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Title: Novel Lead-Free Lightweight Radiation Attenuating Material for Interventional Procedures

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Purpose: Heavy lead aprons are used for radiation protection. This is uncomfortable and may accelerate degenerative spine disease. There has been little progress in radiation protection despite increasingly complex interventional procedures. We hypothesized that a radiation shielding material comprised of lower and higher atomic number compounds compared to elemental lead might provide radiation attenuation that is equivalent to lead based materials but with a significantly lighter weight.

Material and Methods: A bi-layer composite was constructed of a 0.85 mm film of 90 weight % barium sulfate powder and 0.48 mm film of 90 weight % bismuth oxide powder compounded with a binder/plasticizer. Attenuation properties of this composite were measured at 60, 90 and 130 kVp for 60 s exposures. Commercially available lead and lead-free shields from thyroid collars labeled as 0.5 mm lead equivalent were used as controls. The ratio of transmitted radiation dose to incident dose provided the attenuation %. Means and standard deviations of attenuation performance, and pass through radiation for the test specimens and controls were computed and compared using a two-tailed Student's t-test.

Results: Measured attenuation values normalized to the incident dose and pass through radiation for the bi-layer barium sulfate/bismuth oxide composite shield were found to be equivalent to 0.5 mm lead sheet and commercial 0.5 mm lead equivalent shielding averaged over 60, 90 and 130 kVp. The bi-layer composite shield exhibited significantly higher attenuation than a commercial lead-free shield at 60 kVp ($p=0.001$) and 90 kVp ($p=0.006$). At 130 kVp the average attenuation trended higher ($p=0.06$).

Conclusions: This novel composite material demonstrated equivalent radiation attenuation to 0.5 mm thickness lead shields with a significant $\geq$40% reduction in weight. This may provide safer, more effective, light weight and comfortable radiation protection during complex procedures. A thyroid collar constructed from these materials was recently cleared by the FDA and the results of an ongoing clinical study will be presented.