Purpose: To develop lead-free polymer composites for shielding diagnostic x-rays employed in interventional radiological (IVR) procedures.

Methods: Polydimethylsiloxane (PDMS) composites of different weight percentages (wt%) were developed from the following high atomic-number (Z) materials: (i) bismuth tungsten oxide (BTO), (ii) bismuth oxide (BO). X-ray attenuation tests were performed using the diagnostic x-ray machine (Ysio, Siemens) for energies from 40 kV to 150 kV. Each sample was placed at a distance of about 20 cm from the ion chamber (x-ray detector) connected to an electrometer (Capintec). For each experiment, the distance between the ion chamber and the floor was at least 50 cm in order to avoid backscattered radiation. All measurements were normalized with reference to the readings obtained with no sample between the source and the detector.

Results: Analysis of percentage attenuation versus x-ray energy indicates that the attenuation capability of all the composites decreases with increasing energy. PDMS composite with 36.36 wt% of BTO shows an overall increase of 18.3% and 50% attenuation relative (absolute differential between the % attenuation) to that achieved by 18.18 wt% of BTO and pure PDMS (no BTO) respectively. For both BTO and BO composites, doubling of the sample thickness showed a relative increase of 16.4% and 12.3% attenuation respectively at 60 kV, the energy typically employed in IVR.

Conclusions:Protective aprons made of high Z metals such as lead or composites of lead are heavy and also toxic due to the presence of lead. In this study, we have shown that light-weight, conformable, cost effective, and non-toxic polymer composites of high Z materials can be designed to effectively attenuate diagnostic x-rays. A composite sample with 60.6 wt% of BO (thickness of 2.67 mm) has shown the best result, by far, with 92.5% attenuation of the beam at 60 kV.