Evaluation and Comparison of Urolithiasis Scoring Systems Used in Percutaneous Kidney Stone Surgery

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Abbreviations and Acronyms

CROES = Clinical Research Office of Endourological Society

CT = computerized tomography

EBL = estimated blood loss

LOS = length of stay

OT = operative time

PCNL = percutaneous nephrolithotomy

SFS = stone-free status

S.T.O.N.E. = stone size, tract length, obstruction, number of involved calyces and essence or stone density

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Purpose: Contemporary predictive tools for percutaneous nephrolithotomy outcomes include the Guy stone score, S.T.O.N.E. nephrolithometry and the CROES nephrolithometric nomogram. We compared each scoring system in the same cohort to determine which was most predictive of surgical outcomes.

Methods: We retrospectively reviewed the records of patients who underwent percutaneous nephrolithotomy between 2009 and 2012 at a total of 3 academic institutions. We calculated the Guy stone score, the S.T.O.N.E. nephrolithometry score and the CROES nephrolithometric nomogram score based on preoperative computerized tomography images. A single observer at each institution reviewed all images and assigned scores. Univariate and multivariate analysis was done to determine the most predictive scoring system.

Results: We enrolled 246 patients in study. In stone-free patients vs those with residual stones the mean Guy score was 2.2 vs 2.7, the mean S.T.O.N.E. score was 8.3 vs 9.5 and the mean CROES nomogram score was 222 vs 187 (each $p < 0.001$). Logistic regression revealed that the Guy, S.T.O.N.E. nephrolithometry and CROES nomogram scores were significantly associated with stone-free status ($p = 0.02$, 0.004 and <0.001, respectively). The Guy and S.T.O.N.E. nephrolithometry scores were associated with estimated blood loss ($p < 0.0001$ and 0.03) and length of stay ($p = 0.03$ and 0.009, respectively). The CROES nomogram did not predict estimated blood loss or length of stay.

Conclusions: All scoring systems and the stone burden equally predicted stone-free status. The Guy and S.T.O.N.E. nephrolithometry scores were associated with estimated blood loss and length of stay. A single scoring system should be adopted to unify reporting.

Key Words: kidney; urolithiasis; nephrostomy, percutaneous; nomograms; research design

There has been a marked increase in the prevalence of kidney stone disease in the United States in the last 2 decades, approaching 7% in females and 10.3% in males in 2010.[1] With this dramatic increase in stone disease incidence and prevalence the use of PCNL to treat a large stone burden has continued to increase.[2–4] Despite continuous refinements in surgical techniques and technology the overall complication rate of PCNL has also increased.[5] An accurate estimate of treatment success is crucial

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for optimal decision making and informed patient counseling.

To characterize kidney stone complexity preoperative radiological evaluation with CT has become common practice in the United States. CT provides high resolution spatial imaging for accurate characterization of the stone size and distribution, pelvicalyceal anatomy, anomalies and anatomical relationships that may dictate the feasibility and risks of different treatment modalities.

With these measurable stone and patient features the Guy stone score,[6] S.T.O.N.E. nephrolithometry[7] and the CROES nephrolithometry nomogram[8] were introduced for systematic and quantitative assessment of kidney stones. In addition to imaging characteristics, these models also take into account other patient features that contribute to disease outcome, such as obesity, renal surgical history, spinal cord injury and spina bifida status, as well as surgeon experience. These parameters are thought to provide the surgeon with an assessment of the complexity and intricacy of each patient. The scoring systems serve as disease stratification tools that allow the surgeon to more accurately predict PCNL outcomes to improve patient counseling and surgical planning.[6–8]

Another potential advantage of scoring systems is uniform and standardized reporting across different series. To date comparative evaluation of treatment for urolithiasis has been limited by the lack of a widely accepted standardization system.[9,10] Uniform academic and clinical reporting would empower physicians to better compare data from different institutions and improve the overall quality of urological research.

To date there has been no direct comparison of the existing scoring systems.[6–8] Comparison and analyses of these tools support refinements and improvements in these systems, which may ultimately facilitate the creation of a more universal and widely accepted scoring system. Thus, we evaluated and compared these scoring systems to assess their relative predictive value for surgical outcomes. We also reviewed the features of each system, similarities and differences, applicability in clinical practice and relevance in academic reporting.

METHODS

After obtaining institutional review board approval we retrospectively reviewed the charts of patients treated with PCNL between 2009 and 2012 at a total of 3 academic institutions.

Selection Criteria

Study exclusion criteria included age less than 18 years, a history of surgery on the ipsilateral kidney, nephrostomy tube or stent placement in the ipsilateral kidney preoperatively and no available preoperative CT images. Patients who underwent repeat PCNL for recurrent stones on the ipsilateral kidney were included in analysis. If a patient underwent bilateral procedures, we selected 1 side at random to improve the independence of data points.

Measurements

We calculated the Guy score, S.T.O.N.E. nephrolithometry and the CROES nephrolithometric nomogram on all patients based on preoperative CT images, as described by Thomas,[6] Okhunov[7] and Smith[8] et al, respectively. A single observer from each institution reviewed all images and performed scoring according to each system. We provided standardized instructions to all reviewers on the application of each scoring system before data collection.

Perioperative Data

We collected patient demographic, clinical, perioperative and followup data in retrospective fashion. Collected information included age, gender, body mass index, surgical and medical history, renal anomalies, ASA® (American Society of Anesthesiologists) score, EBL, fluoroscopy time, OT, stone location and size, number of renal punctures, number and location of dilated tracts, intraoperative and postoperative complications within 30 days, and LOS.

Outcomes

The primary study outcome was a comparison of the ability of the Guy score, S.T.O.N.E. nephrolithometry and the CROES nomogram to predict stone-free rates after PCNL. We defined stone-free status in our study as absent residual stones or stone fragments less than 2 mm at the termination of the procedure as confirmed by postoperative CT.[11,12] CT was performed in all patients before discharge home or within 3 months postoperatively.

The secondary outcome was to evaluate the ability of the scoring systems to predict perioperative and postoperative complications within 30 days of the procedure. We classified all intraoperative and postoperative complications according to the modified Clavien system.[13] We also evaluated perioperative variables such as fluoroscopy time, OT, EBL and LOS.

Our surgical techniques were described previously.[14,15] Groups at all participating institutions had substantial experience with the PCNL procedure and the surgical technique was performed in similar fashion at the 3 academic institutions.

Statistical Analysis

We divided patients into 2 groups based on postoperative SFS. Baseline characteristics were compared between stone-free and nonstone-free patients using the chi-square test for categorical variables and the Student t-test for continuous data. The Guy score and the CROES nomogram were used in 4 groups each and S.T.O.N.E. nephrolithometry was used in 3. Descriptive statistics were used to show the stone-free rate across the 4 groups for each scoring system. ROC curves were generated for each scoring system and for the stone burden, which was measured in mm^2. The AUC and asymptotic 95% CI were calculated for each ROC curve. All statistical analysis was