Published in final edited form as:

Urol Pract. 2020 May ; 7(3): 167–173. doi:10.1097/upj.0000000000000082.

In-Office Ultrasound Facilitates Timely Clinical Care at a Multidisciplinary Kidney Stone Center

Mathew D. Sorensen,

Department of Urology

Division of Urology, Veterans Affairs Medical Center, Seattle, Washington

Jeff Thiel,

Center for Industrial and Medical Ultrasound, Applied Physics Laboratory

Jessica C. Dai,

Department of Urology

Michael R. Bailey^{*},

Department of Urology

Center for Industrial and Medical Ultrasound, Applied Physics Laboratory

Barbrina Dunmire,

Center for Industrial and Medical Ultrasound, Applied Physics Laboratory

Patrick C. Samson,

Department of Urology

Helena Chang,

Department of Urology

M. Kennedy Hall,

University of Washington and Department of Emergency Medicine

University of Washington School of Medicine

Brianna Gutierrez,

Department of Urology

Robert M. Sweet,

Department of Urology

Jonathan D. Harper

Department of Urology

Abstract

Introduction—A considerable publication record exists comparing sensitivity and specificity of radiological ultrasound (including point of care ultrasound) to computerized tomography for stone

^{*}Correspondence: Applied Physics Laboratory, University of Washington, 1013 NE 40th St., Seattle, Washington 98105 (telephone: 206-619-2035; FAX: 206-221-6578; mbailey@uw.edu).

disease. However, the practical application of in-office ultrasound to support the growing number of kidney stone centers around the world represents a nuanced topic that is ripe for study and discussion.

Methods—We provide a descriptive analysis of how in-office ultrasound is being used as an adjunct to clinical care based on our experience during 50 days in clinic at an institutionally affiliated, multidisciplinary kidney stone center. Clinic subjects gave consent and underwent ultrasound as part of research studies. Ultrasonograms were shared with and verified by the treating physician before the patient was discharged from care. We counted the number of times research imaging altered the care plan.

Results—Of the 60 patients enrolled the clinician used the information obtained from the studies in 20 (33%) to determine the course of clinical care that resulted in a change in treatment or process.

Conclusions—Ultrasound has the potential to be a cost-effective and valuable tool that can provide more efficient workflow within a kidney stone center or urology clinic.

Keywords

ultrasonography; diagnostic imaging; point-of-care testing; kidney calculi

Ultrasound clearly has a growing role for evaluation of acute renal colic and perhaps an even greater role in followup care.^{1–3} Although ultrasound sensitivity and specificity ranging from 54% to 70% and 91% to 94%, respectively, in contemporary series are lower than the near perfect values for computerized tomography, ultrasound is a sensitive detector of hydronephrosis and can be quite useful in the detection and management of kidney stones if used properly. For example, in the emergency room setting ultrasound can be used to lower the likelihood of incidental diagnoses for the pre- presentation of renal colic and to rule out obstruction. Fields et al showed that of patients who presented with absence of hydronephrosis none required hospital admission within 30 days of initial presentation for renal colic.⁴ Similarly, a multicenter randomized clinical trial showed that using ultrasound in the emergency room for initial diagnosis of nephrolithiasis did not delay appropriate intervention.⁵ Although about 75% of patients eventually required computerized tomography preoperatively, 25% of patients were able to avoid ionizing radiation altogether.

In followup care such as that received in the clinic US is commonly obtained before the clinic visit for reassessment of ureteral calculi, postoperative imaging and surveillance of known stone formers on preventive management. A strength of US is the lack of ionizing radiation, and weaknesses are variable accuracy and overestimation of stone size, especially in stones smaller than 10 mm.⁶ However, measuring the width of the stone shadow and not the stone may help mitigate oversizing.^{7,8}

To our knowledge, no study has investigated the value of US in the clinic setting, especially within a kidney stone center. In parallel to clinical care at the University of Washington ultrasound research on the detection, sizing and ultrasonic propulsion of urinary stones has been performed.^{9–13} These series all include a research US examination shared in real time with the treating urologist.¹⁴ We report instances when data derived from the research US

changed the predetermined clinical course. We provide a descriptive analysis of our experience with office US and its usefulness in facilitating timely clinical care in patients with kidney stone disease.

Methods

The University of Washington kidney stone center was formed in 2016 as a stand-alone outpatient clinic with providers consisting of 3 endourologists, an endourology fellow, a nephrologist, a dietitian, an advanced practice provider and support staff. Most presenting patients undergo clinical imaging within a month before the stone clinic visit. As part of research studies, patients suspected of having a urinary stone based on symptoms and available imaging and reports in the medical record undergo renal US after giving informed consent. All of these studies received institutional review board approval. Patients were excluded if they were younger than 18 years old, unable to lie comfortably on the examining table for 30 minutes, part of a vulnerable group or non-English speaking. Some research studies had additional specific exclusions such as requiring CT within the preceding 3 months or residual fragments within 6 months of surgery.

US examination was conducted by 1 sonographer registered with ARDMS® and using the Verasonics® V-1. The system was programmed with custom grayscale and Doppler algorithms to enhance the conspicuity of the stone relative to the background tissue. However, these are changes that can be implemented on standard clinical systems and as such do not restrict the general applicability of our results. The real-time or recorded imaging and sonographer findings were shared with and verified by the treating clinician. As such, the clinician could choose to use the US results to influence the care plan before discharging the patient, and this study recorded how often that occurred.

Results

A total of 646 patients were seen over 50 clinic days. Of the subjects 75 fit our inclusion criteria and 60 gave informed consent, resulting in 20 instances (33% of the subjects imaged for research) where US provided additional information for the clinician that resulted in a change in treatment. In all other cases the research imaging did not differ sufficiently from clinical imaging to alter the care plan. Information gained through the screening examination for obstructing and bladder stones is outlined in Appendix 1 and predominantly but not exclusively consisted of whether the stone remained obstructing. Appendix 2 outlines the information gained about renal stones, which differed in nearly all cases.

Management was changed in 20 cases over 50 days. Also, 34 patients over 31 days cancelled their appointments because planned imaging had not been obtained in a timely fashion before the visit. There were an additional 92 cancellations where no reason was given, some of which may have been due to similar issues. It is not known how many of these patients would have kept the appointment had in-office US been available to obtain the planned followup imaging, or how many did not undergo imaging but kept the appointment and how that affected care.

Discussion

Our data support that in-office US could potentially lessen missed visits and late cancellations, and improve efficiency of patient care, including clarification of unclear image reports when actual films are not available, helping to determine if obstructing ureteral stones are still present and expediting surgical decisions. All 5 clinic providers obtained specific information that could be ascertained in minutes with real-time US and that was not provided by existing imaging studies or radiology reports. The providers were able to evaluate the in-office US to obtain the needed information. Our data were collected while performing other research and therefore likely underestimate actual usage if in-office clinical US were readily available. Utilization was so high and for such a broad range of applications that it is noteworthy that clinics may find, as we did, that access to in-office US may have greater use and value than might be expected.

The AUA has long advocated increased use of US in urological care. Many training programs currently do not include abdominal/renal US experience, and so the uptake has been slow. As a direct result of our research experience, we have made several changes to our practice and program. Our stone clinic added an ultrasound system several months ago, and the endourology fellow and attending physicians now routinely image at least 1 to 2 cases per clinic, a number that is expected to grow. All of the endourologists are now using US guidance to gain percutaneous access and may quickly use US within the clinic in patients planning to undergo percutaneous nephrolithotomy. Additionally the University of Washington urology residency program has added a hands-on course taught by sonographers and endourologists for all residents on kidney imaging with US. The strengths, weaknesses, opportunities and threats of having a sonographer in the office are summarized in the figure, although performing US without a sonographer is also an option.¹⁵

Certainly the addition of an in-office US system or sonographer raises additional considerations for a busy urology practice. With use of in-office US the immediate interpretation of imaging falls to the provider if these studies are to be used to inform patient care in real time. Thus, any potential liability in missed imaging findings may also fall to the providers unless infrastructure is in place for formal review and quality assurance, either in-office or with radiologist oversight. However, all of our patients already had fairly recent (within 3 months) clinical imaging and radiological reports obtained per their routine care, which could reduce the risk of missed incidental findings by the clinic provider. Moreover, although sonographers are typically covered by supervising physician liability or malpractice insurance, there is liability insurance available for sonographers as well.

Additional costs associated with the system itself must also be considered. In our experience US instruments range from \$30,000 to \$120,000 and often include an optional annual service contract. The basic service contract covers preventive maintenance, service calls, cleaning and software upgrades. US transducers may be fragile, and probes in high service areas or that are handled roughly may need to be replaced in 1 to 3 years at a cost of about \$10,000. The only consumable cost is ultrasound gel, which totals less than \$100 yearly. Imaging for stones takes 10 to 30 minutes for a full examination (a few minutes if looking for something specific and without plans to bill) but may vary based on factors such as user

experience, patient habitus or mobility and extent of renal disease. There are many ways and options to archive images/reports and share/view images if needed. The cost of imaging archives and image viewers varies widely from free online versions to full expansive systems.

Two and 4-year undergraduate programs in sonography are offered throughout the country. Sonographers are often registered with ARDMS in a handful of specialties. The appropriate specialty for stones would be abdominal. Some states require the sonographer be registered with ARDMS for reimbursement. Median salary (all levels of experience) in 2016 was \$71,000 yearly for full-time sonographers, excluding overtime and on-call work.¹⁶ Sonographers may be hired part time or full time, and like nurses and other health care professionals, are also employed as traveling or per diem/temporary workers. According to the U.S. Department of Labor, employment of diagnostic medical sonographers is projected to grow 26% from 2014 to 2024, much faster than the average for all other occupations.¹⁷ For stone disease in particular the growing focus on minimizing patient exposure to ionizing radiation has further invigorated interest in US use.^{18,19} As imaging technology evolves, medical facilities will continue to adopt US to replace more invasive, costly, radiation dependent studies.

In addition to sonographers, urologists can operate in-office US systems to obtain images. This practice is facilitated by completing an AUA certification course. ARDMS also offers registries for physicians who scan and interpret ultrasound. Various certificate programs exist throughout the United States on many topics, as do continuing education opportunities. However, the AUA program appears to be only for urologists. We suggest there would be benefits to opening the AUA program to advanced practice and other providers in the clinic.

The cost of equipment and staff could be offset by replacing imaging referrals with in-office imaging. There is a \$116 (\$60) office or hospital reimbursement under CPT code 76775 for ultrasound, retroperitoneal (eg renal) with image documentation, complete (limited) in the Ambulatory Payment Classifications under the hospital outpatient prospective payment system, although third-party reimbursement amounts and coverage policies for specific procedures will vary by payer and locality.^{20,21} Obstetrics/gynecology, emergency medicine, vascular and other specialties use US equipment and document appropriately to meet standards for receipt of reimbursement with or without sonographers, and this reimbursement could justify or defray the costs associated with the up-front investment in hardware, quality assurance image management software or personnel.²² The scope of practice would have to be determined based on user knowledge of US in urology. A sonographer may be seen as a component, along with a dietitian, nephrologist, researcher and endourology specialist as well as laboratory access, that makes a stone center comprehensive. While our experience is from a specialized kidney stone clinic, other US applications in a urology office could include prostate, testes, bladder, renal transplant and penile duplex. US guidance is also useful during in-office procedures such as prostate and renal biopsy, and has continued to advance not only in imaging, but also in therapeutic ways such as our use of burst wave lithotripsy of kidney stones.²³

Conclusions

Of 60 research ultrasound examinations there were 20 instances in which the clinician review of the US immediately impacted clinical care. These data may justify inclusion of in-office sonography at a kidney stone center or other urology practice. With appropriate steps the availability of an in-office US machine and, if needed, a sonographer could produce the required imaging and provide immediate actionable clinical information to inform patient counseling, surgical scheduling or followup planning without waiting for further radiology imaging and reporting.

Acknowledgment

University of Washington School of Medicine Kidney Stone Center clinical staff assisted with the study.

Supported by NIH NIDDK Grant P01 DK043881 and Puget Sound Veterans Administration.

Study received institutional review board approval.

Appendix

Appendix 1.

Clinical benefits of in-office ultrasound for obstructing stones and bladder stones

No. Cases	
5	<p>Purpose of Visit: Patient was being seen for an obstructing stone. Clinical ultrasound imaging provided insufficient detail: the report was vague on location of the stone and stone size.</p> <p>Outcome of US: Ureteral stone was visualized. Current ureteral stone location and hydronephrosis status provided.</p> <p>Expected clinical outcome without office US: Delay surgery for additional clinical imaging.</p> <p>Change in clinical outcome: Surgery was scheduled without further imaging and a stone was identified and treated in surgery.</p>
7	<p>Purpose of Visit: Patient was being seen for an obstructing stone. Previous clinical imaging provided insufficient detail.</p> <p>Outcome of US: No hydronephrosis or ureteral stone was observed.</p> <p>Expected clinical outcome without office US: Delay surgery for additional clinical imaging.</p> <p>Change in clinical outcome: No surgery or further imaging was scheduled. Patient was counseled on stone disease prevention. None of these patients returned for surgery or to the emergency department or had the stone detected by additional imaging (measured 3 months after research imaging).</p>
1	<p>Purpose of Visit: Patient was being seen for an obstructing stone. Provider saw inconsistencies between prior US and CT imaging and between imaging and reported OR observations.</p> <p>Outcome of US: Ureter and kidney stones were visualized.</p> <p>Inconsistencies were resolved.</p> <p>Expected clinical outcome without office US: Schedule clinical US, justify to peer-review by insurance provider, consult with radiologist, and likely then schedule surgery.</p> <p>Change in clinical outcome: Surgery was scheduled without further clinical imaging.</p>
2	<p>Purpose of Visit: Patient was being seen for potential bladder stone.</p> <p>Outcome of US: Stones were visualized in the bladder.</p> <p>Expected clinical outcome without office US: Delay surgery for additional clinical US.</p> <p>Change in clinical outcome: Surgery was scheduled.</p>

Appendix

Appendix 2.

Clinical benefits of in-office ultrasound for renal stones

No. Cases	
2	<p>Purpose of Visit: Patient was being seen for renal stones. Stone side was questioned.</p> <ul style="list-style-type: none"> • The left and right designation appeared to be reversed on the clinical CT exam report. • Patient record indicated a history of <i>Situs Inversus</i>. <p>Outcome of US: Stone location was identified and left versus right clarified.</p> <p>Expected clinical outcome without office US: Delay surgery for additional imaging.</p> <p>Change in clinical outcome: Surgery planned with appropriate laterality.</p>
1	<p>Purpose of Visit: Patient was being seen for renal stones and being scheduled for ureteroscopy. A foreign object, seen on KUB plain-film x-ray but not fluoroscopy, also remained in the kidney after a previous surgery and was to be removed with the stone. The provider inquired if US could localize the object.</p> <p>Outcome of US: The object was not localized with US. A US machine was not wheeled into the OR. Surgeon used localization from the KUB x-ray and cut scar tissue with a laser to reveal and remove the object.</p> <p>Expected clinical outcome without office US: The provider would have taken time to attempt US in the OR when the wire segment was not initially visible with the ureteroscope.</p> <p>Change in clinical outcome: This case was not counted as a change to clinical outcome, but the benefit was saving time by not attempting US imaging in the OR.</p>
1	<p>Purpose of Visit: Elderly patient being seen for renal stones. Subject was contraindicated for shock wave lithotripsy (SWL) and there was concern over conducting surgery.</p> <p>Outcome of US: The stone was visualized and deemed small and in a stable location in the lower pole.</p> <p>Expected clinical outcome without office US: Delay surgery for additional imaging.</p> <p>Change in clinical outcome: No surgery or further imaging was scheduled. Patient was counseled on stone prevention.</p>
1	<p>Purpose of Visit: Patient was being seen for renal stones of an uncommon stone type (silica), and it was not clear whether US would be able to detect the stone for surveillance.</p> <p>Outcome of US: It was confirmed stone was visible on US.</p> <p>Expected clinical outcome without office US: Order clinical US and x-ray KUB for surveillance.</p> <p>Change in clinical outcome: Clinical ultrasound was ordered for surveillance imaging.</p>
1	<p>Purpose of Visit: Patient being seen in clinic 3 months after surgery. Imaging shortly after surgery showed a large residual fragment. Lab analysis of fragments from surgery showed uric acid stones and the patient had been on alkalization treatment for a month.</p> <p>Outcome of US: US indicated the size of the fragment did not appear reduced.</p> <p>Expected clinical outcome without office US: Schedule clinical US and follow-up visit in 6 months.</p> <p>Change in clinical outcome: The patient's alkalization dose was increased and he was scheduled for a 3-month follow-up visit to monitor the medication use and future clinical imaging to evaluate effectiveness of stone dissolution.</p>

Abbreviations and Acronyms

ARDMS	American Registry for Diagnostic Medical Sonography®
AUA	American Urological Association
CT	computerized tomography
KUB	plain x-ray of kidneys, ureters and bladder
US	ultrasound

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Strengths <ul style="list-style-type: none"> • Available billing codes • Real-time US may provide additional information not seen in prior CT or KUB images • office based • non-ionizing • investment can be used in other urology areas 	Opportunities <ul style="list-style-type: none"> • Efficient patient care (one location, one visit) • Fewer cancelled appointments • Avoid surgery on stones that have passed • Provide additional care • Training for new technologies that use US guidance
Weaknesses <ul style="list-style-type: none"> • Cost, although it is low • Additional time - 10-30 minutes • US is less sensitive or specific as CT 	Threats <ul style="list-style-type: none"> • Liability of interpreting US and missing diagnoses • User-dependence

Figure.
SWOT (strengths, weaknesses, opportunities, threats) analysis¹⁵ of in-office ultrasonography for kidney stones