The mini C-arm has become increasingly popular in the practice of orthopedics. To the authors’ knowledge, its use in the pediatric orthopedic outpatient clinic has not been reported. The purpose of this study was to evaluate the practice efficiency and radiation exposure to the patient when the mini C-arm was used in the pediatric orthopedic outpatient clinic. One hundred consecutive midshaft and distal forearm fractures were evaluated by one orthopedic surgeon in follow-up using a mini C-arm. For each case, the radiation physicist calculated the amount of skin exposure in milligray (mGy). The average skin exposure to the patient from the mini C-arm was 0.58 mGy, compared with 0.2 mGy for anteroposterior view and lateral view radiographs. Use of the mini C-arm, in place of plain radiographs obtained in the radiology department, decreased time waiting during clinic visits by 23 minutes. This study reports 2 important findings. First, surprisingly, the mini C-arm used a slightly higher radiation dose than standard imaging with plain radiographs. Second, use of the mini C-arm saved time and improved the efficiency of the clinic visit. Overall, the mini C-arm improves quality and efficiency in the pediatric orthopedic outpatient clinic. [Orthopedics. 2016; 39(6):e1097-e1099.]

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Materials and Methods

The Penn State College of Medicine Institutional Review Board approved this study. All data were de-identified once collected from charts and reported in aggregate form only. One hundred consecutive pediatric forearm fractures were evaluated by one orthopedic surgeon (W.L.H.) in follow-up in the outpatient clinic using a mini C-arm (OrthoScan, Inc, Scottsdale, Arizona). An examination room in the back corner of the clinic was exclusively designated for the use and storage of the mini C-arm. Per the radiation physicist (S.H.K.), no lead lining or other modifications of the room were necessary for safe operation of the mini C-arm.

For each fracture evaluation, the radiation emitted in milligray (mGy) and the time in seconds were recorded. The treating surgeon includes a paragraph in the clinic note stating that the mini C-arm was used, the interpretation of the images obtained, the radiation emitted, and the time of radiation exposure. A log book is also kept with the patient information and corresponding radiation emitted and time of radiation exposure. The log book is examined by radiation physics on an annual basis. Using these data, a radiation physicist (S.H.K.) calculated the amount of skin exposure for each fracture evaluated. This study examined fractures evaluated in the pediatric orthopedic outpatient clinic that were previously reduced in the emergency department. The mini C-arm was used to assess fractures for postreduction healing, loss of reduction, and/or potential growth arrest. Because approximately 5% of reduced fractures displace in the cast, imaging is an important component of fracture follow-up care.6 The Figure shows an image obtained with the mini C-arm.

For comparison with the time needed to obtain conventional plain radiographs in the radiology department, time data for 20 consecutive forearm fractures imaged in the radiology department were recorded. Descriptive statistics were generated. The treating orthopedic surgeon wore his hospital-issued radiation safety badge for all mini C-arm evaluations.

Results

One hundred postreduction evaluations were studied. The sex distribution was 65% male and 35% female. The average age was 10.3 years (range, 1-17 years). The fractures evaluated were divided into 6 categories based on their location (distal or midshaft forearm) and the bones involved (radius, ulna, or both). The most common fracture patterns were those of the distal radius (45%), distal radius and ulna (38%), and midshaft radius and ulna (13%). The remaining fracture categories encompassed a smaller proportion of the fractures evaluated (Table). The average external skin radiation exposure to the patient was 0.58 mGy and the average length of exposure was 1.22 seconds. The surgeon did not experience changes in radiation safety badge exposure during the study. Use of the mini C-arm, in place of radiographs obtained in the radiology department, which is located 25 yards down the hall, decreased imaging wait times by 23 minutes (range, 18-29 minutes) in the authors’ clinic.

Discussion

At the authors’ institution, a forearm radiograph exposes the patient to 0.10 mGy of radiation per view. This value is comparable to those reported in the literature.3 The authors’ policy for follow-up fracture care dictates obtaining an anteroposterior view and a lateral view of the fracture. This exposes patients to 0.20 mGy of radiation with each set of radiographs obtained. Based on the data collected, use of the mini C-arm exposes patients to more radiation than comparable radiographs.5,7 Sharieff et al8 reported that the image quality from the mini C-arm was highly reliable and that these images could be used as an alternative to postreduction radiographs. On the basis of the number of fractures and the average radiation exposure, the mini C-arm is a viable alternative to conventional radiographs for follow-up care.
of their experience with the patients in this study, the current authors concur with Sharieff et al.8

When obtaining imaging studies, the diagnostic information provided must be weighed against the theoretically damaging radiation to which the patient is exposed, particularly in the form of cancers and genetic damage.9 Radiation exposure to patients can be minimized by using dose-reducing recommendations.10 The authors’ institution has a policy of minimizing radiation exposure when using the mini C-arm. These recommendations include having physicians stand away from the mini C-arm (2 m if possible), using lead aprons (including by the patient), having physicians keep their hands out of the beam, and minimizing unnecessary imaging.11-14

In the current study, use of the mini C-arm decreased the overall length of follow-up visits. Compared with radiographs obtained in the radiology department, use of the mini C-arm decreased imaging wait times by 23 minutes. Decreased appointment times have an important impact on patient satisfaction scores. In today’s practice environment, patient satisfaction is used by health care systems as a measure of quality. Segal et al15 found that waiting time significantly correlated with the rating of providers on patient satisfaction surveys in pediatric orthopedic practices. The more time-efficient workflow achieved by incorporating the mini C-arm into orthopedic practice will potentially improve patient satisfaction scores, increasing the quality measured.

The decrease in time spent waiting for imaging has increased the time available for seeing patients. The authors estimate that use of the mini C-arm has enabled 2 new patients to be seen per half day of clinic or 4 new patients to be seen per full day of clinic. With professional and facility fees, the authors estimate that this increase in new patients seen correlates with an additional $500 in billing per half day of clinic or $1000 in billing per full day of clinic. Charges for a plain radiograph of the distal or midshaft forearm total $300: $150 for the radiograph technician fee and $150 for the radiologist fee. Because the authors do not charge a technical or reading fee when the mini C-arm is used in the pediatric orthopedic outpatient clinic, the patient saves $300. The primary expense of operating the mini C-arm is the printer paper ($360 per year). The increased billing from the efficiency created by the mini C-arm offsets the operating expense of the mini C-arm unit.

Shortcomings of the current study included its retrospective design, small sample, just one mini C-arm unit being studied, and data being collected from only one surgeon and center.

CONCLUSION

Use of the mini C-arm in the pediatric orthopedic outpatient clinic led to 2 important findings. First, surprisingly, the mini C-arm used a slightly higher radiation dose than standard imaging with plain radiographs. Second, use of the mini C-arm saved time and improved the efficiency of the clinic visit. Use of personal protective equipment and safe imaging practices is recommended to enhance safety. Overall, the mini C-arm improves quality and efficiency in the pediatric orthopedic outpatient clinic.

REFERENCES


