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# Patient Radiation Exposure During Fluoro-Assisted Direct Anterior Approach Total Hip Arthroplasty

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ABSTRACT

*Background:* This study sought to quantify the total patient radiation exposure during fluoro-assisted direct anterior approach (DAA) total hip arthroplasty (THA). We hypothesized that the patient radiation exposure would fall within acceptable published limits for a 1-time patient exposure.
*Methods:* After institutional review board approval, we performed a retrospective chart review of consecutive unilateral primary DAA THAs at 2 institutions (N = 157) between 2012 and 2014 by a single fellowship-trained arthroplasty surgeon assisted by residents and fellows. Incomplete dose reporting information was the sole exclusion criterion. Patient electronic medical records were queried regarding exposure time (seconds), radiation emittance (mGy), and peak kilovoltage (kVp). Descriptive statistics were calculated. Pearson correlation coefficients were used to determine the correlation between variables.
*Results:* Mean radiation dose for patient exposure measured 2.97 ± 1.63 mGy (range: 0.29-9.83). Positive but weak linear relationship with radiation dose and body mass index (BMI; $r = 0.34$; $P < .0002$). Average exposure time per procedure was 23.74 s (range: 11.3-61.7). Average kVp per procedure was 75.38 (range: 65-86). Average BMI was 28.32 (range: 16.6-39.8). There was a significantly strong correlation between kVp and BMI ($r = 0.75$; $P < .0001$).
*Conclusions:* Total patient radiation exposure was nearly identical with previously published values for a screening mammogram (3 mGy) and 4 times less than that of a standard chest computed tomography (13 mGy). Although it is difficult to ascertain the exact patient-absorbed radiation, our data suggest that a 1-time exposure during DAA THA is likely negligible and provides the surgeon with additional data for counseling patients preoperatively.



Radiation exposure is an unavoidable risk for everyone. According to the Environmental Protection Agency, the average radiation dose per person per year is 620 millirem or 6.2 milligray (mGy). Gray (Gy) is a unit of measure of ionizing radiation defined as 1 J of energy absorbed by 1 kg of matter. A portion of the annual radiation exposure is secondary to naturally decaying radioactive isotopes, radon, and other background radiation. However, nearly half of the annual dose is attributed to medical diagnostics and treatment [1]. Radiographs have been used in medicine since Röentgen's discovery in 1895, with intraoperative fluoroscopy gaining popularity in the early 1980s. Between 1980 and 2006, the number of radiographic procedures performed increased 47%, with the cumulative estimated dose increasing by 727% [2]. According to the Environmental Protection Agency, <0.1% of annual radiation is from occupational exposure [1]. It stands to reason that orthopedic surgeons, particularly those with a high reliance on intraoperative fluoroscopy, have an above average annual radiation exposure. In one European hospital system, orthopedic surgeons had a fivefold increase in lifetime cancer rates as compared to other employees who used radiographs [3].

As surgeons, we constantly weigh the risks and benefits for our patients associated with a given surgery. Total hip arthroplasty (THA) has well-documented risks that are routinely discussed with the patient preoperatively; however, with the increasing use of the

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fluoro-assisted direct anterior approach (DAA), there may be additional unforeseen risks for our patients and potentially the surgeon. Over the last decade, utilization of the direct anterior approach for THA has increased with excellent patient outcomes reported [4]. The approach is often aided by the use of fluoroscopy to confirm placement and size of implants and equilibrate leg length and offset [5]. This among other potential advantages has made the approach more attractive and its use more prevalent. As with other approaches, there is a learning curve; however, over time, the accuracy of an acetabular component's abduction angle and version has been reported as high as 96% using the DAA [6]. No studies to date have quantified the potential radiation exposure for patients undergoing fluoro-assisted direct anterior approach THA nor the potential risk to the surgeon performing the procedure. We designed a study to report such data and better inform both surgeons and potentially patients of any additional risk.

## Materials and Methods

After obtaining institutional review board approval, we performed a retrospective chart review of consecutive unilateral primary direct anterior approach total hip arthroplasties (DAA THAs) performed at 2 institutions (N = 157) between 2012 and 2014. All procedures were performed by a single fellowship-trained arthroplasty surgeon (BC) and assisted by residents and fellows. Procedures performed at the beginning of the study were well beyond the surgeon's initial learning curve of 50-100 cases often referenced by those performing direct anterior approach total hip arthroplasty [7,8]. Incomplete dose reporting data was the sole exclusion criterion used.

Patient electronic medical records were queried regarding exposure time (seconds), radiation emittance (mGy), body mass index (BMI), and peak kilovoltage (kVp). The radiation dose recorded by the individual C-arm fluoroscopy units was measured in mGy, as was the total exposure time and the peak kVp. kVp represents the maximum voltage across the X-ray tube. Increased kVp produces photons of higher energy and thus increased penetrance through the target matter. C-arm fluoroscopy machines used were identical between institutions (General Electric OEC 12-in 9800 Series). The emitter was always located posterior to the patient below the operative table with the intensifier coming over the patient anteriorly. All procedures were performed on a HANA table with carbon fiber spars. Distance between the intensifier and the patient was always within 6 in when images captured and often as close as possible. Descriptive statistics were calculated. Pearson correlation coefficients were used to determine the correlation between variables.

## Results

Of the 157 DAA THAs performed over the 2-year time period, 117 cases had complete records and were included in the analysis. The average patient BMI was 28.32 (range: 16.6-39.8). There were 60 female and 57 male patients with 62 left and 55 right hips performed. The average exposure time per procedure was 23.74 seconds (range: 11.3-61.7). The average absorbed dose of radiation was 2.97 ± 1.63 mGy (range: 0.29-9.83). The average amount of maximum energy used to create the image was 75.38 kVp (range: 65-86). We did find a positive but weak linear relationship with radiation dose and BMI ($r = 0.34$; $P < .0002$) and is demonstrated in Figure 1. There was a significantly strong correlation between kVp and BMI ($r = 0.75$; $P < .0001$) as illustrated in Figure 2. In regard to fluoroscopy time and BMI, there was very weak correlation ($r = 0.10$; $P < .28$; Fig. 3).

## Discussion

Exposure to ionizing radiation is potentially a risk for patients and a career long risk for orthopedic surgeons and other

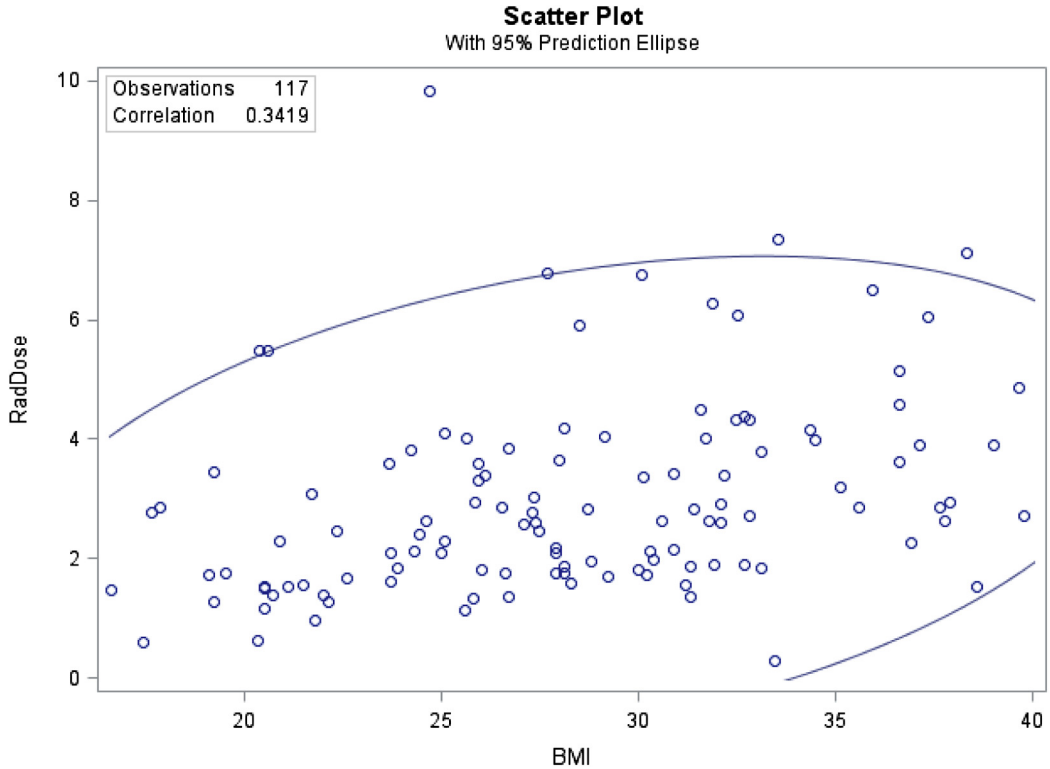


**Fig. 1.** Correlation between patient radiation dose per procedure and body mass index (BMI).