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THE ROLE OF DUAL ENERGY COMPUTED TOMOGRAPHY FOR BIOCHEMICAL CHARACTERISATION OF URINARY STONES-STUDY AT A TERTIARY CARE CENTER

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ABSTRACT Nephrolithias is a growing problem worldwide due to the increase in risk factors contributing to the disease burden. Renal calculi are known to be the most common factors responsible for the development of chronic renal failure. In a prospective study done by Taylor and co-workers, which was spanned over 46 years have shown that obesity and weight gain and their effect on renal calculi. The studies show that the risk factors that have increased over the years mostly contribute toward the development of renal calculi which are radiolucent and can be missed and can be a concern for the urologist when the patient presents with symptoms suggestive of colic. Hence we conducted the study Renal CT is a the diagnostic tool considered as a standard for diagnosing renal calculi. Hence we conducted the study compare the urinary stone chemistry as determined by Dual-Energy Computed Tomography (DECT) with direct analysis by Fourier Transform Infrared Spectroscopy (FTIRS) and predict its applicability in management.

KEYWORDS :

BACKGROUND AND OBJECTIVE

Nephrolithias is a growing problem worldwide due to the increase in risk factors contributing to the disease burden. Renal calculi are known to be the most common factors responsible for the development of chronic renal failure. In a prospective study done by Taylor and co-workers, which was spanned over 46 years have shown that obesity and weight gain and their effect on renal calculi[1,2]. There is documentation in studies that the risk factors that have increased over the years mostly contribute toward the development of renal calculi. These stones are radiolucent and can be missed and can be a concern for the urologist when the patient presents with symptoms suggestive of colic. Recently, Dual Energy Computed Tomography (DECT) that applies X-ray at two different energies has been claimed to be able to identify stone composition with accuracy prior to in-vivo analysis3-6. Hence we conducted the study Renal CT is a the diagnostic tool considered as a standard for diagnosing renal calculi and one of the methods to predict pre-operative stone mineralogy in vivo like Urine biochemical parameters also Hounsfield unit value of urinary calculi obtained from Non-contrast CT have been shown to influence treatment [3-5]. But the exact stone composition can be determined only after extraction. Hence we conducted the study compare the urinary stone chemistry as determined by Dual-Energy Computed Tomography (DECT) with direct analysis by Fourier Transform Infrared Spectroscopy (FTIRS) and predict its applicability in management.

MATERIALS AND METHODS

A non- randomized prospective clinical study was conducted involving 50 patients having calculus in the kidney or ureter who underwent various procedures for the same between the periods of January 2015 to August 2016 after obtaining informed written consent. Scanning was done using 128-slice DECT scanner. Stones extracted were subjected to Fourier transform infrared spectroscopy (FTIRS). The calculus compositions were then retrospectively compared with respective DE ratios. Analysis of variance (ANOVA) was used to determine if significant differences existed between the DE ratio values of each calculus group.

RESULTS AND OBSERVATIONS

50 stones were analyzed by DECT and FTIRS. Main component of the stones were calcium oxalate monohydrate(35), calcium oxalate dihydrate(2),uric acid (6), Mixed (7). ANOVA analysis showed that there was a significant difference in the DE ratio between the groups ($p<0.001$). UA had the lowest DE ratio, followed by progressively higher values in mixed and calcium oxalate stones.(Table-1) DE ratio of <1.18having 100% sensitivity and specificity for identifying UA calculi using ROC analysis.(Table-2) The discriminant DE ratio values obtained in our study for identifying calculus composition are<1.18 for UA, 1.18-1.43 for mixed stones, >1.43 for Calcium oxalate stones. These values are near similar to those reported by a phantom study performed by Qu et al. [4]

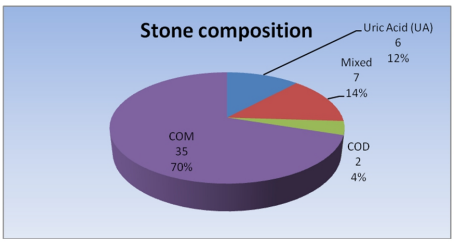
Table 1: Mean and range of dual-energy (DE) ratios of calculi

Stone composition	No.	DE Ratio
Uric Acid (UA)	6	1.002+0.02(0.98-1.02)
Mixed	7	1.427+0.08(1.33-1.59)
COD	2	1.395+0.01(1.39-1.40)
COM	35	1.507+0.08(1.35-1.86)

Table 2: analysis to differentiate the various calculus groups

Calculus groups	Statistically significant	DE Ratio Cut-off value	Sensitivity%	Specificity%	Area under curve
UA vs Mixed	Yes	1.17	100	100	1
UA Vs COM	Yes	1.18	100	100	1
Mixed - COM	Yes	1.43	89	71	0.8841

Figure1: Stone composition of calculi



Discussion

There is increasing evidence of increase in the risk factors associated with development of renal calculi like Diabetes mellitus7 combined calcium and vitamin D supplements in post-menopausal women8 Obesity due to reduction in urinary pH and associated nephrolithiasis. 10

Urinary calculi are commonly encountered in clinical practice and their composition or mineralogy has a crucial role in determining patient management. With the recent commercial availability of dual-energy computed tomography (DECT), many investigators have evaluated the ability of this scanning method to identify calculus composition before extraction, i.e., in vivo. DECT consists of scanning the same anatomic region at two different energy levels. Because of inherent differences in atomic number, calculi of differing compositions exhibit disparate attenuation properties at different energy or kilovoltage levels. This property is exploited to predict the composition of the calculi. In our study we found that, DECT was accurate in differentiating UA, struvite, and CA calculi from calcium oxalate calculi. As the former are associated with urinary tract infections hence we suggests that by using DECT it is possible to evaluate the composition and treat infection if any so that the best management be given. We also found that in 15 cases when USG and x-ray KUB did not detect calculi DECT detected the calculi.

Conclusion

DE-CT is useful for not only estimation of stone fragility and stone skin distance but also prediction of stone composition.

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