



Long-term Radiation Safety Profiles of X-rays After Undergoing Femoral Intramedullary Nailing

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BACKGROUND

The purpose of our study is to determine the effects of a femoral intramedullary implant on the amount of radiation the most radiosensitive organs are exposed to when compared to a native femur using both manual and AEC settings, as well as fluoroscopy.

Ionizing radiation from medical imaging has come under increased scrutiny, as almost half of the radiation exposure experienced by the population in the United States is from medical imaging. As such, increased focus on decreasing the amount of exposure our patients received by modifying classic manual x-ray techniques. Automatic Exposure Control (AEC) is a technique that accomplishes this goal by allowing x-ray to reduce the required radiation dose and exposure while maintaining imaging consistency, regardless of the body habitus of the subject. The purpose of our study is to determine the effects of a femoral intramedullary implant on the amount of radiation the most radiosensitive organs are exposed to when compared to a native femur using both manual and AEC settings, in addition to fluoroscopy.

METHODS

Calibration of ionizing chamber was performed in the days prior to the experiment. A mobile MOSFET system (BEST Medical) was calibrated with X-ray at kVp of 70, 80, 100, 120, and 138 kVp, phantom temperatures at 0, 21, and 43°C, and exposure ranges from 0.03 to 10 R. A fresh frozen cadaver had both MOSFETs and thermoluminescent dosimeter (TLD) probes placed at 5 locations to detect radiation (sigmoid colon (SC), right pelvic wall (RPW), left ovary (LO), pubic symphysis (PS), anterior pubic skin). X-rays centered at the left hip were taken using both Manual and AEC settings with probes recording the exposures at each location. X-rays were taken with the intramedullary implant in situ. Following this, the intramedullary implant was removed, and probes were confirmed to be placed in the same position. The previously performed protocol was repeated and values were recorded.

RESULTS

By calibrating the chamber and accumulating exposures, we were able to achieve dose-measured accuracy of 6%. Manual results prior to implant placement were PS: 0.361mSv; LO: 0.170mSv; SC: 0.276mSv; RPW: 0.110mSv and skin: 0.364mSv. Manual results after placement of the implant were PS: 0.378mSv; LO: 0.150mSv; SC: 0.288mSv; RPW: 0.191mSv; and skin 0.469mSv. The relative risk of manual exposures are PS: 1.05; LO: 0.88; SC: 1.05; RPW: 1.74; skin: 1.29. AEC results prior to implant placement were PS: 0.063mSv; LO: 0.042mSv; SC: 0.063mSv; RPW: 0.038mSv and skin: 0.071mSv. AEC results after placement of implant were PS: 0.066mSv; LO: 0.035mSv; SC: 0.062mSv; RPW: 0.032mSv and skin: 0.068mSv. The relative risk of AEC exposures are: PS: 1.05; LO: 0.83; SC: 0.98; RPW: 0.84; skin: 0.96. Fluoroscopy radiation exposure with equivalent and under a dangerous threshold with the nail and and out.

	Rt PW	Lt OV	Sig Colon	Pub sym	Skin
Nail In Manual (mGy)	0.191	0.129	0.303	0.348	0.433
Nail In AEC	0.033	0.035	0.065	0.055	0.061
Nail out manual	0.106	0.162	0.296	0.338	0.306
Nail Out AEC	0.033	0.035	0.065	0.055	0.061
	Rt PW	Lt OV	Sig colon	PS	Skin
Nail out Fluoro (mGy)	0.014	0.063	0.011	0.007	0.008
Nail in fluoro	0.014	0.041	0.011	0.007	0.008

	R PW	LT OV	Sig Colon	PS	Skin
RR Manual	1.74	0.88	1.05	1.05	1.29
RR AEC	1.05	0.86	0.98	0.84	0.96

CONCLUSION

The average background radiation exposure to a person in America is approximately 3mSv per year. Epidemiological studies have shown cancer risk associated with exposure follow a linear model when threshold levels below 90mSv of exposure were experienced. While this linear model has been confirmed in dose ranges between 10 – 90mSv, when exposures sit in the lower ranges (1-10mSv), there continues to be debate regarding increased risk and linear progression. Radiation exposure to the most radiosensitive pelvic and abdominal organs does not increase following placement of a femoral intramedullary nail. These values also stay below the concerning threshold in both categories. This is in direct contrast to previous studies which demonstrated that radiation values increase up to 3x greater after placement of a total hip implant (to >1mSv per exposure). This is especially valuable information when considering patient's who receive a femoral intramedullary is commonly used in a trauma setting with younger patient populations. This points to the long-term safety of continued x-ray use in patients following the placement of a femoral intramedullary nail.