

Studies on the Prevalence of Urolithiasis and Chemical Composition of Urinary Stones in Purnia Division of Bihar, India

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Abstract: Prevalence of urinary stone disease in Purnia division of Bihar province of India has been studied over a period of three years (2014 to 2016). Chemical composition of 165 surgically removed urinary stones from the division has also been studied. A month wise data of urolithiasis cases reported and diagnosed during the period of work were collected from the government hospitals, private nursing homes and diagnostic centers located within Purnia division. The data were collected with the help of a carefully structured questionnaire. One hundred sixty five surgically removed urinary stones were collected at random from the hospitals and private nursing homes of Purnia division. The stones were analyzed qualitatively for their chemical composition, adopting standard methods. Results revealed a gradual increase in the number of urolithiasis cases in the division over the years. District wise too, there has been a gradual rise in the cases. Male to female ratio of urolithiasis cases was found to be approximately 3:1. Maximum prevalence of the disease was observed in middle age (35 to 44 years) group. The months of June and July were seen to be the peak period when maximum number of cases surfaced. A predominance of the upper urinary tract calculi, particularly in males, was observed. Most of the calculi (81.8%) were found to be of mixed crystalloid composition, with calcium, oxalate and phosphate radicals, dominating. Uric acid/urate, ammonium, magnesium and carbonate were detected in rather less number of stones. Cystine was not found in any stone. Our observations in the present work would serve as a guide to the local physicians and surgeons to assess the factors behind the disease, and also to plan for combating/minimizing the incidence of urolithiasis in this region.

Keywords: Urolithiasis, Nephrolithiasis, Urinary stones, Urinary calculi, Renal calculi, Epidemiology of urolithiasis, Urinary stone composition, Purnia division.

INTRODUCTION

Urinary stone disease is related to a number of risk factors [1]. It is also a recurrent disease. Once an individual has had a stone, he/she has 35-50% chance of having recurrent stone at some time later in life [2]. The rates of urinary stone formation have also been found to vary geographically [3]. Certain geographical regions have been identified as endemic stone belts [1]. The regional variation in the prevalence of the disease as well as in the risk factors might be due to a variation in the climate, water quality, food habits etc. Review of literature in urolithiasis in the recent past indicates that the disease is prevalent in India [4-16], as well as, in many other countries [17-28]. In India, there is an increased prevalence of the disease in the northern and western regions [4-11,13,15], with some pockets located in Kerala, Maharashtra, Tamil Nadu, Assam, Manipur, Bihar and Jharkhand.

Chemical composition of urinary stones from a zone also reflect the type of stones with reference to

which the zone is a stone belt. Though the stone constituents are virtually restricted to only a few compounds, the slight variations might reflect the differences in urine biochemistry. The urine biochemistry, in turn, is remotely related to the geographical and ecological factors of the zone.

With the above views in mind, we have presently studied the prevalence of urolithiasis disease in Purnia division of Bihar (India). We have also studied the chemical composition of surgically removed urinary stones from the region. Purnia division is located in the northeastern region of Bihar province of India. This region has recently been witnessing an increasing number of urolithiasis cases [14]. In fact, we had earlier conducted similar studies in this region, way back in the period, 1999-2001. However, over the years, there have been many changes in this region. Population has increased sizeably with a parallel increase in the medical facilities. Patients earlier used to move out to the bigger cities for treatment. But now a days, a large

chunk of patients, owing to the improved medical/surgical facilities, prefer to get treated locally. As such, after a lapse of more than one decade of our previous study, we thought of reinvestigating the scenario of urolithiasis in this region in order to understand the changes, if any, in the increase/decrease of the cases, location site in the urinary tract and chemical nature of the stones.

MATERIALS AND METHODS

A survey was conducted through a carefully structured questionnaire, at the government hospitals, private nursing homes and diagnostic centers of Purnia division to collect information about the number of urolithiasis cases being reported and diagnosed. Surveys were conducted in Purnia town (the divisional headquarter), as well as, in other district headquarters of this division.

Since Purnia is a medically important town in the Kosi region of Bihar and is also the divisional headquarter, large number of private nursing homes as well as practicing surgeons are available; mostly the patients prefer to get treatment here, particularly for surgery requiring diseases. The division of Purnia, being comparatively under-developed, has little medical facilities in the interior places. People prefer Purnia for the treatment of chronic and complicated diseases. As

such, a wider survey at the hospitals and diagnostic centers of Purnia would reflect the level of any disease in the entire zone with a fair degree of accuracy.

A month wise data of urolithiasis reports, for the period 2014-2016, was collected along with the patient-details. One hundred sixty five surgically removed urinary stones were collected at random from hospitals and private nursing homes of Purnia division. The stones were analyzed qualitatively for their chemical composition, adopting standard methods [5].

RESULTS

Results obtained in the present work are recorded in Tables 1 to 4. A gradual increase in the total number of urolithiasis cases in the division was observed over the years. In the year, 2014 the no. of cases were 584, whereas it rose to 772 in 2016. District wise too, there has been a gradual rise in the cases. Male to female ratio of urolithiasis cases was found to be approximately 3:1. Maximum prevalence of the disease was observed in middle age (35 to 44 years) group. A predominance of the upper urinary tract calculi, particularly in males, was observed. Most of the calculi were found to be of mixed crystalloid composition, with calcium, oxalate and phosphate radicals, dominating.

Table-1: Year and month wise distribution of Urolithiasis cases reported from different districts of Purnia division (Bihar) in the period 2014-2016

District	year	Month												Total
		Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	
Purnia	2014	1	3	2	4	8	20	36	42	30	2	3	1	152
	2015	4	2	6	10	10	24	40	38	26	8	6	2	176
	2016	2	5	8	8	12	26	33	48	42	6	7	4	201
Katihar	2014	3	2	4	7	15	20	36	30	23	10	4	2	156
	2015	5	1	8	12	16	18	29	42	28	3	6	2	170
	2016	2	4	10	8	12	28	41	32	40	8	3	1	189
Araria	2014	3	6	5	10	13	26	23	24	18	6	4	3	141
	2015	2	5	4	12	17	32	38	40	23	5	2	2	182
	2016	2	4	6	9	18	43	32	48	25	7	3	1	198
Kishanganj	2014	2	5	4	13	15	28	30	14	18	4	2	0	135
	2015	0	3	8	12	22	33	26	21	26	10	4	2	167
	2016	3	5	9	14	19	36	31	28	21	6	8	4	184
Total		29	45	74	119	177	334	395	407	320	75	52	24	2051

Table-2 Age, Sex and Urinary tract location wise distribution of urolithiasis cases reported from Purnia division (Bihar) in the period, 2014-2016

Age Group	Male			Females			Male+Female		
	UUT	LUT	TOTAL	UUT	LUT	TOTAL	UUT	LUT	TOTAL
0-4	00	00	00	00	00	00	00(0.0)	00(0.0)	00(0.0)
5-14	17	28	45	12	08	20	29(1.4)	36(1.8)	65(3.2)
15-24	64	73	137	20	10	30	84(4.1)	83(4.0)	167(8.1)
25-34	286	62	348	42	15	57	328(16.0)	77(3.8)	405(19.7)
35-44	397	84	481	71	28	99	468(22.8)	112(5.5)	580(28.3)
45-54	278	21	299	129	78	207	407(19.8)	99(4.8)	506(24.7)
55 & above	181	23	204	89	35	124	270(13.2)	58(2.8)	328(16.0)
Total	1223	291	1514	363	174	537	1586(77.3)	465(22.7)	2051(100.0)

Figures in Parentheses indicate percentage.

UUT =Upper Urinary Tract, LUT =Lower Urinary Tract.

Table-3: Distribution of chemical composition of stones according to the site of location in the urinary tract

Type of stone(pure/mixed) &Chemical composition	Site of location		Total
	UUT	LUT	
Pure:			
Calcium oxalate	14 (8.5)	03 (1.8)	17 (10.3)
Calcium phosphate	06(3.6)	05 (3.0)	11 (6.7)
Uric acid	02 (1.2)	00 (0.0)	02 (1.2)
Sub Total	22 (13.3)	08 (4.8)	30 (18.2)
Mixed:			
Calcium oxalate & Phosphate	57 (34.5)	06(3.6)	63 (38.2)
Calcium oxalate & Uric acid	05 (3.0)	01(0.6)	06 (3.6)
Calcium oxalate, phosphate & Uric acid	23 (13.9)	02 (1.2)	25 (15.2)
Calcium oxalate, phosphate & Ammonium urate	05 (3.0)	09 (5.5)	14 (8.5)
Calcium oxalate, Phosphate, Magnesium and Ammonium	08 (4.8)	10 (6.1)	18 (10.9)
Calcium, Magnesium, Ammonium & Phosphate	02 (1.2)	04 (2.4)	06 (3.6)
Calcium, Magnesium, Ammonium, Phosphate & Carbonate	01 (0.6)	02 (1.2)	03 (1.8)
Sub Total	101 (61.2)	34 (20.6)	135 (81.8)
Total	123 (74.5)	42 (25.5)	165 (100.0)

Figures in parentheses indicate percentage.

UUT=Upper Urinary Tract, LUT= Lower Urinary Tract.

Table-4: Distribution of mineral constituents of stones according to the site of location in the urinary tract

Mineral Constituent	Site of location		Total
	UUT	LUT	
Calcium	121 (73.3)	42 (25.5)	163 (98.8)
Oxalate	112 (67.9)	31 (18.8)	143 (86.7)
Phosphate	102 (61.8)	38 (23.0)	140 (84.8)
Ammonium	16 (9.7)	25 (15.2)	41 (24.8)
Magnesium	11 (6.7)	16 (9.7)	27 (16.4)
Carbonate	01 (0.6)	02 (1.2)	03 (1.8)
Uric acid/Urate	35 (21.2)	12(7.3)	47 (28.5)
Cystine	00 (0.0)	00 (0.0)	00 (0.0)

Figures in Parentheses indicate percentage.

UUT =Upper Urinary Tract, LUT =Lower Urinary Tract.

DISCUSSION

Urolithiasis disease is mainly related to the metabolic disturbances in the body and consequent alteration of urinary composition and pH. However, certain ecological and geographical factors have also been identified to promote this disease.

Presently, we have observed a gradual increase of urolithiasis cases in Purnia division over the period, 2014-2016 (Table -1). The incidence seems to be high in Purnia district of the division. Closely followed by Araria, Katihar and Kishanganj. Population wise, the ratio seems to be highest for Araria district. The incidence was found to be very high in the months of May, June, July and August that is in the summer season. June and July showed up as the peak months. Excessive dehydration seems to be the reason behind this. In fact, stone formation is a long process, but the patient generally feels the disease upon super saturation of the crystalloids in the urinary tract. This is because, only then, the stone growth becomes rapid and the associated symptoms of urinary tract obstructions and

pain follow. Such a possibility of acute super saturation increases vastly in the summer season and also in the arid zones. Rajasthan, for example, is a well-known stone belt. Its arid zones have shown a high incidence of urolithiasis [11].

Age and sex wise breakup of urolithiasis cases (Table- 2) in Purnia division reveal a greater percentage of males affected by this disease. The incidence among females seems to be quite low (26.2%) as compared to males (73.8%). Male to female ratio of urolithiasis cases was found to be approximately 3:1. Age wise, maximum incidence has surfaced for middle aged persons (35 to 44 years). Upper urinary tract calculi have shown up in higher percentage (77.3%) as compared to the lower urinary tract ones (22.7%). A large chunk of the total calculi, reported, have been found in the renal pelvis and upper calyceal system. Among pediatric calculi, majority of cases were bladder stones. One remarkable point that surfaced in the study is a gradual rise of incidence of urolithiasis in the adolescent age. In advanced age group (55+) the male-

female ratio of patients was 1.6: 1. Thus, males slightly outnumbered the females. This shows that particularly in pediatric and geriatric age group, females are less immune to urolithiasis. This might be due to low oestron levels of females of these age groups. So far as location is concerned, males seem to suffer mostly by upper urinary tract calculi. In females, the cases were found to be somewhat evenly distributed between upper and lower urinary tract, however, an edge of upper urinary tract ones exists. On the whole, 77.3% of the total cases showed to be of the upper urinary tract. Lower urinary tract cases were only 22.7%.

Chemical composition of the urinary stones has also some relevance to the location of stone. Out of 165 surgically removed urinary stones, analyzed presently, 123 stones were of upper urinary tract and the remaining 42 belonged to the lower urinary tract. Most of the stones were found to be of mixed crystalloid composition. A total of 81.8% of stones were of mixed type, containing calcium oxalate, calcium phosphate, magnesium ammonium phosphate (struvite), uric acid, ammonium urate, etc., in two or more combinations (Table-3). Only a total of 18.2% stones were found to be of pure (single constituent) type. These mostly consisted of calcium oxalate, calcium phosphate or uric acid. Most of the pure stones were of calcium oxalate ones. Only two stones were found to be of pure uric acid, suggesting rarity of such stones. In fact, rarity of pure uric acid stones is a commonly observed fact. Among the mixed stones, a great majority (38.2%) were calcium oxalate and phosphate containing. Out of these, a majority (34.5%) again were from the upper urinary tract.

Out of the mineral constituents, calcium seems to be an omnipotent mineral in the stones. A study of Table - 4 shows that 98.8% of the total analyzed stones contained calcium. Followed by calcium, the abundance of the radicals was in the order, oxalate (86.7%), phosphate (84.8%), uric acid/urate (28.5%), ammonium (24.8%), magnesium (16.4%) and carbonate (1.8%). In fact, out of 165 stones, carbonate was detected only in three stones. Cystine was not found in any stone. Calcium, oxalate, phosphate and uric acid/urate were found to be more abundant in upper urinary tract calculi, while, ammonium, magnesium and carbonate were seen to be more dominant in the lower urinary tract calculi. This might be due to the formation of magnesium ammonium phosphate (struvite) and carbonate apatite stones in the lower urinary tract, as secondary bladder stones.

A comparative study of the chemical composition of urinary stones in the present study with our own previous work (conducted in the period, 1999-2001), as well as, with that reported from other parts of stone belts of India, shows that the stone composition is a function of both, the time as well as the region. Compared to our observations in the

previous study [14], the present scenario of urolithiasis seems to have changed a little in the region. Earlier we had found the occurrence of 60.8% upper urinary tract calculi and 39.2% lower urinary tract calculi, but now (in the period, 2014-2016), we found the occurrence of 77.3% cases of upper urinary tract calculi and 22.7% as lower urinary tract calculi. Thus, there seems to be a gradual shift towards the predominance of upper urinary tract calculi, over the years, in our own region. It is seen that the chemical composition of stones, that we have found previously as well as presently in Purnia division, mostly tally with that of Chandigarh, reported by Thind and Nath[5], particularly in important constituents like calcium, oxalate and phosphate. Ammonium, magnesium, carbonate and uric acid/urate, however, have been found to be a little low by us, as compared to Chandigarh calculi. Urinary calculi from Rajasthan have mostly been found to be rich in calcium, oxalate and phosphate content [11]. Magnesium mostly was found in lower percentage. Uric acid/urate was found to be in relatively high value. Out of the other stone belts of India, Delhi calculi showed exceptionally low (28.3%) percentage of oxalate [4]. Calcium and phosphate too, showed up relatively low. Uric acid/urate, however, was in high percentage (66.3%). We, in the present study, found relatively lower percentage of urate, as well as, ammonium and magnesium. In Purnea, most of the calculi, in our previous as well as present study, were found to be oxalate rich; phosphate, however, also showed up substantially. Prevalence of urolithiasis has recently been increasing in south India too [12, 16]. In a recent study, Madhusudan et al. [16] from Shimoga (Karnataka) have found calcium, phosphate and oxalate to be the dominating radicals in the urinary stones of their region. They observed the incidence of urolithiasis to be higher in the rural population.

Thus, on the whole, it looks that ecological factors, climatic conditions and dietary patterns have a good deal of say in the chemical composition of urinary stones in a belt.

CONCLUSION

Epidemiological studies of a disease of a region reveal proneness of the population of the region to the concerned disease. This, in turn, would help in unravelling various ecological and geographical factors, causing the disease. Such studies would not only help in deciding the region as endemic/epidemic belt for the disease, but also would throw light on the etiology and physiology of the disease.

Our present results and observations in this paper point to a gradual increase of urolithiasis cases, over the years, in Purnia division of Bihar Province of India. Compared to our previous studies in the early yester decade, the present results indicate to an enormous increase of urolithiasis cases in the region. The ever increasing urinary stone proneness of the local

population indicates this belt to be tending towards becoming an endemic urinary stone belt. There is a gradual shift of urinary calculi towards the upper urinary tract. From chemical composition point of view, there is a predominance of mixed oxalate phosphate calculi. Uric acid and other organic calculi are in rather low incidence.

Our work in this paper would serve as a preliminary report of urolithiasis in Purnia division. It would also serve as a guide to the local physicians and surgeons to assess the factors behind the disease, and also to plan for combating/minimizing the incidence of urolithiasis in this region.

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