Chemical Components of Urinary Stones According to Age and Sex of Adult Patients

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Objective: *Report the relationship of composition with age and sex of the patients.*
Material and Method: *A series of 426 urinary stones, 33 from the lower (LUT) and 393 from the upper urinary tract (UUT) of adults, were analyzed for their chemical composition using infrared spectroscopy. The majority of LUT stones were from males (n = 26) and in the age group beyond 60 years (n = 20).*
Results: *Calcium oxalate (CaOx) and uric acid and urate (UA-UR) were the main constituents in LUT stones of males and UA-UR and magnesium ammonium phosphate (MAP) of females. While UA-UR was distributed in all age group of males, it was only detected in elderly females. In cases of UUT stones, the peak finding for both sexes was for the 50-59-year-olds (age class). The MAP component was found more commonly in UUT stones of females, particularly in the younger age groups. CaOx and calcium phosphate (CaP) were the main components of UUT stones in both sexes (CaP was slightly more common in females) with the highest proportion in the 30-49-year-olds (age class), thereafter they declined and were replaced with UA-UR.*
Conclusion: *Although the proportion of LUT stones in the present study was small, the present findings agree with previous studies on the role of both age and sex in the etiopathogeny of urinary stones.*

Keywords: *Urinary stone, Stone composition, Age and sex of stone patients*

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Urinary stone disease is endemic in Northeast Thailand[1-3]. In the last 30 years, stone patterns have changed from a very high prevalence in the lower urinary tract (LUT) (particularly among children)[1] to the upper urinary tract (UUT) in adults[2,3]. Chemical analysis of these stones indicates that calcium oxalate (CaOx) is the main component[4,5] as in the West[6-9]. Some reports from the West have demonstrated an association between stone composition and both age and sex[10-13].

CaOx and uric acid (UA) stones are more frequently detected in males, over against calcium phosphate (CaP) and magnesium ammonium phosphate (MAP) in females[10,11]. With regard to age, a study in the United Kingdom revealed that calcium stones were more prevalent in persons between 40 and 50 years of age than those over 60 for UA stones[11].

In Japan, weddellite and whewellite stones were most common in persons between 30-40 and 40-50 years of age, respectively[12]. In France, using a multivariate approach, based on correspondence factor analysis, the relationship among stone composition, patient age and sex was confirmed[13].

In the present study, the authors examined the relationship between stone composition, age and sex, which has never been reported in Thailand.

Material and Method

Urinary stones, from both LUT and UUT, were collected from patients with complete hospital records and only those over 20 years of age who had

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undergone surgical stone removal, between 2003 and 2005, at the two main hospitals in Khon Kaen municipality.

Prior to analysis, the stones were washed with distilled water to remove attached blood and tissues and dried overnight at 70°C. The stones were cut in half with a fine saw and the resultant sawdust analyzed for chemical composition using infrared spectroscopy (IR). Data on stone composition were restricted to only those common chemical components, *i.e.*, CaOx, CaP, Uric acid and urate (UA-UR), MAP and cystine.

Results

Demographic data

Table 1 shows the demographic data of stone patients. There were 33 LUT stone patients for which the respective mean age for males (n = 26) and females (n = 7) was 65.59 ± 13.76 (range, 34-85) and 48.29 ± 20.32 (range, 22-70) years. Most of the LUT stone patients were over 60 and male (n = 20/33). While prostate hyperplasia was associated with LUT stone findings in 42.3% of male patients, there was no common underlying cause among females.

In case of UUT stone s (n = 393), the respective mean age of male (n = 183) and female (n = 210) patients was 50.85 ± 12.68 (range, 20-79) and 49.61 ± 12.20 (range, 20-73) years. The most affected age class for both sexes was 50-59-year-olds (Table 1). The presence of both LUT and UUT stones occurred in four males and two females.

Chemical composition of LUT stones

The results of IR analysis showed that LUT stones with pure composition were more common in both males (88.46%) and females (85.71%) (Table 2). The overall distribution of each LUT stone component is presented according to sex and age classes (Fig. 1, 2, respectively). CaOx and UA-UR were the major constituents found in stones in males over against MAP and UA-UR in stones in females (Fig. 1). The MAP component was not detected in male LUT stones in the present study.

Although the UA-UR component was distributed throughout all age classes of males, it was only detected in elderly females (over 50-year-olds) (Fig. 2).

Chemical composition of UUT stones

While UUT stones in males of a single component (61.21%) were more common than a mixture of constituents (39.89%), in females the distribution was more balanced (Table 3). The most abundant chemical component of pure stones was CaOx, in both males (35.52%) and females (18.57%). Overall, CaOx and CaP were the major components in both sexes of UUT stones (Fig. 1). There was one case of a male with a cystine

Table 1. Demographic data of patients with stones in the lower urinary tract (LUT) and upper urinary tract (UUT)

	Male	Female
LUT stones		
Age (years)		
Mean ± SD	65.59 ± 13.76	48.29 ± 20.32
Range	34-85	22-70
Class		
20-29	-	1
30-39	2	2
40-49	3	-
50-59	1	1
60-69	8	1
70-79	8	1
> 80	4	-
Total	26	7
UUT stone		
Age (years)		
Mean ± SD	50.85 ± 12.68	49.61 ± 12.20
Range	20-79	20-73
Class		
20-29	10	14
30-39	29	37
40-49	46	52
50-59	54	62
60-69	30	42
> 70	14	3
Total	183	210

Table 2. Characteristics of stones from the lower urinary tract (LUT) according to their chemical components

LUT stone	Male	Female
Single component		
CaOx	9 (34.62%)	1 (14.29%)
CaP	-	1 (14.29%)
UA-UR	16 (54.84%)	2 (28.58%)
MAP	-	2 (28.58%)
Subtotal	23 (88.46%)	6 (85.71%)
Mixed components		
CaOx and CaP	3 (11.54%)	-
Urate and MAP	-	1 (14.29%)
Subtotal	3 (11.54%)	1 (14.29%)
Total	26	7

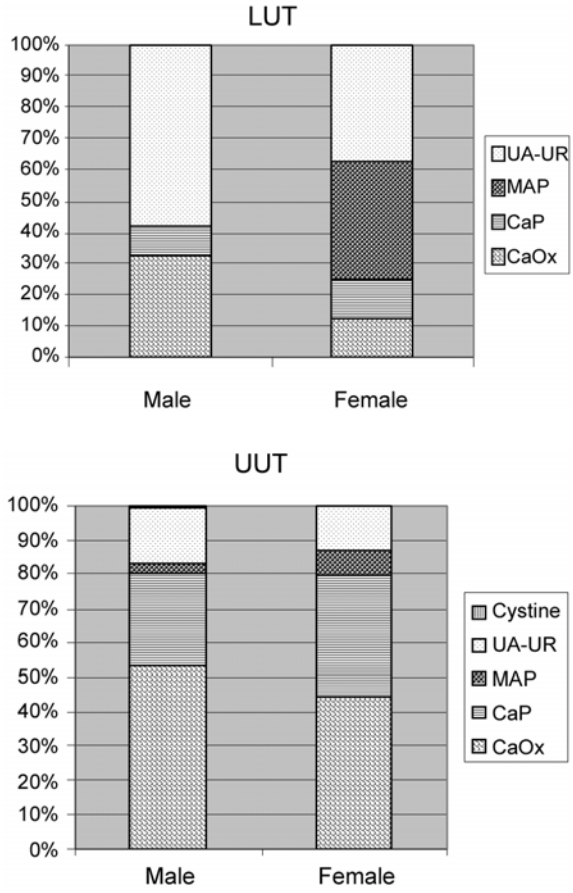

Fig. 1 Percentage distribution of components of stones from lower urinary tract (LUT) and upper urinary tract (UUT)

stone in the present study. The distribution of each chemical component in relation to the number of UUT stones, according to age classes of the patients, is presented in Fig. 3.

In males, CaOx was the main constituent in all age classes with the highest percentage in the 20-29- and 30-39-year-olds. The distribution of calcium-containing components (CaOx and CaP) in males was highest for the 30-39- and 40-49-year-old age classes, thereafter the proportion declined with increasing age and was replaced with UA-UR.

In females, both CaOx and CaP were the main constituents for all age classes. As with males, the occurrence of calcium-containing components declined with increasing age. Though MAP was distributed in all age classes up to 60-69-year-olds in both sexes, more was observed in the youngest age

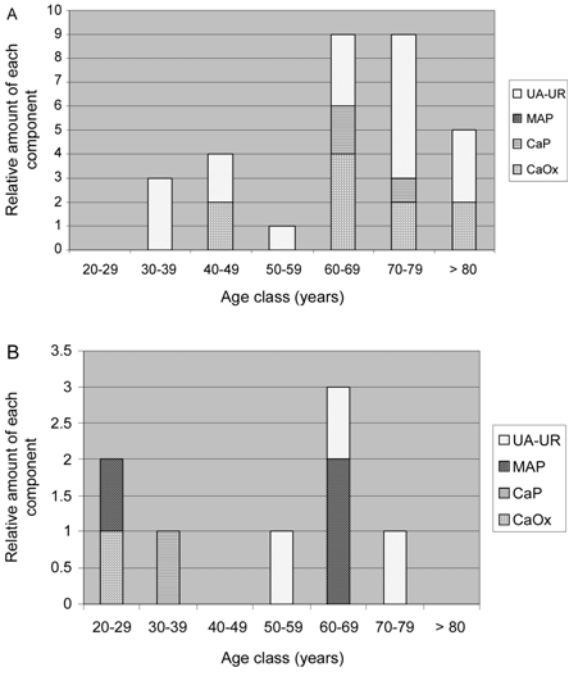

Fig. 2 Distribution of each component in relation to the number of lower urinary tract (LUT) stones according to age classes in male (A) and female (B)

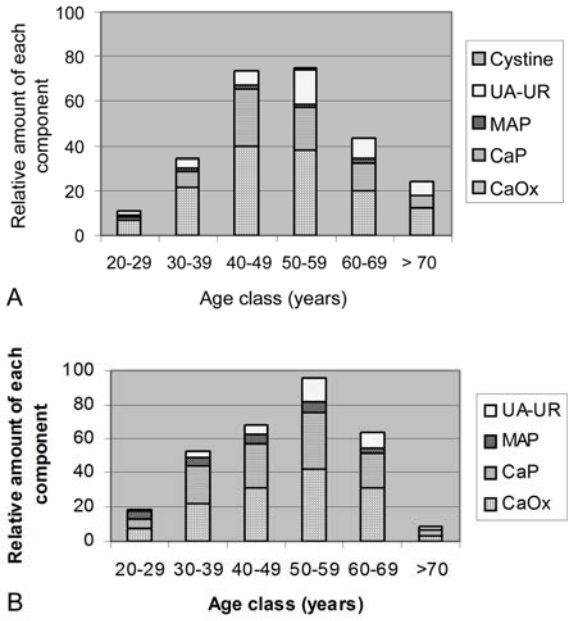

Fig. 3 Distribution of each component in relation to the number of upper urinary tract (UUT) stones according to age classes in male (A) and female (B)

Table 3. Characteristics of stones from the upper urinary tract (UUT) according to their chemical components

UUT Stone	Male (%)	Female (%)
Single component		
CaOx	65 (35.52)	39 (18.57)
CaP	7 (3.83)	19 (9.05)
MAP	5 (2.73)	15 (7.14)
UA	25 (13.66)	30 (14.29)
Urate	7 (3.83)	2 (0.95)
Cys	1 (0.55)	-
Subtotal	110 (61.21)	105 (50.00)
Mixed components		
CaOx and CaP	62 (33.88)	91 (43.33)
CaOx and UA/Urate	9 (4.92)	4 (1.90)
CaOx and MAP	1 (0.55)	7 (3.33)
CaP and UA/Urate	-	2 (0.95)
CaP and MAP	1 (0.55)	-
UA/Urate and MAP	-	1 (0.48)
Subtotal	73 (39.89)	105 (50.00)
Total	183 (100)	210 (100)

class of females (20-29-year-olds). UA-UR, by comparison, increased in both sexes after the 40-49-year-olds age class.

Discussion

The main objective of the present study was to describe the distribution of chemical constituents of urinary stones, obtained from both LUT and UUT, according to age and sex, neither of which has been reported in Thailand. Most of the LUT stones were of a single chemical constituent and were found more frequently in males, especially those over 60 years of age.

UA-UR were the main components of LUT stones in both sexes as in Europe but different from the USA[15]. The percentage of UA-UR in LUT stones for either sex was about two to three times higher than that in UUT stones (Fig. 1). This high occurrence of UA-UR may be influenced by metabolic factors such as pH and degree of urinary UA-UR saturation. Any defect in urine ammoniagenesis is considered the main factor causing low urine pH in UA stone formers[16,17], a progressive condition with age[18].

The present results suggest that metabolic factors related to the formation of UA-UR component were more prominent in LUT stones. Recently, Abate et al reported an association among hyperuricemia, low urine pH, reduced ammoniagenesis, and insulin resistance in recurrent UA stone formers[19], which is suggestive considering the present finding of a high occurrence of UA-UR in both LUT and UUT stones in the elderly.

A preponderance of UUT stones as well as the marked prevalence of CaOx component in males in the present study agrees with reports from other countries[7,13,20]. While the distribution of calcium-containing stones in both sexes declined with increasing age, the incidence of UA-UR stones increased. The high prevalence of UA-UR stones in the elderly has been reported in many industrialized countries[11-14]. This decline in calcium-containing stones may reflect the decrease in calcium excretion in the elderly[21,22]. In view of the well-established pH dependence of UA nephrolithiasis, the rising proportion of UA stones with age may parallel a progressive defect in urine ammoniagenesis that manifests with aging[18], a main factor causing low urine pH in UA stone formers[16,17].

The present study confirms previous reports of a higher proportion of CaP in UUT stones in females than in males over all age groups[11,23]. CaP stone-formers usually have a higher urine pH than patients with stones comprising principally CaOx[24]. CaP stones are often associated with either urinary tract infections (UTI) or UTI and metabolic disorders[23], which support the role of metabolic factors in the pathogenesis of CaP stones. In the present study, the presence of MAP or infection stones in the UUT of females was nearly three times higher than in males, as reported elsewhere[13]. Thus, the presence of MAP components in UUT stones of all age classes of females (except those over 70 years of age) suggests UTI is a common pathogenic factor of stones in females, especially for those containing CaP.

The present results support previous reports on the role of age and sex on the etiopathogenesis of both LUT and UUT stones, which should be taken into consideration in stone management and intervention.

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องค์ประกอบทางเคมีของก้อนนิ่วทางเดินปัสสาวะตามอายุ และเพศของผู้ป่วยที่เป็นผู้ใหญ่ในภาคตะวันออกเฉียงเหนือของประเทศไทย

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ทำการวิเคราะห์องค์ประกอบของก้อนนิ่ว จำนวน 426 ก้อน ซึ่งได้จากการผ่าตัดทางเดินปัสสาวะส่วนล่าง (LUT) 33 ก้อน และทางเดินปัสสาวะส่วนบน (UUT) 393 ก้อน โดยวิธีอินฟราเรด สเป็คโตรสโคปี (infrared spectroscopy) จากนั้นได้อธิบายถึงความสัมพันธ์ระหว่างองค์ประกอบของก้อนนิ่วกับเพศและอายุของผู้ป่วย พบว่าก้อนนิ่วจาก LUT ส่วนใหญ่เป็นของผู้ชาย (n = 26) และอยู่ในช่วงอายุมากกว่า 60 ปี ขึ้นไป (n = 20) องค์ประกอบที่พบมากในก้อนนิ่วจาก LUT ของผู้ชาย คือ แคลเซียมออกซาเลต (CaOx) และกรดยูริกกับยูเรต (UA-UR) ส่วนของผู้หญิง คือ UA-UR กับแมกนีเซียม แอมโมเนียม ฟอสเฟต (MAP) ในขณะที่ UA-UR พบเป็นองค์ประกอบ ของก้อนนิ่วในทุกกลุ่มอายุของผู้ชาย แต่ในผู้หญิงพบเฉพาะในกลุ่มผู้สูงอายุ ในกรณีของก้อนนิ่วจาก UUT กลุ่มอายุ ที่พบมากที่สุด คือ 50-59 ปี และในทั้งสองเพศ ในขณะที่ MAP คือองค์ประกอบที่พบได้บ่อยกว่าในนิ่วจาก UUT ของผู้หญิง โดยเฉพาะในกลุ่มอายุน้อย ส่วน CaOx และแคลเซียมฟอสเฟต (CaP) คือ องค์ประกอบหลัก ของก้อนนิ่วในทั้งสองเพศ (เฉพาะ CaP พบในก้อนนิ่วของผู้หญิงมากกว่าผู้ชายเล็กน้อย) โดยพบในสัดส่วนที่มากกว่า ในกลุ่มอายุปานกลาง (30-49 ปี) หลังจากนั้นจึงค่อย ๆ ลดลงเมื่ออายุสูงขึ้นแล้วแทนที่ด้วย UA-UR ถึงแม้อัตราส่วนของก้อนนิ่วจาก LUT ในการศึกษาครั้งนี้จะมีน้อย แต่ผลการศึกษาก็สอดคล้องกับการศึกษาอื่น ๆ ที่ได้รายงานการพบบทบาทของอายุ และเพศของผู้ป่วยที่มีต่อการเกิดนิ่วชนิดต่าง ๆ ในทางเดินปัสสาวะ