Ulster Med J 2019;**88(1):**21-24

Clinical Paper

Renal and Ureteric Stone Composition: A five year retrospective study for Northern Ireland

Matthew Tyson[1], Nathen Grimes[2], Laura McAuley[1], Derek Hennessy[1], Ajay Pahuja[3], Michael Young[1]

Accepted: 26th July 2018
Provenance: externally peer reviewed.

Key Words: Calculi, Renal, Ureteric, Stone, Calcium oxalate, phosphate, struvite, urate, Cystine

ABSTRACT

Introduction: The study aimed to present the types of renal and ureteric stones (calculi) present in the population of Northern Ireland. The data may help in future planning treatment of stone services, patient education and prevention.

Methods: Consecutive retrospective renal and ureteric stones analysed over 5.75 years (January 2008 – September 2013) in Northern Ireland. Exclusions included patients < 16 years, and calculi listed as bladder stone.

Results: Total of 1618 stones analysed. Male to female calculi ratio 1.93: 1. Age range 16 – 94 years (52.2 mean), most common age for stone analysis 31–60 years. From 2008 to 2012 the number of stones analysed increased by 132.9%. Calcium was demonstrated in 94.5% (1529) of stones, of which 2.5% (40) pure calcium oxalate. Calcium oxalate and phosphate 72.9% (1182) of all stones, male to female ratio 2.4:1. Stones containing uric acid 9.6% (156), with uric acid male to female ratio 4.83:1. Struvite 13.7% (222), male to female ratio 1:1.6. Pure cystine 1.1% (18) of stones, male to female ratio 1:1.3.

Conclusion: There is a high proportion (94.4%) of stones containing calcium oxalate in Northern Ireland; these patients should be aiming to produce 2L of urine a day to aid prevention. Most common age for stone analysis (31–60) is in keeping with most common age for presentation. The steep increase in calculi analysis of 132.9% must be met with personalised stone treatment and prevention strategies.

INTRODUCTION

Renal stones (calculi) have afflicted the human population for thousands of years, having been identified in Egyptian mummies, and even make up part of the classical Hippocratic Oath from the 4th century BC[3] Renal stones can be identified in 8% of the population[2], which translates to 148160 people living with renal stones in Northern Ireland. In the United Kingdom renal colic is common, with 12% of men and 6% of women having at least one episode of renal colic in their lifetime, with the annual incidence of 1-2 per 1000 and incidence peaking at 40-60 years of age for men and late 20's for women.[2,4] This translates to a potential 3752 patient presentation per year for renal colic in Northern Ireland, with potential for consuming Emergency Department time and resources. The difference between male and female risk is decreasing, this is likely due to the increase in obesity and western diet.[5] The overall incidence of renal stones is rising. In America, an incidence rate of 1 in 20 in 1994 has almost doubled to 1 in 11 when compared to year 2007-2010 data.[7] The risk of further stone development is high, with 30% to 40% chance of recurrence at 5 years.[5]

The aim of the study was to present the epidemiological data for renal stone composition for Northern Ireland. The data could aid planning of the urological service including treatment and prevention of patient's renal and ureteric stones. A retrospective review of 5.75 years of renal and ureteric stones submitted for analysis was conducted between 2008 and 2013, to allow for adequate numbers and an appreciation of the growing demand for the service. The European Association Urology (EAU) states that composition of the stone is important for future treatment and prevention strategies[1], hence the need for renal stone analysis. Stones are classified in many ways, the commonest is grouping by their biochemical constituents.

MATERIALS AND METHOD

The retrospective study period was from January 2008 to September 2013 inclusive. A consecutive list of urinary tract stones was generated by the central laboratory responsible for analysis. The majority of Northern Irish renal stones are sent for analysis at the same laboratory. During the study period all stones were analysed with wet chemistry methods. Exclusion and inclusion criteria are demonstrated in table 2.

1. Craigavon Area Hospital, 2.Altnagelvin Hospital, 3. Belfast City Hospital, Northern Ireland

TABLE 1.

Common Renal Calculi[2]

Stone Type	Percentage of all stones	Notes
Calcium-based calculi 	60-80% of all stones	Composed on Calcium oxalate, or more rarely calcium phosphate. Commonly contain oxalate and phosphate.
Struvite stones (Triple phosphate, infection stones) 	10 -15%	Composed of Calcium, magnesium and ammonium phosphate. Slightly more common in women
Uric Acid 	5-10%	Form in acidic urine, and common in patients with diet high in animal protein
Cysteine 	1%	Caused by hereditary Cystinuria.
Other	1%	Including drug stones, xanthine, carbonate.

(Images open access, BAUS)

TABLE 2:

Inclusion and exclusion criteria

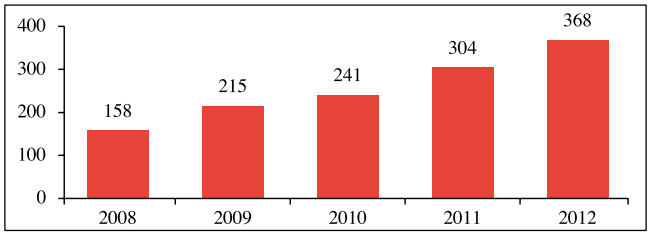
All urological stones submitted for analysis between 04/01/2008 and 18/09/2013	• Total 1808
Patient <16 excluded	• Total 47
Non labeled renal or ureteric stones excluded	• Total 82
Stones excluded for laboratory reasons	• Total 61
Total number of renal and ureteric stones in series	• 1618 renal and ureteric calculi

RESULTS

Between the 04/01/2008 to the 18/09/2013 a total of 1618 renal and ureteric stones were analysed. Overall, 1.93:1, male to female ratio. The number of stones analysed per year is demonstrated in Table 3, with an increase of 132.9% calculi analysed from 2008 to 2012 (most recent complete year).

TABLE 3

Number of Stones Analysed per year

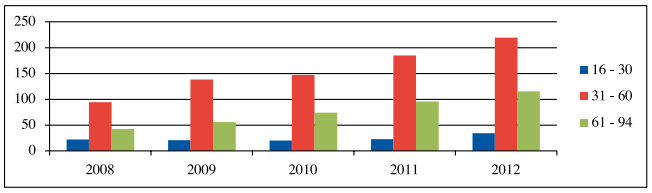


(2013 was an incomplete year in the series, demonstrating 332 stones analysed over 9 months of the year).

Overall distribution of patient age for stones analysed, table 4, noted age range of 16-94 years (mean 52.2 years).

TABLE 4

Number of Stones per Year per Age Group



Calcium containing stones totalled 94.5% (1529) of all stones analysed. Calcium oxalate mixed with varying concentrations of phosphate was 73.1% (1182) of stones. Pure calcium oxalate stones totalled 2.5% (40). No pure calcium phosphate stones were reported. Reviewing the written reports of the 1182 stones reported as calcium oxalate containing phosphate, there were 8 reports not specifying the type of calcium phosphate, otherwise apatite was listed, but not brushite.

Uric acid containing stones totalled 9.6% (156). There were no pure ammonium urate stones, but there were 1.1% which contained ammonium urate in part.

Overall 13.7% of stones were Struvite containing. Of these 99% contained some degree of calcium oxalate and 51.8% contained some dahilite (carbonate) in composition. Overall, as expected, 1.1% of analysed calculi were cystine based.

DISCUSSION

The number of stones being analysed has increased considerably year on year, for all age groups, during the study period (132.9%, 2008 year to 2012). The population of Northern Ireland is increasing,[8] as is the rate of obesity,[9] and so there will be a continued predicted increase in renal stone presentations. To ensure the most reliable results, the EAU recommend infrared spectroscopy or x-ray diffraction[1] over the wet chemistry method which was practised during this study period. Smaller samples are able to be analysed using infrared spectroscopy over wet chemistry, with a moderate increase in cost[16]. Whilst x-ray diffraction allows exact differentiation of all crystalline components, the high cost is often restricting[16]. It is unlikely that analysis by infrared spectroscopy or x-ray diffraction would see a significant shift in stone composition for Northern Ireland.

The 31-60 year old age group demonstrated the largest number of renal stones analysed each year of the study, in keeping with expected age of first calculi presentation.[2] However with an aging population,[8] the over 61 years group had the highest increase in stone analysed with a 173.8% increase (2008 to 2012 complete years).

Northern Irish calculi do not demonstrate any dramatic deviation away from the normal text book distribution for composition or epidemiological distribution.[2] There does appear to be a possible higher proportion of calcium oxalate calculi containing some degree of calcium phosphate, comprising 72.9% of calculi analysed. Mixed calcium oxalate and phosphate calculi are common,[2] tending to have a higher urinary pH then those with pure calcium oxalate stones, and demonstrate lower urinary citrate, hypercalciuria, and patients experience more frequent stone events.[10] Given the high proportion of calcium oxalate containing phosphate, this may be associated with incomplete distal tubular acidosis in the population.

Calcium phosphate in the form of brushite is a high risk for recurrence, but in the 5 year study only a possible 8 brushite calculi were identified, the remainder being calcium phosphate in the form of apatite.

Cysteine stones comprised 1.1% of stones analysed, in keeping with the expected number.[2] These stones are more likely to present in the paediatric population, where they comprise 6-8% of stones. Their management is multimodality, including paediatrics, renal, urology and dieticians,[11] and given the small numbers in Northern Ireland, may be best managed under a centralised team. The adult fluid urine output should aim to exceed >3L/day, with dietary restriction in methionine and salt intake no greater then 2g/day to reduce recurrence.[1]

The gold standard for adult identification of renal or ureteric

TABLE 5

Stones by composition, age and sex for Northern Ireland 2008 -2013

Stone composition	AGE 16-30 years		AGE 31-60		AGE 61+		Male to Female ratio	Overall total
	Male	Female	Male	Female	Male	Female		
Calcium Oxalate and Phosphate	76 (6.4%)	38 (3.2%)	530 (44.8%)	211 (17.9%)	230 (19.5%)	97 (8.2%)	2.4:1	1182 (73.1%)
Calcium Oxalate	0	0	19 (47.5%)	7 (17.5%)	7 (17.5%)	7 (17.5%)	1.86:1	40 (2.5%)
Uric Acid	0	0	26 (37.1)	6 (8.6%)	32 (45.7%)	6 (8.6%)	4.83:1	70 (4.3%
In Part Uric acid	0	1 (1.2%)	31 (36%)	12 (14%)	37 (43%)	5 (5.8%)	3.8:1	86 (5.3%)
Struvite	10 (4.5%	16 (7.2%)	39 (17.6%)	74 (33.3%)	35 (15.8%)	48 (21.6%)	1:1.6	222 (13.7%)
Cystine	3 (16.7%)	5 (27.8%)	5 (27.8%)	4 (22.2%)	0	1 (5.6%)	1:1.3	18 (1.1%)
Total	89	60	650	314	341	164	1.93:1	1618

calculi is a non-contrast CT KUB (Kidney, Ureter, and Bladder).[2] Since 94.5% of all calculi analysed contained some degree of calcium, this may aid calculi identification on plain X-ray KUB. Thus a plain x-ray KUB should be conducted the same day as identification of calculi on CT KUB if conservative or pharmacological management of calculi is planned.

The potential for a treatable cause of calculi production highlights the need for these patients to undergo at least a basic calculi workup, and can be undertaken prior to urological or endocrinology review. This must include medical history, drug history, prior renal calculi or family history, urinalysis (especially pH) and blood for renal function, calcium and uric acid. Primary hyperparathyroidism is responsible for an estimated 5% of calcium stone formation, with 20% of patients with primary hyperparathyroidism forming stones.[10]

Patients can potentially reduce their risk of calculi formation by undertaking general preventative measures. Such as fluid intake of 2.5-3.0 l/d (litres a day), aiming for a urine output of 2.0-2.5 l/d, normal calcium intake (1-1.2g/d), low salt (NaCl 4-5g/d), reduced animal protein (0.8-1.0 g/kg/d).[1] Obesity is on the rise with 61% of adults measured in Northern Ireland 2014, are either overweight (37%) or obese (24%),[12] but a BMI of 18-25 should be the aim to reduce risk of stones, as well as other health benefits.[1]

With the rise in obesity in Northern Ireland, the number of uric acid stones and also calcium oxalate stones may increase.[13] There would be the potential to treat more patients medically, with chemo-lysis of their uric acid stones, and thus avoiding potential surgery. The identification of stone composition is becoming more reliable with the use of diagnostic non-contrast CT, as well as reducing radiation dose.[14]

The data gives an extensive view of renal calculi composition with age and sex distribution throughout Northern Ireland. Data is incomplete from the Western Trust however, with the majority of their calculi sent to Birmingham for analysis. The addition of these calculi is unlikely to change the overall impression given the large numbers already involved in the study, covering a population of 1.63 million, from a total Northern Irish population of 1.876 million[17].

The stone burden for Northern Ireland is likely to increase, requiring an increase in surgery. The dramatic 173.8% increase in the 61 year old and beyond group could provide challenges to future surgery and increasing risk to the patient with an age related increase in co-morbidity.[15] To limit the burden on the health care system, preventative measures should be undertaken at a population level, tackling adequate hydration and obesity.

Acknowledgement: Billy Graham; Mater Hospital Belfast for aiding data collection.

REFERENCES

1. European Association of Urology. Urolithiasis. Available at: http://uroweb.org/guideline/urolithiasis/#3. Acessed 02.05.18
2. British Association of Urological Surgeons. Kidney Stones. Available at: https://www.baus.org.uk/patients/conditions/6/kidney_stones. Accessed 02.05.18
3. Tefekli A, Cezayirli F. The history of urinary stones: in parallel with civilization. Sci World J. 2013 Nov 20;2013:423964.
4. Bultitude M, Rees J. Management of renal colic. BMJ. 2012 Aug 29;345:e5499.
5. Best Practice Advocacy Centre New Zealand. *Managing patients with renal colic in primary care: know when to hold them. BPJ. 2014 60.*
6. *National Institute of Health and Clinical Excellence*. Renal or ureteric colic – acute. Available at: https://cks.nice.org.uk/renal-or-ureteric-colic-acute#!backgroundsub:2. Accessed 02.05.18
7. Romero V, Akpinar H. Kidnet Stones: A Global Picture of Prevalence, Incidence, and Associated Risk Factors: Reveiws in Urology. 2010 (12) 86-96
8. *Northern Ireland Statistics and Research Agency*. Statistics, Population. Available at: https://www.nisra.gov.uk/statistics/population. Accessed 02.05.18
9. Northern Ireland Assembly Archive Site. Inquiry into Obesity – Institute of Public Health in Ireland. Available at: http://archive.niassembly.gov.uk/record/committees2008/HSSPS/090226_obesity.htm. Accessed 02.05.18
10. Potts, J. Essential Urology: A Guide to Clinical Practice. 2nd Ed. New York. Humana Press. 2012.
11. Ahmed K, Dasgupta P, Khan MS. Cystine calculi: challenging group of stones Postgraduate Medical Journal 2006;82:799-801.
12. Department of Health, Social Services and Public Safety Northern Ireland. A Fitter Future For All. Available at: http://www.northerntrust.hscni.net/pdf/FitfuturesforallObesityFrameworkNI2012.pdf. Accessed 02.05.18
13. Jeong JY, Doo SW, Yang WJ, Lee KW, Kim JM. Differences in Urinary Stone Composition according to Body Habitus. Korean J Urol. 2011 Sep;52(9):622-5.
14. Chaytor RJ, Rajbabu K, Jones PA, McKnight L. Determining the composition of urinary tract calculi using stone-targeted dual-energy CT: evaluation of a low-dose scanning protocol in a clinical environment. Br J Radiol. 2016 Nov;89(1067):20160408.
15. Chikuda H, Yasunaga H, Horiguchi H, Takeshita K, Sugita S, Taketomi S, et al. Impact of age and comorbidity burden on mortality and major complications in older adults undergoing orthopaedic surgery: an analysis using the Japanese diagnosis procedure combination database. BMC Musculoskelet Disord. 2013 May 28;14:173.
16. Basiri A, Taheri M, Taheri *F.* What is the State of the Stone Analysis Techniques in Urolithiasis? Urology Journal. 2012 April; 09;02.
17. Population UK, Northern Ireland Population 2018. Available at:
18. https://www.ukpopulation.org/northern-ireland-population/