AbstractID: 3071 Title: Establishing urinary stone composition nondestructively using x-ray coherent scatter: a novel technique with potential clinical applications

Purpose: Current kidney stone analysis techniques are limited in their abilities to simultaneously characterize composition and structure. Laboratory techniques like infrared spectroscopy (IRS) likely miss vital components as they require small powdered samples for analysis. We investigate the application of x-ray coherent scatter (CS) based analysis to identify topographic urinary stone composition non-destructively, ex vivo. CS is dependent on molecular structure and can therefore distinguish different compounds. The use of diagnostic x-ray equipment facilitates examination of structural arrangements of minerals within intact calculi.

Method and Materials: Tomographic images of CS properties of a stone-mimicking phantom, containing common stone components were acquired with a purpose-built scanner. These were analyzed to assess the accuracy of CS analysis when applied to urinary calculi. The composition of intact human urinary calculi was then examined by CS and compared to the clinical gold standard, IRS.

Results: Composition maps of the phantom generated from CS patterns, demonstrate that stone components can be accurately separated in the presence of many different chemicals. Similar maps from intact stones revealed the spatial arrangement of constituent minerals. Primary stone components were identified by both CS and IRS. However, less prevalent secondary components were missed by IRS in some instances. Composition as determined by CS analysis is thus shown to generate scatter cross sections that match the features of stone cross sections better than IRS-determined composition.

Conclusion: Coherent scatter from diagnostic x rays can be used to identify structure and composition in urinary calculi non-destructively. This can provide substantially more clinically-relevant information than currently available from IRS. The CS-derived composition images presented here support the development of CS analysis as a means for identifying stone composition characteristics both at the laboratory level, for post-operative analyses and explorations of responses to therapy, and possibly for in situ composition assessments.