Purpose:

To quantitatively evaluate effects of image artifacts of hip prostheses on the accuracy of structure delineation and tissue density calculation on kV and MV CT images.

Methods:

Five hip prostheses made of stainless steel, titanium and cobalt chrome alloys were positioned inside a water tank and scanned respectively on a Philips CT and a Tomotherapy Hi-Art unit. Prostheses were positioned to mimic single and bilateral implantations. Rods of tissue materials of lung, water and bone were placed at locations next and distal to metal implants near femoral head, neck and stem of prostheses. kV and MV CT scans were repeated for each placement. On CT images, cross-sectional outlines of metal implants and tissue rods were delineated. Densities of rod materials were determined and compared to the true values.

Results:

Metal artifacts were severe on kV CTs and minimal on MV CTs. Cross-sectional outlines of metal implants and tissue rods on kV CTs were severely distorted by artifacts while those on MV CTs remained clearly identifiable. For kV CTs, deviations of measured tissue density from true value were up to 51.3%, 30.6% and 40.9% respectively for lung, bone and solid water. The magnitude of deviation was generally larger at locations closer to metal implants and greater with bilateral implants than single implant. For MV CTs, deviations of measured density from true value were less than 6% for all three tissue materials either with single or bilateral implants. Magnitude of deviation appeared to be uniform and independent of locations relative to metal implants.

Conclusions:

High Z metal artifacts on kV CTs can have severe impact on the accuracy of structure delineation and tissue density calculation, while on MV CTs, the impact is substantially less and insignificant. MV CTs should be considered for treatment planning on patients with high Z metal implants.