Absorbed radiation dose can be significantly reduced with low-dose, pulsed fluoroscopy while maintaining image fidelity.

Ionizing radiation exposure from fluoroscopy is and continues to be a significant concern for affected patients and all practicing endourologists, particularly those who operate in high-volume settings and in academic, teaching institutions. While annual radiation exposure limits for all workers are set and maintained by federal regulatory agencies, there currently exist no unified or consensus guidelines for how endourologists should protect themselves during fluoroscopy-guided procedures, and the prevalence of dosimeter usage by endourologists to routinely track exposure levels is relatively low.

Michelle Jo Semins, MD, assistant professor, and director of the UPMC Mercy Kidney Stone Clinic, first became interested in better understanding radiation exposure patterns for endourologists and how to minimize exposure for physicians, operating room team members, and patients in 2011 when she first joined the UPMC Department of Urology as a faculty member. Dr. Semins was periodically alerted to high ALARA levels during her first year at UPMC. “Transitioning to a teaching environment was one of the reasons for the higher levels I was getting. This caused me to begin to think about ways I could reduce my radiation exposure, and it turn led me to actively study the problem given that virtually all of my cases over the course of my career are going to involve the use of radiation to one degree or another,” says Dr. Semins.

One of Dr. Semins’ first studies sought to better understand what radiation exposure patterns may look like, and how practicing endourologists in high-volume institutions typically protect themselves during procedures. This was followed by several studies beginning in 2013 that have examined the use of low-dose and pulsed fluoroscopy, and a combination of both to determine to what degree radiation exposure could be curtailed. Dr. Semins also has examined pulsed fluoroscopy and its relationship to fluoroscopy time in ureteroscopy and radiation exposure. “This is important for patients, too, given the fact that recurrent stone disease is a common occurrence, and these patients may need numerous procedures during their lives. Reducing their exposure levels and possible future complications is paramount as well,” says Dr. Semins.

While her studies into radiation exposure are relatively new within her research portfolio, Dr. Semins has for some time researched and continues to investigate the management of kidney stones during pregnancy. She has authored numerous peer-reviewed papers, book chapters, reviews, and presentations on the topic.
Single Pulse-Per-Second Fluoroscopy and Radiation Exposures

The standard for continuous fluoroscopy is 30 pulses per second. However, most machines allow for some type of reduced pulse rate, in addition to a standard low-dose setting which in most cases reduces radiation exposure by approximately 60 percent. While a 60 percent reduction in radiation exposure through the low-dose setting is definitely preferable, Dr. Semins became intrigued about whether or not one could achieve both low-dose setting and pulsed setting together. Would this combination allow for usable image fidelity during procedures, and would it lead to even further reduction in radiation exposure?

“Essentially, I just decided to try a single pulse per second, the lowest possible setting on our fluoroscope, combined with the low-dose setting, and it worked. With a single pulse per second, there is a degree of motion entailed if you try to simultaneously move the fluoroscope while engaging the foot pedal, but modulating my speed, and radiation exposure was captured with dosimeters placed in various proximities to the subject. We were able to confirm that the low-dose setting does correlate to a 60 percent reduction in radiation like we had thought, but during the 60-second exposures of this test, when combining low dose and the single pulse-per-second, actual radiation exposure decreased by 97 percent, which is shockingly high and has great potential with a combined one pulse-per-second. We had thought, but during the 60-second exposures of this test, when combining low dose and the single pulse-per-second, actual radiation exposure decreased by 97 percent, which is shockingly high and has great potential with a combined one pulse-per-second fluoroscopy,” says Dr. Semins.

In summary, with single pulse-per-second fluoroscopy, the usage time decreased from a mean of 77 seconds to 16 seconds. This reduced fluoroscopy time translated into a combined 64 percent reduction in radiation exposure to the surgeon.

In 2017, Dr. Semins and colleagues published findings in the journal Urology from their recently completed study using pulsed fluoroscopy in uroendoscopy. The study examined continuous conventional low-dose fluoroscopy versus one pulse-per-second low-dose fluoroscopy in adult ureteroscopy patients over a 12-month period. The conventional approach was used for the first six months of the study, followed by the pulsed method for the second six-month period. Dr. Semins sought to show how the reduced pulse rate affected radiation exposure during procedures, and how this might translate to a surgeon’s total exposure to ionizing radiation.

In summary, with single pulse-per-second fluoroscopy, the usage time decreased from a mean of 77 seconds to 16 seconds. This reduced fluoroscopy time translated into a combined 64 percent reduction in radiation exposure to the surgeon.

Dr. Semins and colleagues have finished a follow-up bench-top study similar in nature to the first retrospective analysis, showing an even larger radiation reduction potential with a combined one pulse-per-second low-dose fluoroscopy. The results of this study have been completed and submitted for publication, as well as having been presented at last year’s Northeastern Section American Urological Association meeting and the World Congress of Endourology 2017. Using a simulated patient model, 60-second timed exposures were made using various pulse rates (30, 8, 4, 2, 1) with and without the low-dose setting, while radiation exposure was captured with dosimeters placed in various proximities to the subject.

“When we were able to confirm that the low-dose setting does correlate to a 60 percent reduction in radiation like we had thought, but during the 60-second exposures of this test, when combining low dose and the single pulse-per-second, actual radiation exposure decreased by 97 percent, which is shockingly high and has great implications for everyone in the operating room,” says Dr. Semins. She and the entire research team are excited to have these findings published in the near future, along with additional related work they have been involved in during the last five years.

Managing Kidney Stones During Pregnancy

A significant aspect of Dr. Semins’ research and clinical care is related to understanding kidney stone burden and optimal management procedures for women during pregnancy. “Kidney stones during pregnancy can be very problematic, both in terms of the diagnosis and optimal management, given the specific risk factors and other contraindications,” says Dr. Semins. With respect to diagnosis, ultrasound-based imaging is not recommended during pregnancy, as it is typically contraindicated because of radiation exposure to the developing fetus. Management is complicated for many reasons including preserving the ongoing health of the mother and baby.

Certain aspects of antenatal care for a woman with a history of kidney stones or stones, or because of a woman’s underlying disease process, are unique and require management. “Conservative management should typically be the first approach unless there are other mitigating factors that would necessitate surgical intervention. These could be related directly to complications arising from the stone or disease, or because of a woman’s varying obstetrical complications,” says Dr. Semins.

In 2017, Dr. Semins and colleagues published findings in the journal Urology from their recently completed study using pulsed fluoroscopy in uroendoscopy. The study examined continuous conventional low-dose fluoroscopy versus one pulse-per-second low-dose fluoroscopy in adult ureteroscopy patients over a 12-month period. The conventional approach was used for the first six months of the study, followed by the pulsed method for the second six-month period. Dr. Semins sought to show how the reduced pulse rate affected radiation exposure during procedures, and how this might translate to a surgeon’s total exposure to ionizing radiation.

In summary, with single pulse-per-second fluoroscopy, the usage time decreased from a mean of 77 seconds to 16 seconds. This reduced fluoroscopy time translated into a combined 64 percent reduction in radiation exposure to the surgeon.

In 2017, Dr. Semins and colleagues published findings in the journal Urology from their recently completed study using pulsed fluoroscopy in uroendoscopy. The study examined continuous conventional low-dose fluoroscopy versus one pulse-per-second low-dose fluoroscopy in adult ureteroscopy patients over a 12-month period. The conventional approach was used for the first six months of the study, followed by the pulsed method for the second six-month period. Dr. Semins sought to show how the reduced pulse rate affected radiation exposure during procedures, and how this might translate to a surgeon’s total exposure to ionizing radiation.

In summary, with single pulse-per-second fluoroscopy, the usage time decreased from a mean of 77 seconds to 16 seconds. This reduced fluoroscopy time translated into a combined 64 percent reduction in radiation exposure to the surgeon.

In summary, with single pulse-per-second fluoroscopy, the usage time decreased from a mean of 77 seconds to 16 seconds. This reduced fluoroscopy time translated into a combined 64 percent reduction in radiation exposure to the surgeon.
References and Further Reading
For additional information about Dr. Semins’ research into radiation exposure in endourologic procedures and the management of kidney stones during pregnancy, please see the selection of published papers below.


