Length of Normal Kidneys in Thai Adults

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Background: *The length of kidney plays important role in diagnosing chronic kidney diseases. Kidney length can be measured by ultrasound, a cheap, convenient and noninvasive method. There is no report on the length of kidney in healthy Thai people.*
Objective: *To measure the length of normal kidneys in Thai adults volunteers by ultrasonography.*
Material and Method: *Healthy volunteers were recruited and the study was performed from April 2008 to June 2009. All volunteers were examined by the same standard ultrasound machine and the same radiologist throughout the study period.*
Results: *A total of 509 healthy volunteers were enrolled. The average lengths of left and right kidney were 10.24 ± 0.70 and 10.09 ± 0.68 cm, respectively. Male kidney was bigger than the female kidney. Kidney length slightly increased until the age of 50 and become smaller at the age of 60 or more. Kidney length showed no correlation with age, body weight, body mass index and body surface area.*
Conclusion: *The average lengths of left and right kidney were 10.24 ± 0.70 and 10.09 ± 0.68 cm, respectively. The length below 9.00 cm may indicate the state of kidney diseases.*

Keywords: *Kidney length, Ultrasound, Ultrasonography*

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Chronic kidney disease (CKD) is a common disease in Thailand. During disease progression a kidney usually becomes smaller than that in normal stage. It has been widely accepted that a small kidney is the common clinical clue of CKD. Kidney length is one of the crucial clinical tools to diagnose CKD and has been routinely used as an indicator for the progression of kidney disease. Therefore, it is necessary to determine the length of kidney in normal person as clinical reference information to indicate kidney abnormality. The kidney length can be estimated by several methods such as plain x-ray, intravenous pyelogram, renal angiogram, CT scan or ultrasound. Among these approaches, ultrasound is a cheap, convenient, noninvasive and accurate method to evaluate kidney length. Ultrasonography of the kidneys has replaced the conventional standard radiography for evaluation of kidney disease. Ninan VT[1] reported the measurement of the kidney in 100 living kidney donors using different methods including ultrasound, plain x-ray, intravenous pyelegram and renal angiogram. The results indicated that ultrasound appeared to be the most accurate method. Kang KY[2] determined the kidney length in 125 living kidney donors comparing between direct measurement and ultrasound. The results from two approaches showed insignificant differences. Several studies investigated the kidney length in Western people, showing that the length of normal kidney in western adults was approximately 10-12 cm[3]. Ninan VT[1] reported the averaged length of kidney in normal people by ultrasound, giving the size of 9.52 ± 0.62 cm. However, there are very few studies reporting on the kidney length in Asian people. In Thailand, investigation in the length of normal kidney has not yet been conducted. The purpose of this study was to determine the size of a normal kidney in adult Thai volunteers using ultrasonography.

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Material and Method

The institutional ethical committee approved this study and all patients gave written informed consent after reviewing a written summary of the study plan. Healthy volunteers of Rajavithi Hospital were recruited from April 2008 to June 2009. Inclusion criteria were Thai people over 18 years of age, normal clinical

state, stable estimated GFR > 90 ml/min/1.73 m^2 according to the calculation formula of the MDRD Study Equation for Chinese, no history of kidney disease, diabetes or hypertension. Patients were excluded if they were classified by the NKF-K/DOQI definition of CKD[4], had infection, malnutrition, heart failure, pregnancy, known kidney disease, single kidney, hydronephrosis, kidney cyst or were taking certain substances that may interfere with either creatinine secretion or the assay used to measure serum creatinine.

After enrollment, the patient's clinical status was assessed; blood pressure was measured with sphygmomanometer using an appropriate cuff three times in the sitting position after at least 15 min rest, and venous blood and spot urine samples were taken. Serum creatinine was determined by buffered kinetic Jeffe' reaction (compensated method for serum and plasma) using a COBAS INTEGRA 800® analyzer and original creatinine Jaffe generation-2 reagents (Roche Diagnostics, Indianapolis, IN, US). All volunteers were examined by the same standard ultrasound machine and the same radiologist throughout the study period. Ultrasonography of the kidneys was performed with a GE Medical System-Voluson® 730 Expert (General Electric Co. USA). Ultrasonographic measurements of the kidney were performed with the volunteers prone in a position that provided the longest length and could examine any abnormality of the kidney.

The critical statistics in this research was determined as mean ± standard deviation (SD). Group comparison was done using independent sample t-test and one way ANOVA. The relationship between two variables was analyzed by linear regression analysis, whereby $p < 0.05$ was considered as statistically significant.

Results

Among the total of 515 volunteers, three males were excluded for the following reasons: large kidney cysts (two cases) and hydronephrosis (one case). Three females were excluded because they were classified as CKD. A total of 509 volunteers were therefore enrolled (246 males and 263 females), with average age of 43.52 ± 14.74 years as shown in Table 1. Histogram of kidney length of these normal Thai people produced normal average left kidney length of 10.24 ± 0.70 cm and right kidney length of 10.09 ± 0.68 cm (Fig. 1). The lengths of the left and right kidney in males and in females were 10.34 ± 0.70, 10.22 ± 0.65, 10.16 ± 0.69 and 9.97 ± 0.69 cm respectively (Table 1). The kidney was bigger in male than that in female ($p < 0.01$).

For more detailed analysis on age, the population was divided into five age groups: < 30, 30-39.99, 40-49.99, 50-59.99 and 60 years old or more. The left kidney was longer than the right kidney for all age and sex groups (Table 2). Kidney length tended to increase until age 50 and became smaller after age 60 (Table 2). In males, the kidney length slightly increased until age 50.00-59.99 and became smaller after 60 or more. The shrinkage was about 0.3 cm in both sides. In females, the kidney length slightly increased until age 40.00-49.99 and tended to get smaller after 50 or more. The shrinkage was about 0.3 cm in both sides also (Table 2). The relationship analysis of the size and other body characteristics showed that the kidney length was poorly correlated with age, body weight, body mass index (BMI) and body surface area (BSA) (Fig. 2-5).

Table 1. General basic information of the subjects

	Total (n = 509)	Male (n = 246)	Female (n = 263)
Age (years)	43.52 ± 14.74	42.13 ± 14.64	44.83 ± 14.74
Height (cm)	162.34 ± 8.52	168.60 ± 6.05	156.49 ± 5.97
Body weight (kg)	61.62 ± 11.97	67.78 ± 11.44	56.79 ± 10.35
Body mass index (kg/m^2)	23.30 ± 3.69	23.44 ± 3.42	23.18 ± 3.93
Body surface area (m^2)	1.66 ± 0.19	1.76 ± 0.17	1.57 ± 0.15
Systolic BP (mmHg)	118.98 ± 12.09	123.13 ± 10.63	115.11 ± 12.09
Diastolic BP (mmHg)	72.88 ± 8.90	74.98 ± 8.56	70.91 ± 8.78
Serum creatinine (mg/dl)	0.81 ± 0.18	0.94 ± 0.14	0.69 ± 0.12
GFR (ml/min/1.73 m^2)	109.23 ± 26.01	100.50 ± 19.74	117.40 ± 28.43
Left kidney length (cm)	10.24 ± 0.70	10.34 ± 0.70	10.16 ± 0.69*
Right kidney length (cm)	10.09 ± 0.68	10.22 ± 0.65	9.97 ± 0.69*

* = Significant at $p < 0.05$, compared between male and female

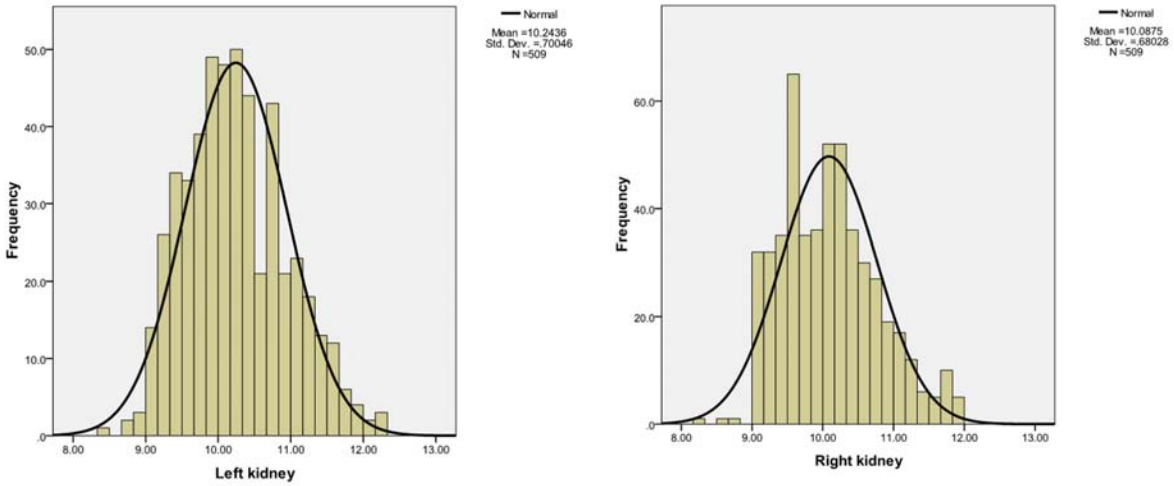

Fig. 1 Histogram of lengths in both kidneys

Table 2. Groups of kidney length according to age and sex

Age group	Total (n = 509)			Male (n = 246)			Female (n = 263)		
	N	LK	RK	N	LK	RK	N	LK	RK
< 30	118	10.24 ± 0.69	10.00 ± 0.66	62	10.36 ± 0.72	10.10 ± 0.72	56	10.09 ± 0.62	9.88 ± 0.56
30-39.99	94	10.28 ± 0.65	10.08 ± 0.69	48	10.41 ± 0.66	10.22 ± 0.61	46	10.14 ± 0.62	9.93 ± 0.75
40-49.99	114	10.29 ± 0.66	10.29 ± 0.68#*	56	10.29 ± 0.62	10.32 ± 0.63	58	10.30 ± 0.69	10.25 ± 0.73#*
50-59.99	100	10.28 ± 0.76	10.12 ± 0.70*	45	10.43 ± 0.81	10.37 ± 0.64#*	55	10.16 ± 0.71	9.92 ± 0.69
60 or more	83	10.10 ± 0.75	9.92 ± 0.61	35	10.15 ± 0.69	10.06 ± 0.57	48	10.06 ± 0.80	9.82 ± 0.63

= $p < 0.05$, compared with age < 30 years old group, * = Significant at $p < 0.05$, compared with age > 60 years old group, LK = Left kidney, RK = Right kidney

Discussion

The information on normal length of the kidney is very important for clinician in diagnosing kidney disease. Decrease in kidney length of patients is indicative of CKD. This present study evaluated the kidney length in normal adult volunteers at Rajavithi Hospital by ultrasound. The average length of the left kidney was 10.24 ± 0.70 cm and the right kidney was 10.09 ± 0.68 cm. In addition, the left kidney was bigger than the right kidney in both sexes. This result is in concomitant with previous studies in Asian adults[5,6]. Wang F previously reported the average length of normal kidney in 205 Malaysians, as measured by ultrasound, to be 10.5 (9.8-1.1), 10.2 (9.6-11.9), 10.0 (9.4-10.6) and 9.8 (9.2-10.3) cm for the left and right kidney of males and females, respectively[5]. Lee BH[6] measured the length of normal kidney in 1,388 Koreans by ultrasound and found that the left and right kidney of males and females were 10.77 ± 0.79, 10.66 ± 76, 10.49 ± 0.78 and 10.27 ± 0.75 cm, respectively. The normal length of kidneys in Thai healthy volunteers varies from 9.0-11.0 cm. A kidney length below 9.00 cm may be indicative of kidney disease.

Previous studies suggested that some factors may affect the kidney length[7,8]. The length of the kidney has been reported to correlate with sex, age, body weight, BMI and BSA[9]. This present study found that the length of both kidneys in male were significantly bigger than those of females. The kidney length was correlated with age, indicating that the length was likely to increase in children and middle-aged subjects but was smaller when the subjects become older. Typically, the length of the kidney is used as one of the body parameters to evaluate the growth rate in children[10,11]. This present study found that the kidney length slightly increased until age 50

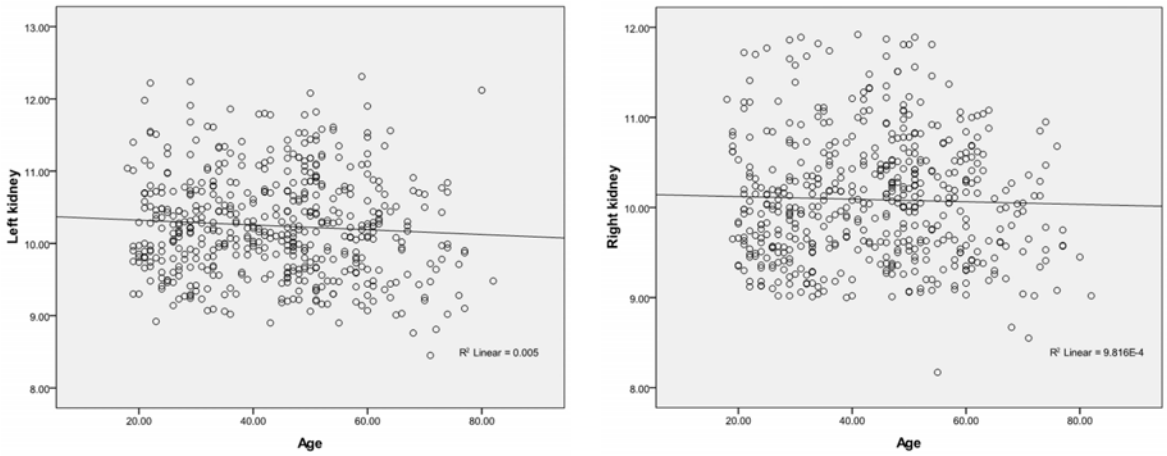

Fig. 2 Relationship between kidneys length and age

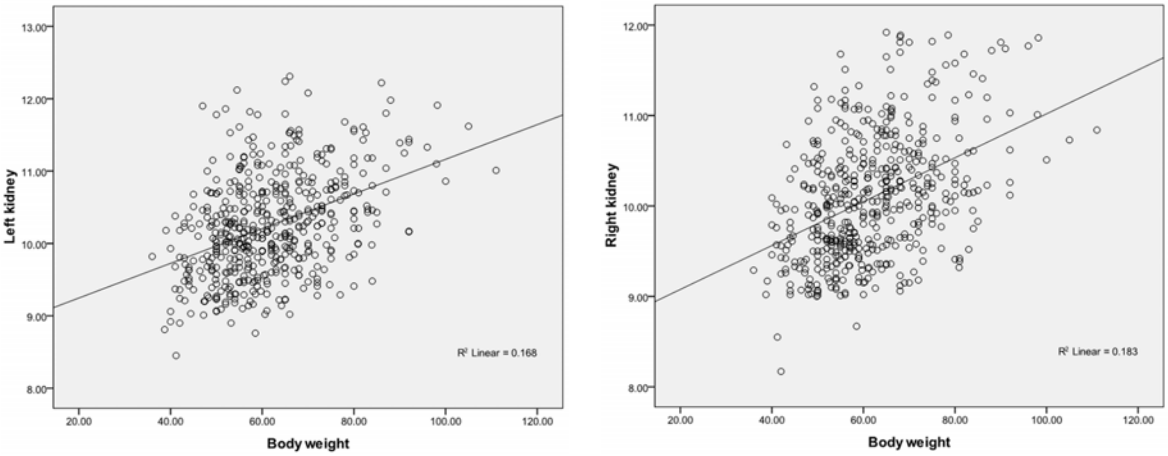

Fig. 3 Relationship between kidneys length and body weight

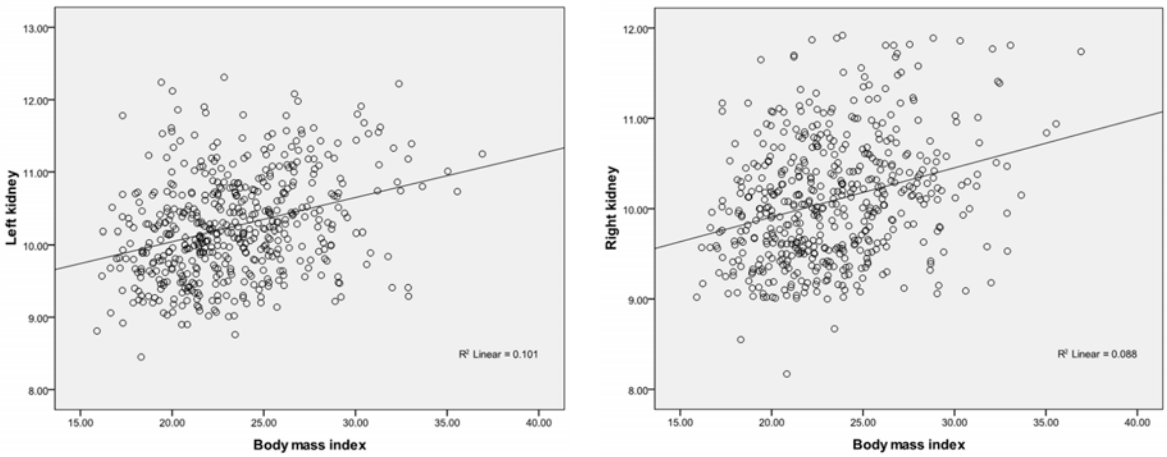

Fig. 4 Relationship between kidneys length and body mass index

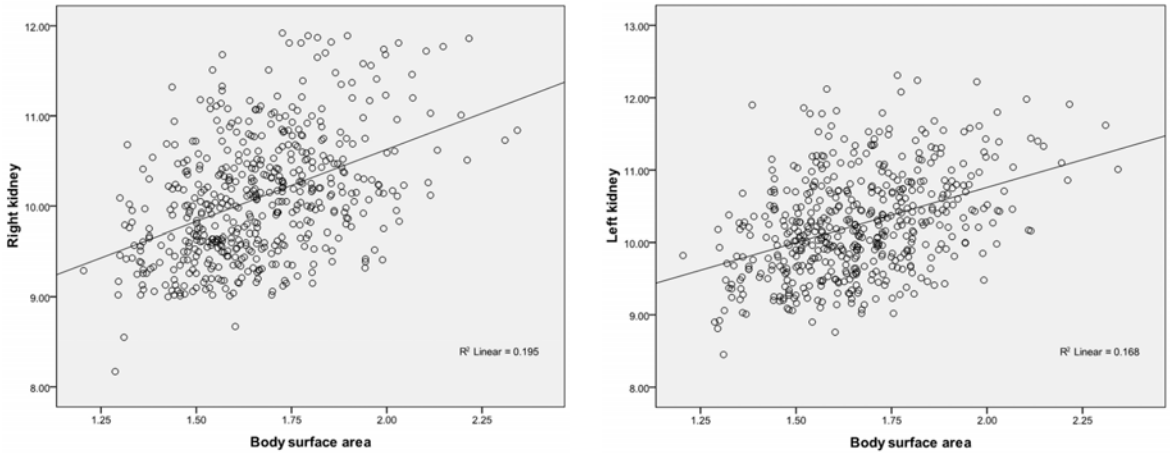

Fig. 5 Relationship between kidneys length and body surface area

and became rather smaller after age 60. The result was consistent with previous studies that after age 50, the size of kidney became smaller by 0.5 cm for every 10 years of age[12-14]. The study of Lee BH in Korea showed that the kidney length was not different between 40-70 years of age but it would be considerably smaller after age 80 or more[6]. A study in 400 Isfahani adults by Hekmatnia A showed that the kidney length was smaller after age 60 or more[15]. The kidney length insignificantly changed between 30-60 years of age, but was significantly smaller after 60 or more, and then quickly smaller at age 70 years or more. Lee BH found that the kidney size was not significantly different between age 40-70 years, but it was significantly smaller at age 80 years or more[6]. In analysis of the relationship between kidney length and BMI or BSA, a study by Bircan O in 673 normal Turkish people found that the kidney length was directly related to BMI in those who were 9-19 years old[16]. The study of Lee BH in Korea showed that the kidney length is closely related to BSA[5]. This present study shows quite different results from previous studies that the kidney length was poorly correlated with body weight, BMI and BSA.

Conclusion

Ultrasound is the most practical approach to evaluate the length of kidney. The average length of left kidney was 10.24 $\pm$ 0.70 cm and right kidney was 10.09 $\pm$ 0.68 cm. Practically, the length of kidney below 9.00 cm may indicate kidney disease.

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Potential conflicts of interest

None.

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ความยาวไตของคนไทย

อุดม ไกรฤทธิชัย, ศิริพร หลีหเจริญกุล, จิรพงศ์ ดาวเรือง

***ภูมิหลัง**: ความยาวของไตมีความสำคัญในการวินิจฉัยโรคไตเรื้อรัง การตรวจขนาดไตโดยวิธีอัลตราซาวด์จะมีราคาถูก ง่ายและเชื่อถือได้ ความยาวของไตในคนไทยปกติยังไม่เคยมีการศึกษามาก่อน*

***วัตถุประสงค์**: ต้องการหาความยาวของไตในคนไทยที่มีสุขภาพปกติโดยวิธีอัลตราซาวด์*

***วัสดุและวิธีการ**: การศึกษานี้เริ่มตั้งแต่เดือนเมษายน พ.ศ. 2551 ถึง มิถุนายน พ.ศ. 2552 อาสาสมัครที่มีสุขภาพปกติจะได้รับการตรวจหาความยาวของไตโดยวิธีอัลตราซาวด์จากรังสีแพทย์คนเดียว และเครื่องอัลตราซาวด์เครื่องเดิมตลอดการศึกษา*

***ผลการศึกษา**: มีอาสาสมัครที่มีสุขภาพปกติ 509 ราย เข้าร่วมการศึกษา ความยาวของไตซ้ายเท่ากับ 10.24 $\pm$ 0.70 เซนติเมตร และไตขวาเท่ากับ 10.09 $\pm$ 0.68 เซนติเมตร เพศชายจะมีไตยาวกว่าเพศหญิง ความยาวไตจะเพิ่มขึ้นจนถึงอายุ 50 ปี และความยาวไตจะลดลงเมื่ออายุมากกว่า 60 ปี ความยาวไตไม่มีความสัมพันธ์กับอายุ, น้ำหนักตัว body mass index และ body surface area*

***สรุป**: ความยาวของไตซ้ายเท่ากับ 10.24 $\pm$ 0.70 เซนติเมตร และไตขวาเท่ากับ 10.09 $\pm$ 0.68 เซนติเมตร โดยความยาวไตน้อยกว่า 9.00 เซนติเมตร อาจบ่งบอกว่ามีโรคไต*