

Complications of Surgical Management of Upper Tract Calculi in Spina Bifida Patients: Analysis of Nationwide Data

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Abbreviations and Acronyms

ARF = acute renal failure
LOS = length of stay
NIS = Nationwide Inpatient Sample
NSQIP = National Surgical Quality Improvement Program
PCNL = percutaneous nephrolithotomy
SB = spina bifida
SWL = shock wave lithotripsy
URS = ureteroscopy
UTI = urinary tract infection

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Purpose: The management of upper urinary tract stones in patients with spina bifida is challenging but poorly described in the literature. We compared urolithiasis interventions and related complications in patients with spina bifida to those in other stone formers using a national database.

Materials and Methods: We retrospectively reviewed the NIS to identify hospital admissions for renal and ureteral stones from 1998 to 2011. We used ICD-9-CM codes to identify urological interventions, including shock wave lithotripsy, ureteroscopy, percutaneous nephrolithotomy and ureteral stent placement. NSQIP data were used to identify postoperative complications.

Results: We identified 4,287,529 weighted stone hospital admissions, including 12,315 (0.3%) of patients with spina bifida. Compared to those without spina bifida the patients with spina bifida who had urolithiasis were significantly younger (mean age 34 vs 53 years), more likely to have public insurance (72% vs 44%) and renal vs ureteral calculi (81% vs 58%), and undergo percutaneous nephrolithotomy (27% vs 8%). After adjusting for age, insurance, comorbidity, treatment year, surgery type, stone location and hospital factors patients with spina bifida were more likely to have urinary tract infections (OR 2.5), urinary complications (OR 3.1), acute renal failure (OR 1.9), respiratory complications (OR 2.0), pneumonia (OR 1.5), respiratory insufficiency (OR 3.2), prolonged mechanical ventilation (OR 3.2), sepsis (OR 2.7), pulmonary embolism (OR 3.0), cardiac complications (OR 2.4) and bleeding (OR 1.6).

Conclusions: Compared to those without spina bifida the patients with spina bifida who were hospitalized for urolithiasis were younger, and more likely to have renal stones and undergo percutaneous nephrolithotomy. Urolithiasis procedures in patients with spina bifida were associated with a significantly higher risk of in-hospital postoperative complications.

Key Words: urolithiasis, postoperative complications, lithotripsy, ureteroscopy, spina dysraphism

SPINA bifida is the most common permanently disabling multisystem birth defect in the United States.^{1,2} Urological complications of SB may include neurogenic bladder, urinary incontinence, recurrent UTIs,

vesicoureteral reflux and urolithiasis. Patients with SB are at well documented increased risk for lower urinary tract stones.^{3,4} However, SB is also associated with an increased risk of upper tract urolithiasis with

potentially etiological factors such as urinary stasis, frequent instrumentation, bacteriuria and recurrent UTIs.

Upper tract urolithiasis can be potentially more harmful to patients with SB than to others. Because patients with SB may have neurosensory defects and be at increased risk for bacteriuria, urolithiasis may present later with urosepsis rather than with earlier symptoms such as flank/abdominal pain.⁵⁻⁷ Anecdotally we have noted that managing upper tract calculi is often challenging. Surgical procedures in patients with SB have the potential to be technically difficult since they are often complicated by an abnormal body habitus, skeletal malformation, obesity and aberrant genitourinary anatomy. We hypothesized that treatment related complications are more common in patients with SB but to our knowledge this risk has not been analyzed in any study. Therefore, we compared treatments and related complications of urolithiasis interventions in patients with SB to those in other stone formers using a national database of all ages.

MATERIALS AND METHODS

Data Source

The NIS is an all-payer database managed at HCUP (Healthcare Cost and Utilization Project) and sponsored by the AHRQ (Agency for Healthcare Research and Quality). NIS data are obtained from a 20% stratified probability sample of American hospitals based on 5 hospital characteristics, including ownership status, number of beds, teaching status, urban/rural location and geographic region. The NIS includes post-stratification discharge weights that may be used to calculate national estimates.⁸

Selection

Patients and covariates. We identified all inpatient hospital encounters between 1998 and 2011 for patients with an ICD-9-CM diagnosis code for upper tract urolithiasis (592.0 and 592.1). Patients with SB were identified based on an ICD-9-CM diagnostic code (741 and 756.17).

Predictor variables were a priori selected based on biological plausibility and/or demonstrated associations in the literature. Covariates included basic patient demographics such as age, gender, race, insurance payer (public vs private), median household income quartiles by ZIP Code™, the Elixhauser comorbidity index,⁹ treatment year, treatment modalities such as SWL (ICD-9-CM 98.51), URS (ICD-9-CM 56.31), PCNL (ICD-9-CM 55.03, 55.04) and ureteral stent placement (ICD-9-CM 59.8), and stone location. We also used hospital level factors such as hospital teaching status (metropolitan nonteaching, metropolitan teaching and nonmetropolitan), geographic region (Northeast, South, Midwest and West) and size.

Outcomes. The primary outcome was immediate postoperative complications during the same admission.

Complications were identified by the ICD-9-CM code that most closely corresponded to the complications described by the NSQIP (supplementary Appendix, <http://jurology.com/>).^{10,11} As the main outcomes we included superficial and deep surgical site infections, peritoneal abscess, ARF, UTI, postoperative urinary complications, postoperative respiratory complications, pneumonia, postoperative respiratory insufficiency, adult respiratory distress syndrome, systemic sepsis, pulmonary embolism, greater than 96-hour mechanical ventilation, cerebrovascular accident, postoperative cardiac complications, acute myocardial infarction, cardiac arrest, bleeding and deep vein thrombus. We also examined in-hospital deaths, LOS and total hospital costs for the admission.

Statistical Analysis

Bivariate analysis was done to compare patient demographics and hospital level characteristics in patients with and without SB who had urolithiasis. We used the Rao-Scott chi-square test, t-test or Wilcoxon rank sum test as appropriate based on data characteristics and distribution. All analyses were weighted using NIS specific estimated weights and covariance matrices. NIS cost-to-charge files were used to convert hospital charges to cost. Due to file availability cost was only estimated from 2001 to 2011.¹² Multivariate logistic regression for NSQIP postoperative complications and in-hospital deaths, and negative binomial regression for LOS and cost were fitted to examine factors, specifically SB, that predicted the outcomes. Generalized estimating equations were used to account for the NIS complex survey design in addition to hospital clustering effects. An α of 0.05 and 95% CIs served as criteria for statistical significance. Analysis was done with SAS® 9.2.

RESULTS

Demographics

We identified a total of 4,287,529 weighted upper tract stone admissions, including 12,315 (0.3%) weighted in patients with SB (table 1). Mean \pm SD patient age was 52.6 ± 0.1 years. Males were 49.5% of the overall cohort.

Compared with those without SB the patients with SB who had urolithiasis were significantly younger (mean age 34.3 ± 0.5 vs 52.6 ± 0.1 years, $p < 0.001$). They were also more likely to have public insurance (71.5% vs 43.5%) and renal calculi (67.7% vs 40.0%), undergo PCNL (26.5% vs 6.0%), be treated at a teaching hospital (67.7% vs 40.0%) and have increased LOS (mean \pm SD 3.7 ± 5.1 vs 1.9 ± 2.0 days, each $p < 0.001$). Mean overall LOS was 1.9 ± 2.0 days.

Postoperative Complications

On bivariate analysis compared to patients without SB who had urolithiasis patients with SB who underwent surgical intervention were more likely to experience postoperative UTIs (OR 2.1), urinary complications (OR 4.7), respiratory complications

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