Laser Targeting with C-arm Fluoroscopy: Effect on Radiation Exposure for Pediatric Patients

By Kellie Schenk, MD and Lynne Johnston, RT(R)(M), CRA

EXECUTIVE SUMMARY

- The primary purpose of obtaining laser targeting devices for C-arm fluoroscopy was to attempt to reduce radiation to the pediatric population in Connecticut Children's Medical Center's commitment to Imaging Gently.
- Fluoroscopy times for placing central lines in the operating rooms were documented for two months prior to the installation of the lasers and then for twenty procedures after installation and training on the devices.
- Fluoroscopy times trended down 25% calculated by a simple mean and standard deviation.

Reducing radiation exposure from medical imaging is the responsibility of all users of imaging equipment. As a member of the Image Gently Alliance, we adhere to the recommendations of the Pause and Pulse campaign. Radiation dose reduction is one of the primary concerns of the Connecticut Children's Medical Center (CCMC) Radiology Department in Hartford, Connecticut. As a recipient of the AHRA & Toshiba Putting Patients First grant, CCMC was able to purchase two laser targeting systems that were retrofitted onto existing C-arm units.

Mobile image intensifier systems (C-arms) are used frequently at CCMC in the operating room for a variety of surgical procedures such as central line placement, treatment of orthopedic injuries, and urological procedures. C-arm systems are able to provide both spot imaging as well as fluoroscopic imaging, which allows the generation of real time images. It is very important to consider the radiation dose to both the patient and to the operating room personnel from the modality.

Every strategy for decreasing radiation dose should be thoroughly evaluated for effectiveness and ease of use including pulsed fluoroscopy, last image hold, and collimation. The hypothesis of this study is that having a laser localizer system will also decrease the radiation dose by eliminating unintentional radiation prior to localizing the area of interest.

While it is important to decrease radiation doses to all populations, the pediatric population is the most sensitive to the stochastic effects of radiation. A significant source of radiation accumulation in the pediatric population is from fluoroscopy, particularly in children with chronic medical problems who need frequent evaluations and image guided procedures. Pediatric patients in particular are at the highest risk for radiation induced cancers. It is estimated that without dose reduction techniques, one minute of fluoroscopy is equivalent to approximately ten chest radiographs. It is therefore imperative that all techniques for reducing radiation doses be utilized.

Techniques for dose reduction that were already in use at CCMC included pulsed fluoroscopy, last image hold, and collimation. Laser targeting devices were also already in use, but there is very little research/evidence to show that the targeting systems actually reduce fluoroscopy times.

A CCMC pediatric radiology resident conducted a performance quality improvement project to determine if having a laser targeting system would decrease the radiation dose by eliminating unintentional radiation prior to localizing the region of interest.

Materials and Methods

Total fluoroscopy times were recorded for each central line case performed in the two months prior to installation of the laser targeting system. Cases from all surgeons performing this operation were included (n = 24). After the laser targeting device was installed the surgeons were given a short tutorial by the radiology technologists on the use of the device. For the next several months, fluoroscopy times were again recorded for each central line placed with laser guidance (n = 25). Fluoroscopy times were compared as an estimate of relative radiation exposure.

Any pediatric patient (under 18 years of age) at CCMC receiving a central line in the operating room with the assistance of C-arm fluoroscopy was included in the study. A waiver for consent was obtained by the IRB at CCMC. No identifiable patient information was recorded at any time during the study. In addition, no identifiable information was recorded about the surgeons performing the procedures.

This was a prospective study. Central line placement was the procedure chosen for comparison because it is a common procedure and all of the surgeons performing the procedure use C-arm fluoroscopy to assist them. All surgeons at CCMC receive fluoroscopy training, including the importance of dose reduction, prior to obtaining in hospital fluoroscopy privileges. No additional training on dose reduction was provided prior to the study or after installation of the targeting system.

Fluoroscopy times from all pediatric surgeons performing central line placements were obtained for two months prior to installation of the targeting device (n = 20). The device was installed and all of the radiology technologists who accompany the C-arms to the operating suites were trained in its use. The surgeons using the C-arms were given brief instruction on the use of the device by the radiology technologists prior to their first time using it. Fluoroscopy times were again recorded for the 20 subsequent cases after the installation.

There is a trend towards fluoroscopy times being lower when a laser targeting system is used.

A simple mean and standard deviation was calculated for fluoroscopy times pre and post placement of the laser targeting system. A one tailed Students test was used to compare the two groups for statistically significant differences. The data were initially evaluated using every data point acquired. Several cases were noted to have very long fluoroscopy times and were likely complicated, difficult cases. These cases with flouro times greater than 55 seconds significantly increased the standard deviations for each group, limiting the ability of the study to assess for differences in fluoroscopy times. Because of this, one patient from the pre laser group was excluded and two patients from the post laser group were excluded and the data was reanalyzed. The data from individual surgeons were also compared. Due to the low sample number for each surgeon, this data was not analyzed for statistical significance.

Results

Fluoroscopy times were reduced, on average, 17% when using the C-arm with laser targeting compared to the C-arm without laser targeting (p = .36). The data were reanalyzed after removing three difficult cases from the dataset, defined as cases using longer than 55 seconds of fluoroscopy time. With difficult cases removed, fluoroscopy times were reduced from 17.4 to 12.9 seconds, on average, in the laser targeting group. This represents a P value of .12 which is not of statistical significance. See Figures 1–4.

Discussion

There is a trend towards fluoroscopy times being lower when a laser targeting system is used. Although these findings do not reach statistical significance, the trend towards reduction in radiation dose is interesting. When the data are separated out for the individual surgeons,

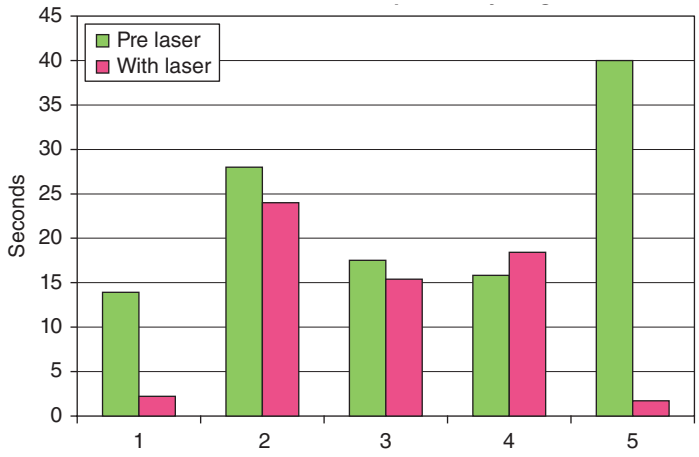


Figure 1 • Mean fluoro times separated by surgeon

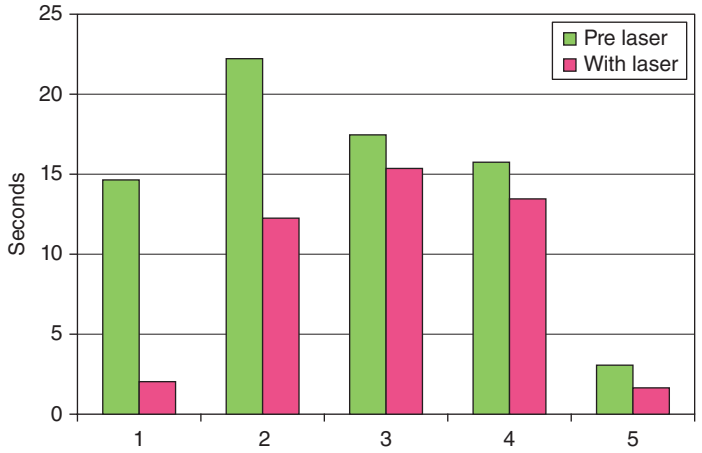
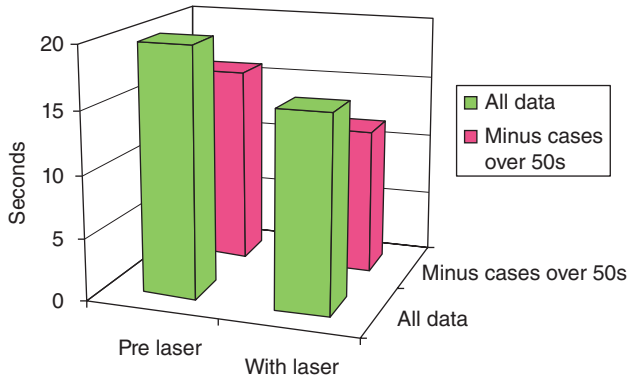


Figure 2 • Mean fluoro times minus cases > 50 seconds



	p-values
All data	0.2
Data minus the 4 cases >50 seconds	0.12

Figure 3 • Mean Fluoroscopy times

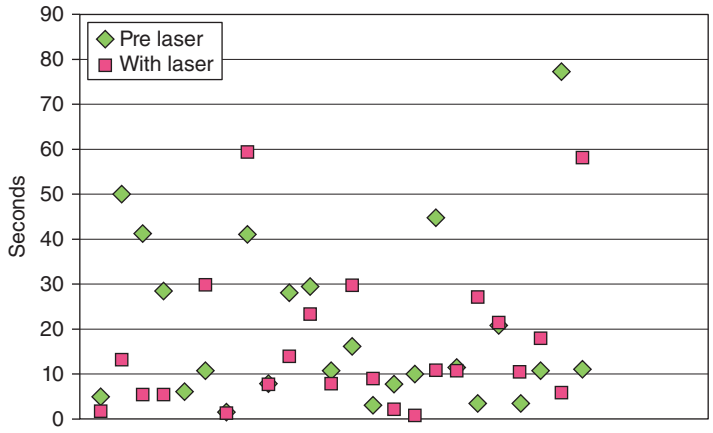


Figure 4 • Fluoro times for each case

4 out of 5 surgeons saw a decrease in their average fluoroscopy times. And, when difficult cases lasting more than 55 seconds were removed from the data set, all of the surgeons saw a decrease in their average fluoro times.

The primary limitation of the study was the large variation in fluoroscopy times due to variations in technique and fluoroscopy use between surgeons, resulting in large standard deviations for the mean fluoroscopy times. The total number of cases in each group was small. A larger cohort would have given the study greater power to identify small differences in fluoroscopy times. The study was also biased as it could not by nature be blinded. The presence or absence of the targeting device was clearly known by each surgeon. Although the surgeons were not given any additional training in dose reduction when the laser targeting devices were installed, it is possible that the placement of the device helped remind the surgeons of the need to keep doses low.

This study cannot be generalized to all users of fluoroscopy. Particularly, radiologists should be studied separately as they have more familiarity with the modality and may not see a significant benefit from using the targeting system. Residents, however, may benefit from such a tool, as resident fluoroscopy times can be longer in the beginning of their training. This study was conducted only with procedures that were performed by pediatric surgeons and excluded radiologists w residents.

Conclusion

Fluoroscopy times trended down, on average, 25% after installation of the laser targeting device but limitations in the study design may have limited the ability to measure a statistically significant difference. A larger cohort would allow for a more statistically significant result. Despite the lack of statistically significant results, it became the preference of the surgeons to use the laser targeting device.

We will continue to use the laser devices at CCMC in an effort to keep radiation doses as low as possible. Having the laser aids the technologist in properly aligning the c-arm in the desired position without exposing the patient to radiation. Prior to the installation of the devices, it could take several seconds of fluoro time to acquire the area of interest in the field of view.

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Kellie Schenk, MD obtained her undergraduate degree at the University of Washington and her medical degree at the Oregon Health and Science University. She is currently a fourth year radiology resident at Hartford Hospital. Kellie will be returning to Portland, Oregon to complete a Fellowship in body imaging in the 2014/2015 academic year. Academic interests include MR imaging and limiting radiation exposure to vulnerable populations.

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