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Original Research Paper

Pathology

STONE ANALYSIS- A 5 YEARS REVIEW

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ABSTRACT Kidney stones are solid masses that are formed when there are high levels of calcium, oxalate, cystine, or phosphate and too little liquid. There are different types of kidney stones. Calcium oxalate stones are the most common type of kidney stone. Nowadays it is thought that kidney stones are a systemic disorder. The stone composition can differ from a distinct single crystal to a compound mixture of many dissimilar crystals. The epidemiology of kidney stones is evolving. The gender gap has narrowed, and diet, obesity, and environmental factors have been implicated. Understanding of the epidemiology is required to comprehend the degree to which modifiable etiological factors are responsible for stone formation and to undertake measures for preventing recurrence. Many methods for stone analysis are available, including dry and wet chemical spot tests, X-ray powder diffraction, Fourier transform infrared (FT-IR) spectroscopy and Raman spectroscopy. The Guidelines on Urolithiasis of the European Association of Urology recommend infrared spectroscopy or X-ray diffraction for kidney stone analysis and consider wet chemical tests as outdated. Have shared our experience with FITR for kidney stones analysis in this article.

KEYWORDS : Calcium Oxalate, Calculi, FT-IR, Infrared Spectroscopy, Kidney Stone.

INTRODUCTION

Our body uses food for energy. After the body uses what it needs, waste products travel through the bloodstream to the kidneys and are removed through the urine. Urine has various wastes in it. If there is too much waste in too little liquid, crystals can begin to form. These crystals may stick together and form a solid mass in the kidney (a kidney stone). It may stay in the kidney or travel down the urinary tract and cause infection and obstruction.

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We reviewed last 5 years data and found 64% cases were found in 30-60 years of age. Males were most commonly affected. Dimensionally smallest stone was 0.1mm and largest stone was 2.5 cm. The FI-TR analysis showed most common composition in 2611 stones analysed were Calcium Oxalate Monohydrate (90%), Calcium Oxalate monohydrate (49%), Calcium apatite (34%), Ammonium urate (28.1%) and Uric acid (11%).

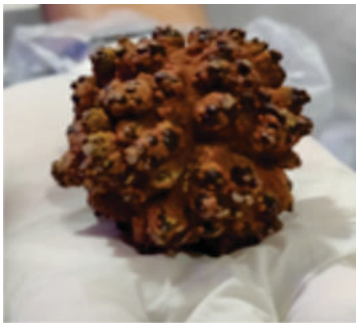

Figure 1a: Gross appearance of a Kidney Stone.

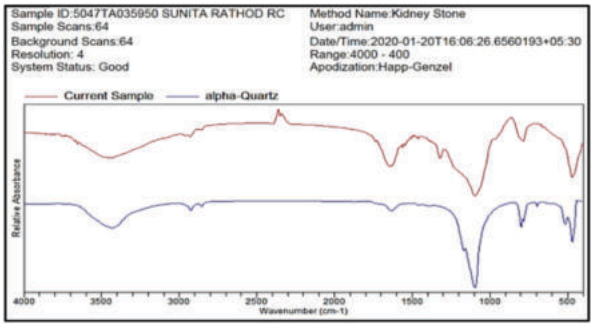

Fig 1b. Graph of Alpha Quartz

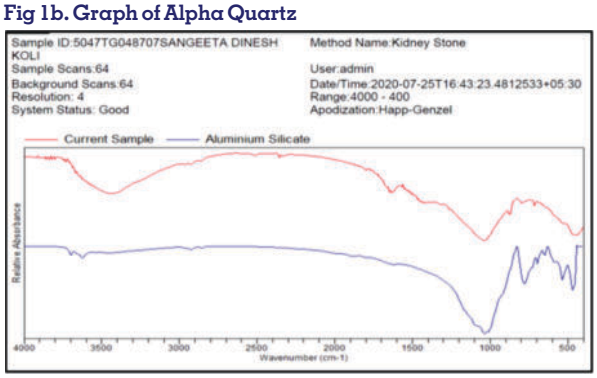

Fig 2. Graph of Aluminum Silicate

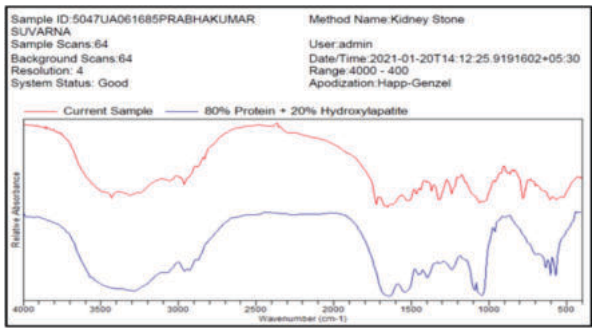

Fig 3. Graph of Calcium Phosphate/Hydroxyapitate

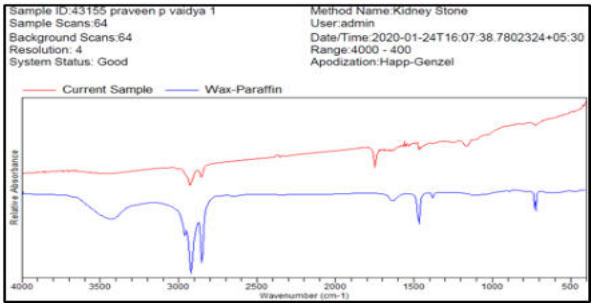

Fig 4. Graph of Wax paraffin

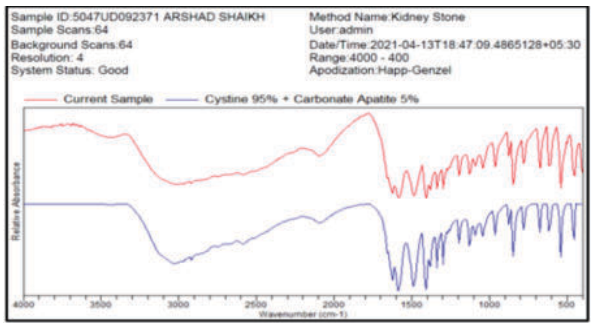

Fig 5. Graph of cysteine

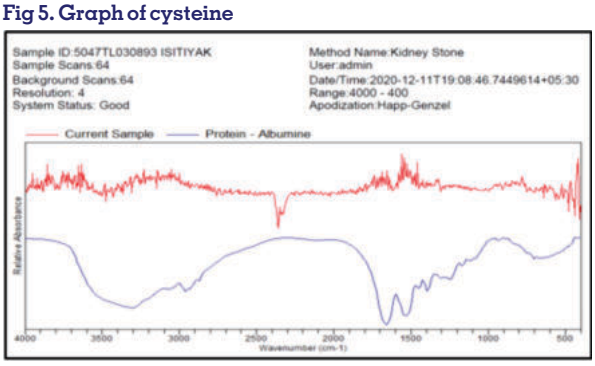

Fig 6. Graph of protein albumin

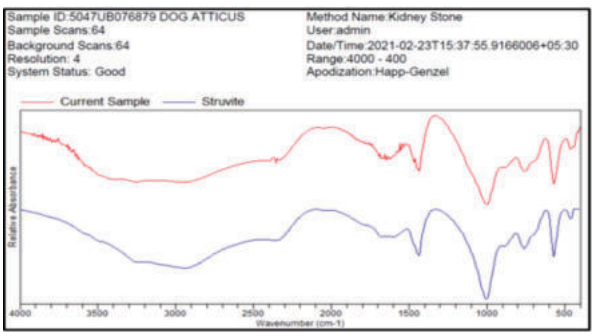

Fig 7. Graph of Struvite

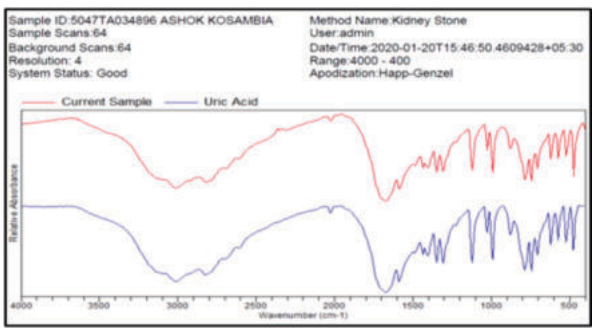

Fig 8. Graph of Uric acid

SUBJECT AND METHODS

This study was a *retrospective* single-centre study, which included 2612 patients from Jan 2017 to June 2021.All stones were analysed by *Fourier Transform infrared spectroscopy* (FI-TR). The stone sample were received in a clean dried sterile container, and stored in 20-22° C. The large specimens were grinded to dust by pestle and mortar and placed for analysis. The FTIP results were compared with the stone IR spectra with Bruker's BLG 1 and 2 spectral libraries.

RESULTS

The Male patients contributed 1787(68% cases) and Females contributed 822(32% cases).

49% of the samples received were as Multiple stones (>16 pieces of stone) 30% of the cases received for analysis were Single stone.

Lightest stone received was 700 mg and Heaviest stone received was 38 grams. (Fig. 1a)

Table – 1 Distribution Of Samples

Year	No of samples testes
2017	187
2018	887
2019	834
2020	456
2021	247

Table – 2 Age Distribution

Age Group (years)	No of Samples	%
0-5	100	3.8
5-10	313	12
10-15	394	15.1
15-30	499	19.1
30-60	1679	64.3
>60	423	16.2

Table – 3 Chemical Composition Of The Stone

Chemical Components in the stone	No of Stones with the chemical
2,8 Dihydroxyadenine	1(0.03%)
Alpha Quartz (Fig.1b)	2(0.06%)
Aluminium Silicate (Fig. 2)	5(0.1%)
Ammonium urate	734(28.1%)
Calcium Bilirubinate/Gall stones	3(0.09%)
Calcium Carbonate/Calcite	13(5%)
Calcium Oxalate Dihydrate	1305(49%)
Calcium Oxalate Monohydrate	2355(90%)
Carbonate Apatite/ Amorphous Carbonated Calcium Phosphate (Fig. 3)	891(34%)
Others like Cellulose based Linen Ligature, Cerumen, Wax paraffin (Fig 4), Acid Protein & Calcium sulphate	1 each (0.1%)
Cholesterol	15(0.5%)
Cystine (Fig. 5)	5(0.1%)
Magnesium hydrogen phosphate trihydrate /Newberyite	9(3.4%)
Potassium Urate	3(0.09%)
Proteins (Fig 6)	74(2.8%)
Struvite (Fig. 7)	77(2.9%)
Uric acid (Fig. 8)	306(11%)
Xanthine	1(0.03%)

DISCUSSION

It is worldwide underlined that the determination of crystalline, molecular composition and quantification of all stone components are helpful to establish the etiology of stones disease and prevent future stones. Different methodologies exist for the analysis of renal stones. These

include qualitative "dry" chemical spot tests and quantitative X-ray crystallography, infrared spectroscopy (FT-IR), and "wet" chemistry tests.

FITR is the most appropriate technique for stones analysis and is becoming the gold standard for stone analysis. The infrared spectrum originates from the vibrational motion of the molecules. The vibrational frequencies are a kind of fingerprint of the compounds. This property is used for characterization of organic and inorganic compounds present in renal calculi. The band intensities are proportional to the compound concentration and hence qualitative estimations are also obtained. Figures 1 to 8 compare standard curve to sample curve.

Our demographic results were in concordance to rest of the world data; as stone tends to occur in older age group and most commonly in kidney according to V Asyana et. al

As compared to other FITR studies like Khan et al we also found calcium and oxalate in majority of stone composition (approximate 90%)

We also found rare components like Calcium oxalate dihydrate (49%), Carbonate apatite (34%), Uric acid (11%), Struvite (2.9%), Cysteine (0.1%), Xanthine (0.03%), Quartz (0.06%). Similar findings were also reported in Aniello Primiano et.al

The spectrum of a pure calcium oxalate monohydrate showed a high absorbance at 1616 - 1600 cm-1 and 1314 - 1302 cm-1 belonged to C=O and C-O stretching vibration, respectively as shown in the figures above.

CONCLUSIONS

The present study indicated that the information on chemical composition of urinary stone mostly varied, so accurate identification of components of Kidney stone is important for

- *Correct diagnosis as a wrong diagnosis can led to incorrect medical and dietary treatment.*
- *Clinically, it is pertinent to know the composition of both the stone surface and the center or the core because this information can suggest the formative cause of the stone.*
- *Differentiation of COM crystals from COD crystals was possible by the FT-IR technique but not by chemical analysis*
- *Chemical analysis has been reported as erroneous result on 6.5 to 94% cases and they tend to miss oxalate stone in 25% cases.*
- *Chemical analysis tend to report false positive ammonium or magnesium components hence the stone can be misdiagnosed as of infective etiology*
- *FITR are high sensitivity, reliable, easier, more standardized as results are compared to a Nicodom library, based on strong scientific principles*
- *FT-IR spectroscopy leads to unambiguous information about the stone composition, both for main substances and trace elements, all essentials to guide therapy.*

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