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Characterization of gallstones on dual energy computed tomography using a *in-vitro* phantom model

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PURPOSE: The aim of this study was to differentiate cholesterol gallstone from calcium stone on dual energy CT (DECT) using a in-vitro phantom model.
MATERIALS AND METHODS: We evaluated prospectively 43 stones more than 5 mm of diameter in 21 patients with gallstones. All of the surgically-extracted stones were scanned with *in-vitro* DECT using a distilled water-filled acrylic container phantom model. The DECT scan was performed using a tube voltage of 80/140 kVp and 100/140 kVp, and image sets were divided into 80, 100, 140 kVp sets. Semi-quantitative infrared spectroscopy (FTIR) was performed to confirm the chemical composition of the stones. Hounsfield units (HU) of the stones were measured on three kVp image sets. And, the CT attenuations of the stones were divided into three categories for qualitative comparison, hyper-, iso- and hypoattenuation, compared with the water. According to the FTIR results, we divided gallstones into calcium and cholesterol stones, calculated the sensitivity of DECT and compared the HU values of each stones.
RESULTS: The stones were confirmed as 20 cholesterol stones in 10 patients and 23 calcium bilirubinate stones in 11 patients on FTIR. Cholesterol stones were identified with 95%, 85%, 95% sensitivities and calcium stones were identified with 91.3%, 91.3%, 91.3% sensitivities on the 80, 100, 140 kVp sets, respectively. 70.0% of cholesterol stones showed hypoattenuation at 80 kVp, 85.0% of cholesterol stones showed hyperattenuation at 140 kVp. 91.3% of calcium stones showed hyperattenuation and 8.7% of calcium stones showed isoattenuation at all of image sets. Average CT attenuations of the cholesterol stones were calculated as 9.89 HU, 16.81 HU, 39.75 HU and those of the calcium stones as 206.83 HU, 186.46 HU, and 134.21 HU at 80, 100, 140 kVp image sets, respectively. There were statistically significant at all of the comparative quantitative analyses of 80/100 kVp, 80/140 kVp and 100/140 kVp sets (for cholesterol stones, $p = .020$, $p < .000$, $p < .000$, respectively, for calcium stones, $p = .046$, $p = .001$, $p = .001$, respectively).
CONCLUSION: *In-vitro* DECT can differentiate cholesterol stones from calcium stones. Cholesterol stones usually showed hyperattenuation at high kVp image set and calcium stones showed hyperattenuation at low kVp image set. This results may be used to identify the patients eligible for non-surgical treatment options.