



Ureteral Stent Placement During Shockwave Lithotripsy: Characterizing Guideline Discordant Practice

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OBJECTIVE	To describe utilization patterns of ureteral stent placement during extracorporeal shockwave lithotripsy (ESWL).
METHODS	The Healthcare Cost and Utilization Project State Inpatient and Ambulatory Surgery Databases for Florida (2010-2012), Iowa (2010-2012), California (2010-2011), and New York (2006-2012) were used to identify patients undergoing ESWL with or without concomitant ureteral stent placement. Multivariate logistic regression was used to identify factors associated with ureteral stent placement. Postoperative ER visits and reoperation were compared between groups with multivariate logistic regression.
RESULTS	A total of 128,040 patients undergoing ESWL during the study period were identified. Concomitant ureteral stent placement during ESWL was performed in 20,800 (16.2%) cases. Stent placement was more common among older patients (odds ratio [OR] 1.003 per year, 95% confidence interval 1.002-1.004) and those with greater comorbidity burden (OR 1.10, 1.09-1.11), but also among those with higher income (OR 1.13, 1.08-1.19) and private insurance (OR 1.05, 1.01-1.10). Patients undergoing concomitant ureteral stent placement had higher rates of 30-day postoperative ER visits (8.9% vs 7.3%, $P < .0001$) and 90-day reoperation (13.4% vs 8.2%, $P < .0001$) compared to patients undergoing ESWL alone.
CONCLUSION	A significant portion of patients treated with ESWL undergo concomitant ureteral stent placement, despite clinical guidelines over the last 2 decades discouraging this practice. Use of ureteral stent during ESWL appears driven by both clinical and nonclinical factors. Ureteral stent placement confers no perceivable advantage in postoperative ER visits or reoperation after ESWL based on administrative data from the Healthcare Cost and Utilization Project. UROLOGY 133: 67–71, 2019. © 2019 Elsevier Inc.

Urinary stones impose a substantial disease burden in the United States. The estimated prevalence of stone disease has increased markedly in the last 2 decades, from approximately 5% in 1994 to more than 9% in 2012.¹⁻⁴ Urolithiasis also imposes a significant economic burden to society, with an estimated annual direct expenditure of 2-4 billion US dollars.^{5,6} A significant portion of these costs are driven by surgical interventions.

The 2 most commonly performed interventions for stone disease are ureteroscopy (URS) and extracorporeal shockwave lithotripsy (ESWL); together they comprise 90% of all surgery for urolithiasis.⁷ Data from contemporary series demonstrate that URS may achieve a superior stone-free rate for select patients compared to ESWL.^{8,9}

Consequently, the use of URS has increased in recent years, with a concomitant decline in utilization of ESWL. Despite this, approximately 33%-45% of stone patients in the current era are still treated using ESWL.^{7,10,11}

ESWL is the least invasive surgical stone treatment and provides the opportunity to forego urinary instrumentation, including ureteral stent placement. Over 20 years ago, the American Urological Association (AUA), in their *Report on the Management of Ureteral Calculi*, proposed that routine stenting during ESWL was not necessary, as it had not been shown to improve stone passage rate.¹² This recommendation was further emphasized in the 2007 European Association of Urology/AUA *Guideline for the Management of Ureteral Calculi*.¹³ More recently, the 2016 AUA/Endourological Society *Guideline for the Surgical Management of Stones* reiterated this recommendation based on contemporary data demonstrating no difference in stone-free rate between stented and non-stented ESWL from 8 prospective randomized trials and a meta-analysis.¹⁴

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While guideline recommendations against routine stenting during ESWL have been unequivocal for 2 decades, the rate of ureteral stent placement during ESWL in real-world clinical practice has not previously been defined. This study aimed to quantify the proportion of ESWL cases during which concomitant ureteral stent placement was performed using the Healthcare Cost and Utilization Project (HCUP) state healthcare databases. We further sought to analyze the association between stent placement and postoperative emergency room (ER) visits and reoperation rates.

METHODS

The HCUP State Ambulatory Surgery and State Inpatient Databases were used to identify patients in Florida (2010-2012), Iowa (2010-2012), California (2010-2011), and New York (2006-2012) undergoing ESWL (CPT: 50590; ICD-9: 98.51) as the primary procedure. The primary study outcome was concomitant ureteral stent placement (CPT: 52332; ICD-9: 59.8) during ESWL. Secondary study outcomes included any postoperative ER visit in the first 30 days following surgery (captured in the State Emergency Department Database) or the need for secondary stone surgery in the first 90 days after the primary ESWL. Secondary stone surgery was defined as ESWL (aforementioned codes), URS (CPT: 52352, 52353, 52356; ICD-9: 56.0, 56.31), or percutaneous nephrolithotomy (CPT: 50080, 50081, 50561; ICD-9: 55.03, 55.04). Ureteral stent removal performed in isolation was not considered a secondary stone surgery.

Urban-rural designation for the patient's county of residence was categorized into large metropolitan (>1 million residents), small metropolitan (<1 million residents), micropolitan, or rural based on United States Department of Agriculture Urban Influence Codes. Income was categorized into quartiles, and was defined as the median household income of the patient's residential zip code. Comorbidity burden was assessed using the number of clinically significant chronic diagnoses at the time of surgery.

The HCUP is a collection of databases created through a federal-state-industry partnership and maintained by the Agency for Healthcare Research and Quality. The databases are inclusive of all payers, and represent the largest compilation of longitudinal hospital data in America. Individual patient records were tracked across the State Ambulatory Surgery, State Inpatient Databases, and State Emergency Department Database using a deidentified VisitLink variable, which allows for longitudinal measurement of healthcare utilization in all practice settings.

Baseline clinical and sociodemographic characteristics of patients undergoing ESWL with vs without stent were compared using chi-square for categorical variables and *t* test or Wilcoxon Rank Sum test for normally distributed and non-normally distributed continuous variables, respectively. Multivariate logistic regression was used to identify factors associated with concomitant stent placement during ESWL. Crude rates of 30-day postoperative ER visits and 90-day reoperations were compared between study groups using chi-square and multivariate logistic regression. Statistical significance was defined as *P* < .05. All analyses were performed using SAS Studio 3.5 (SAS Institute, Cary, NC). This study was granted exempt status by the Cleveland Clinic Institutional Review Board.

RESULTS

The HCUP state databases were used to identify 128,040 patients undergoing ESWL in Florida, Iowa (2010-2012), California (2010-2011), and New York (2006-2012). Of these, 20,800 (16.2%) patients underwent concomitant ureteral stent placement during ESWL. Baseline clinical and sociodemographic characteristics of patients undergoing ESWL with vs without stent are outlined in Table 1. Overall, patients undergoing concomitant stenting had greater comorbidity burden, greater proportion of female and white patients, and higher patient incomes. Of these, 121,920 (95.2%) underwent ESWL in an ambulatory surgery setting (14.6% with stent), while 6,120 (4.8%) underwent ESWL in the inpatient setting (50.5% with stent).

Table 2 summarizes results from multivariate logistic regression to identify factors associated with ureteral stent placement during ESWL. Older age (odds ratio [OR] 1.003 per year, 95% confidence interval [CI] 1.002-1.004), female sex (OR 1.14, 95% CI 1.11-1.18), greater comorbidity burden (OR 1.10 per each additional chronic comorbidity, 95% CI 1.09-1.11), and higher income (OR 1.13 for highest quartile, 95% CI 1.08-1.19) were all associated with higher likelihood of stent placement during ESWL.

Conversely, rural residence (OR 0.87, 95% CI 0.79-0.96) was associated with lower likelihood of stent placement. With regards to insurance status, patients with Medicaid were less

Table 1. Baseline clinical and sociodemographic characteristics of patients undergoing ESWL with versus without concomitant stent placement

	ESWL Without Stent <i>n</i> = 107,240	ESWL With Stent <i>n</i> = 20,800
Age in years (mean, std dev)	54.6 (15.4)	55.9 (15.4)
Number of chronic comorbidities (IQR)	0 (0-2)	1 (0-2)
Female	45,506 (42.9)	9362 (45.7)
Insurance		
Medicare	31,178 (29.6)	6756 (32.5)
Medicaid	13,350 (12.5)	2031 (9.8)
Private	55,062 (51.4)	10,492 (50.5)
Uninsured	3510 (3.3)	689 (3.3)
Other	3512 (3.3)	890 (4.3)
Urban-rural category		
Large metropolitan	71,711 (67.0)	13,948 (67.2)
Small metropolitan	25,874 (24.2)	5263 (25.4)
Micropolitan	6679 (6.2)	1046 (5.0)
Rural	2863 (2.7)	496 (2.4)
Race		
White	71,008 (69.3)	14,529 (73.2)
Black	5558 (5.4)	1096 (5.5)
Hispanic	12,206 (11.9)	2603 (13.1)
Asian/Pacific Islander	3559 (3.5)	586 (2.9)
Native American	1335 (1.3)	152 (0.8)
Other	8818 (8.6)	874 (4.4)
Income quartile		
1 (lowest)	23,679 (22.4)	4130 (20.3)
2	28,375 (26.9)	5448 (26.7)
3	28,160 (26.7)	5370 (26.4)
4 (highest)	25,445 (24.1)	5423 (26.6)

ESWL, extracorporeal shockwave lithotripsy; IQR, interquartile range.

All values are *n* (%) unless otherwise specified.

P < .0001 for all.

Table 2. Multivariate logistic regression to identify factors associated with stent placement during ESWL

Variable	Odds Ratio	95% Confidence Interval
Age*	1.003	(1.002-1.004)
Sex		
Male	Referent	
Female	1.144	(1.109-1.181)
Number of comorbidities [†]	1.096	(1.086-1.106)
Insurance		
Medicare	Referent	
Medicaid	0.817	(0.764-0.873)
Private	1.053	(1.008-1.1)
Uninsured	1.11	(1.011-1.219)
No charge	2.236	(1.882-2.655)
Other	1.072	(0.972-1.181)
Urban-rural category		
Large metropolitan	Referent	
Small metropolitan	0.964	(0.928-1.001)
Micropolitan	0.755	(0.702-0.813)
Rural	0.87	(0.785-0.963)
Race		
White	Referent	
Black	0.978	(0.911-1.049)
Hispanic	1.093	(1.041-1.148)
Asian/Pacific Islander	0.874	(0.797-0.959)
Native American	0.616	(0.519-0.731)
Other	0.523	(0.486-0.563)
Income quartile		
1 (lowest)	Referent	
2	1.097	(1.048-1.148)
3	1.06	(1.011-1.111)
4 (highest)	1.134	(1.08-1.19)

P <.0001 for all covariables.

* per each additional year of age.

[†] per each additional chronic comorbidity.

likely to undergo concomitant stenting than patients with Medicare (OR 0.81, 95% CI 0.76-0.87), while patients with private insurance (OR 1.05, 95% CI 1.008-1.10) or uninsured patients (OR 1.11, 95% CI 1.01-1.22) were more likely. Compared to white patients, Hispanic patients were more likely to undergo stent placement (OR 1.09, 95% CI 1.04-1.15), while Asian, Native American, and “Other” race patients were less likely.

Secondary outcomes included postoperative ER visits and need for secondary stone surgery. Patients undergoing ESWL with concomitant stenting had higher ER visit rates in the first 30 days after ESWL (8.9% vs 7.3%, *P* <.0001). On multivariate logistic regression analyses adjusting for between-group differences in baseline characteristics, concomitant stent placement was independently associated with higher likelihood of postoperative ER visit (OR 1.24, 95% CI 1.17-1.31, [Supplementary Table 1](#)). With regards to the need for secondary stone surgery, patients undergoing ESWL with stent had higher 90-day reoperation rates than those undergoing ESWL alone (13.4% vs 8.2%, *P* <.0001). This result persisted on multivariate analyses after adjusting for between-group differences in baseline clinical and sociodemographic characteristics (OR 1.66, 95% CI 1.58-1.75, *P* <.0001, [Supplementary Table 2](#)). Patients undergoing ESWL with stent also had higher rates of subsequent stent placement within 30 days than those who had ESWL without stent (5.4% vs 3.5%, *P* <.0001).

COMMENT

This population-based study of patients undergoing ESWL using the HCUP state databases examines trends in stent placement during ESWL. Despite unanimous recommendations against this practice by all major clinical guidelines, a ureteral stent is still placed during 16.2% of ESWL procedures. Secondary analyses suggest that concomitant stent placement during ESWL does not confer an advantage in unplanned 30-day emergency room visits or 90-day reoperation rates.

No prior studies have examined practice patterns related to stent placement during ESWL. The current study provides insight into real-world clinical practice by quantifying the rate of guideline-discordant care during ESWL. The numerous guideline statements discouraging stent placement during ESWL are based on ample high-level evidence demonstrating no benefit to this practice. In a recent meta-analysis encompassing 8 randomized controlled trials and 876 patients with renal or ureteral calculi (or both), Shen et al showed no difference in stone-free rate between stented and unstented ESWL (78.1% vs 83.0%, relative risk 0.97, 95% CI 0.91-1.03, *P* = .27).¹⁵ In fact, in all 8 of the included studies, no difference in stone-free rate was observed in any single study. Subgroup analyses stratifying renal and ureteral stones similarly showed no difference in the primary outcome, nor were there differences in pain, nausea, vomiting, or UTI between stented and unstented groups. There was, however, a significant increase in lower urinary tract symptoms in the stented group in some studies.

Although clinical guidelines recommend against “routine” stent placement during ESWL, some surgeons may advocate stent placement to facilitate fragment passage during select unusual nonindex cases, such as for larger sized or caudally located renal stones. However, our institutional bias is that if a ureteral stent is considered at the time of ESWL, this may be an indication that an endoscopic procedure (eg, percutaneous nephrolithotomy for larger stones or URS for solitary kidney/chronic kidney disease) may be the more appropriate management approach; “if you need a stent, you need a scope.”

The exact reasons for stent placement during ESWL cannot be determined from the current dataset. However, multivariate analyses provide some insight into factors associated with stent placement. Older patients and those with greater comorbidity burden were more likely to undergo stenting. This suggests that surgeons may be attempting to optimize outcomes in a patient population that might otherwise be at higher risk for perioperative complications.

In addition to the aforementioned clinical factors, non-clinical factors were also associated with stent placement on multivariate analyses. This guideline-discordant practice was more likely among higher income patients with private insurance coverage who reside in the densely populated metropolitan areas. Based on these observations, one might hypothesize that financial incentives may play

a role in surgeons' decision to perform concomitant stenting during ESWL. However, uninsured status was also associated with higher likelihood of stenting, contradicting this hypothesis. Further investigation into the clinical and nonclinical drivers of ureteral stent placement during ESWL is warranted.

In the current study, stent placement during ESWL did not reduce the likelihood of an unplanned emergency room visit in the early postoperative period. These findings contrast with those of a 2002 trial in which patients with renal or ureteral stones less than 20 mm, who were randomized to receive a 4.7Fr stent during ESWL, had significantly fewer ER visits 1 week after surgery compared to unstented patients (5% vs 19%, $P < .05$)¹⁶. A few points are worth noting with regards to this data. First, this trial limited analyses to the first week after ESWL. In our current study, which captures ER visits through the first 30 postoperative days, patients who visited the ER after ESWL did so a median of 6 (IQR 2-16) days after ESWL. Thus, a study period of only 1 week may only capture roughly half of all postoperative ER visits after ESWL. Second, the aforementioned trial applied strict inclusion criteria in a controlled research setting, including stone size <20 mm. Our study, however, reflects real-world practice, which does not always follow strict inclusion criteria. Indeed, we hypothesize that stent placement during ESWL in our current study may have been in part to facilitate stone passage in nonindex patients, such as those with stone size >20 mm.

The present study also demonstrates that ESWL with concomitant stent placement is associated with a higher 90-day reoperation rate compared to in situ ESWL. Contemporary randomized trials suggest that there is no difference in reoperation rate between stented vs nonstented ESWL. Bierkens et al randomized 64 patients with renal calculi to stent vs no stent prior to ESWL.¹⁷ The investigators found no significant difference in reoperation rate in the stented group after 3 months (RR 1.40, 95% CI 0.30-6.66). Another trial prospectively investigated 120 patients presenting with ureteral calculi.¹⁸ Six months after randomization to stented vs unstented ESWL, no significant difference in reoperation rates (RR 3.12, 95% CI 0.69-14.06) was observed. We reconcile the disparity between the current observational study and prior randomized trials by again considering the inclusion criteria of randomized trials. All prior prospective studies comparing reoperation rates for stented vs unstented ESWL apply strict inclusion criteria, and ESWL is only performed in those with the optimal stone characteristics for ESWL use. In such a controlled setting, stenting does not appear to offer a benefit. In the current study, however, we suspect that ESWL may sometimes be performed in nonindex patients, including those with less favorable stone characteristics for ESWL. Indeed, Lantz et al surveyed urologists and found that surgeons who placed stents during ESWL tended to do so when treating larger sized stones.¹⁹ Thus, the higher reoperation rate for stented patients in our study may not be a result of the stent itself,

but rather a reflection of a lower stone-free rate, which we suspect might result from ESWL use in nonindex patients. However, the ability to test this hypothesis empirically is prohibited by the absence of data on stone size, location, and density data in the HCUP databases.

These results should be interpreted in the context of study limitations. First, HCUP does not include stone size, location, or density. Thus, it is difficult to fully frame the observed ER and reoperation outcomes in clinical context. Second, we are unable to discern the specific reasons for stent placement during ESWL. Future studies may consider surveying urologists to explicitly gauge individual surgeon rationale for this practice. Third, the laterality of reoperations is not captured, implying that some of the observed reoperations in both study groups may have been contralateral to the index ESWL. However, one would not expect either study group to have a greater burden of contralateral stones, suggesting that the observed disparity in reoperation rates may indeed be a meaningful outcome. Finally, the heterogeneity in the states and years included in our dataset precludes a time-trend analysis to examine changes in practice patterns over time.

Despite these methodologic considerations, the current study adds considerable value to the existing literature on ESWL. The rate of ureteral stenting during ESWL in real-world practice is quantified for the first time, and suggests ample room for improvement in bringing clinical practice in line with evidence-based guidelines.

CONCLUSION

In spite of robust data from randomized clinical trials and guideline statements from professional organizations recommending against this practice over the last 2 decades, a considerable number of patients in the United States continue to undergo concomitant ureteral stent placement during ESWL. This guideline-discordant practice appears to be driven by both clinical and nonclinical factors. Ureteral stent placement confers no perceivable advantage in postoperative ER visits or reoperation after ESWL based on administrative data from the HCUP.

SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.urology.2019.06.015>.

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