL is more relevant than ever.

We aim to review the PCNL literature and evaluate the most recent advances in techniques in percutaneous stone surgery.

Diagnosis

Among imaging studies used to diagnose nephrolithiasis including ultrasound (US) and plan X-ray films, computerized tomography (CT) has been accepted as the standard for pre-operative stone evaluation. CT is highly sensitive for diagnosing nephrolithiasis, easy to quickly obtain, and cost-effective [6]. In patients with a significant stone burden, CT assists in categorizing stone size, density, and location within the collecting system. CT is also extremely helpful in determining the approach for access into the kidney. If a concern over radiation exposure exists, a low-dose CT can be considered. US can reasonably diagnose renal stones as well, although with a sensitivity and specificity lower than that of CT [7].

Most recently efforts have been made to risk stratify patients with nephrolithiasis based on pre-operative imaging. One example is the S.T.O.N.E nephrolithotomy scoring system that measures five characteristics reflecting stone complexity on CT: stone size (S), tract length (T), obstruction (O), number of calyces involved (N), and "essence" or stone density (E). In an initial study at a single institution examining 117 patients, it was noted that the S.T.O.N.E score can be used to estimate operative time, estimated blood loss (EBL), stone-free rates, and length of stay (LOS) [8]. In a follow-up study, the original authors validate the use of the S.T.O.N.E score in a multi-institutional trial that confirms their initial findings: the higher a patient's score, the lower a patient's stone-free rate, the longer the bleeding time and greater the EBL, the longer the operative time, LOS, fluoroscopy use, and the higher the rate of post-operative complications [9]. Other examples of stone scoring systems include the Guy's stone score and the Clinical Research office of the Endourological Society (CROES) nomogram. In comparing these three scoring systems, Labadie et al. [10] found that despite their differences, they all were able to predict stone-free status of patients.

All of these scoring systems enhance the ability of the surgeon to effectively plan for a percutaneous stone procedure and effectively counsel patients. Each system has its advantages, and we recommend use of one in an effort to streamline risk stratification among patients and assist surgeons in standardizing the dialog of the severity of a patient's condition across institutions.

Preoperative planning

The proliferation of long-term anticoagulation and antiplatelet therapy has followed the increased use of drug-eluting cardiac stents, mechanical heart valves, and therapy for atrial fibrillation [11,12]. Resultantly, the pool of patients requiring PCNL who require these types of medications has increased as well. The length of time a patient may be safely off anticoagulation peri-operatively as well as how to address stones in those patients in whom anticoagulation may not be suspended has not been clearly established. Patients who are too high risk to discontinue anticoagulation for any period of time may benefit from staged ureteroscopic procedures in lieu of PCNL. In high risk cardiac patients, cessation of aspirin may adversely effect cardiac outcomes due the consequential rebound effect. The literature, however, suggests that aspirin can be safely continued peri-operatively in PCNLs without any significant increased risk of bleeding [13,14].

Currently, it is recommended that patients on anticoagulation undergoing procedures that carry a high risk of bleeding, like PCNL, suspend warfarin use 3–5 days before that date of the planned procedure. One study has recommended specifically in PCNL that warfarin be discontinued 5 days before surgery and not resumed until 5 days post-operatively. In addition, low molecular weight heparin may be used to bridge patients during the period of withholding oral antiplatelet agents. These actions carry a risk of major bleeding of 7%, an acceptable value [15].

In addition to post-operative hemorrhage, sepsis from a urinary tract source is a morbid complication of PCNL that can lead to death. Deliberate steps should be taken during pre-operative evaluation by obtaining a urinalysis and urine culture (Ucx) to minimize the risk of developing this condition. Gutierrez et al. [16] assessed 5354 patients who underwent PCNL who had pre-operative urine cultures available. Findings suggested that 865 (16.2%) of study participants exhibited a positive urine culture, and of those patients with a positive culture, 18.2% developed fevers post-procedure compared to 8.8% of patients with a negative pre-operative culture. Moreover, in patients with infections caused by *Enterobacter* species, 23.8% developed a fever, as compared to only 9.7% of those with *Staphylococcus* species infections, suggesting different levels of virulence among bacterial species. When patients display a contaminated urine culture, pre-operative preparation becomes more nebulous. Leavitt et al. [17] has shown that in 291 patients with a negative urinalysis or urine dipstick analysis, none developed post-operative sepsis after PCNL. These findings infer that negative results of these tests may be sufficient in surgical planning; however, we support recommendations that a urine culture prior to PCNL is optimal to minimize the risk of sepsis.

The best predictors of post-PCNL sepsis have been stone cultures or cultures from the renal pelvis [18]. Despite negative urine cultures, stones may harbor bacteria, and even in the absence of active infections, stone fragmentation releases pre-formed bacterial endotoxins that increase the risk of sepsis [19]. Larson et al. [20] has compared stone cultures (Scx) and Ucx in patients undergoing PCNL and has found that Scx and Ucx correlate in 79% of cases. In patients with negative Ucx, Scx was positive in 12.5% of cases. Resultantly, they recommend routinely obtaining Scx to assist in appropriately tailoring antibiotics if a patient were to develop sepsis.

The duration of antibiotic therapy in patients undergoing PCNL preoperatively is also debatable. Studies have previously indicated that high risk patients may benefit from seven days of pre-operative antibiotic therapy even in the setting of a negative urine culture to reduce the risk of sepsis. Administering two versus seven days of pre-operative antibiotic prophylaxis in this cohort of patients was recently assessed [21]. Results displayed that the course of antibiotic therapy in the setting of a negative urine culture had no effect on fevers >38.5 °C, systemic inflammatory response syndrome (SIRS) symptoms, or rates of post-procedure sepsis. Either