ANATOMICAL VARIATIONS OF RENAL EXCRETORY SYSTEM

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Summary

A study was performed using macroscopic dissection of renal pelvis of 45 kidneys. Intrarenal pelvis type was found in 50% of cases. Rarely in 2% of cases there was no pelvis. Men have 2-3 major calyces in 81% of cases. In 19% of cases they have 4 major calyces. Women in 64.7% of cases have 3 major calyces. The data were analyzed using renal-cortical index which can be used in diagnostic procedures of kidney diseases.

Rezumat

Variaţia anatomică a sistemului excretor renal

Un studiu a fost efectuat folosind disecţia macroscopică a pelvisului renal de 45 rinichi. Tipul de pelvis intrarenal a fost depistat în 50% din cazuri. Rar, în 2% de cazuri n-a fost depistat nici un pelvis. Barbatii au 2-3 calice mare în 81% din cazuri. În 19% din cazuri, ei au 4 calice mare. Femeile, în 64,7% din cazuri au 3 calice mare. Datele au fost analizate cu ajutorul indicelui renală-cortical, care poate fi utilizat în procedurile de diagnosticare maladiilor renale.

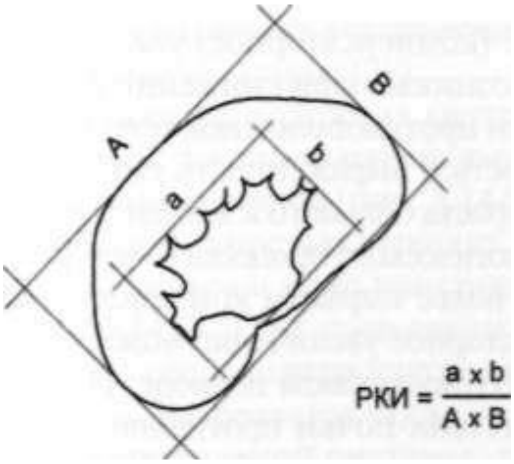
Introduction

In comparison with many other organ variations, anomalies, malformations of kidneys and their vessels are always in the center of attention, both in clinical and in a fundamental aspect. Anomalies of the kidneys occupy one of the first places among the anomalies of other organs and systems. Anomalies of the upper urinary tract occur in 3-5.5% in patients of urological departments. 10% of all genitourinary system malformations are kidney anomalies [15]. Anomalies of the kidneys attract special attention of different specialists because this type of malformation usually affects multiple systems. Kidney malformations can cause intraorganic blood and lymph circulation disorders, urine passage difficulties can lead to chronic non-specific inflammations, which contribute to the development of serious complications such as chronic pyelonephritis, urolithiasis, hydronephrosis. At present, the practical significance of the problem has increased significantly due to the introduction into medical practice of renal allograft, which allow not only to save the lives of patients as long as possible, but are the best way to ensure their medical and social rehabilitation [16]. Among the morphological studies variants of the structure of organs and tissues deserve a special attention due to their individual variability. Ureteropelvic anatomy is important to understand the obstruction of the upper urinary tract. It can be formed by compression of vessels if they are crossed over, and it is observed in 29-65% of cases [9].

The knowledge of the anatomy of the major calyces is important for urological procedures such as percutaneous nephrostomy which is the most appropriate method for the determination of the future of the kidney after obstruction. Pelvis anatomy is important for the interpretation of intravenous urography as the length of the calyces had not been considered an important cause of stone formation, but now this theory is reviewed by many specialists. Anomalies of the renal pelvis system can be misdiagnosed as early signs of various diseases of the urinary system, can proceed with asymptomatic or symptomatic [11]. Surgical technique often depends on the anatomy of the renal collecting system, in particularly the renal pelvis [14].

Material and methods

Variant anatomy was studied using anatomical dissection by Б. З. Перлин [20]. The study was performed on 23 complexes of different sex and age (45 kidneys). Encountered variants of the structure of the urinary tract have been studied and described using renal-cortical index (RCI) and morphometrical method [19].



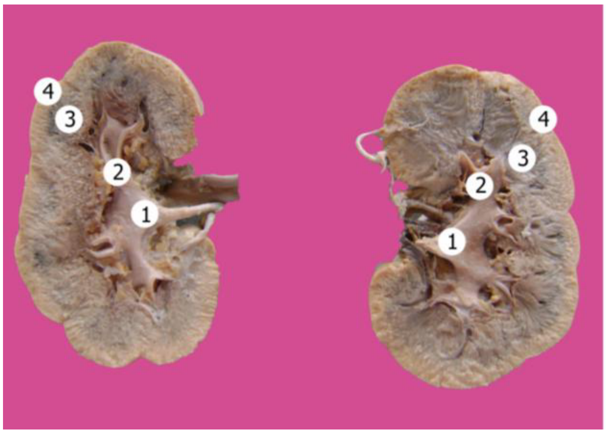
Renal-cortical index (RCI) RCI = a * b / A * B, where a - length pyelocaliceal segment, b - width of pyelocaliceal segment, A- the length of the renal parenchyma, B - width of the renal parenchyma [17].

Results and discussion

Major calyces, pelvis and ureter are the macroscopically visible part of the excretory kidney tract. According to the literature there can be distinguished embryonic, fetal and the mature forms of the excretory tree, which facilitates understanding of X-ray pictures [21]. Other authors describe the ampullar, tree and mixed forms of the renal pelvis. According M. E. Мебель (1957), there is intrarenal, extrarenal, extrarenal with opened posterior surface, mixed and a special type (when the pelvis is absent) excretory tree [8, 22].

The variation anatomy was studied on 45 renal pelvises, of which 27 were male kidneys and 18 -female. The pelvis specimens were classified in shape according to the research of M. E. Мебель. An example of the intrarenal pelvis can be seen on a male kidney specimen 60 years old, where both the kidney pelvis is located entirely within the sinus closed by the parenchyma and has dimensions of 6,5 x 3,5 cm of the left and 5,3 x 3,5 cm of the right kidney (fig. 1) . This type of the pelvis was found in 23 specimens - 50% of cases. According to the literature (M. E. Мебель, 1957) this type occurs in 33% of cases.

Extrarenal pelvis is located outside the sinus and not closed by the renal parenchyma. An example can be seen on the male kidney specimen 60 years old (fig. 2). The kidney pelvis has dimensions of 5,3 x 3,5 cm of the right and 5,5 x 3,5 cm of the left kidney. This type pelvis was found on 5 specimens representing 10% of cases. According to the literature this type occurs in 21% of cases.



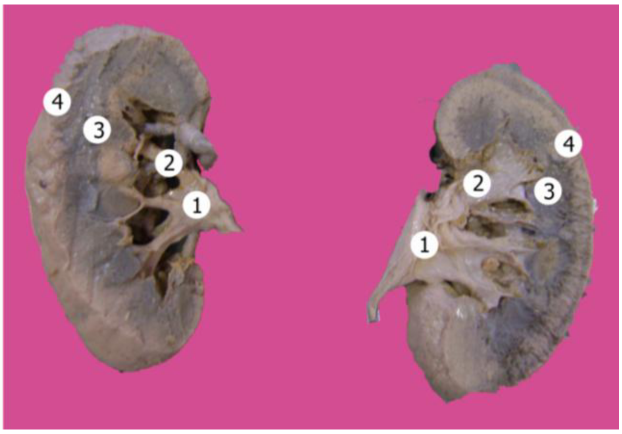


Fig. 1. Intrarenal pelvis type.

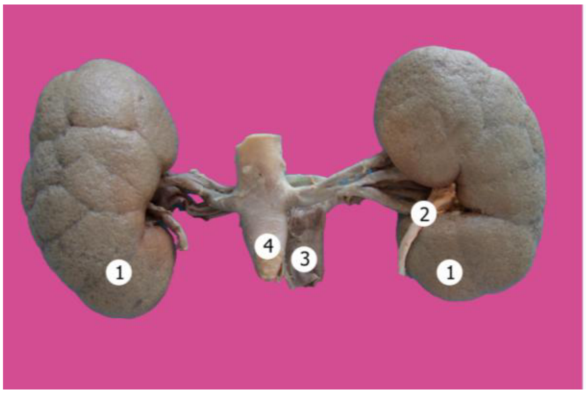
Macro specimen. The object № 17 (male 60 years). 1 - renal pelvis; 2 – major calyx; 3 – Pyramid of Malpighi (medulla); 4 – renal cortex.

Fig. 2. Extrarenal pelvis type.

Macro specimen. The object № 20 (male 60 years). 1 – renal pelvis; 2 – major calyx; 3 - Pyramid of Malpighi (medulla); 4 – renal cortex.

An example of a type of extrarenal pelvis with an open posterior surface may serve the kidney specimen of 72 years old woman (fig. 3). In such case, the posterior surface is free of parenchyma, and the front is covered by a kidney hump. This type of pelvis was found in 9 specimens - 20% of cases. According to the literature this type of pelvis is observed in 17% of cases.

Mixed type in which the pelvis is located partially within the sinus, partly outside it, can be seen on a kidney specimen of 64 year old male (fig. 4). This type of pelvis was found in 8 specimens which corresponds with 18% of cases. M. E. Мебель, 1957 describes this type of pelvis in 28% of cases.



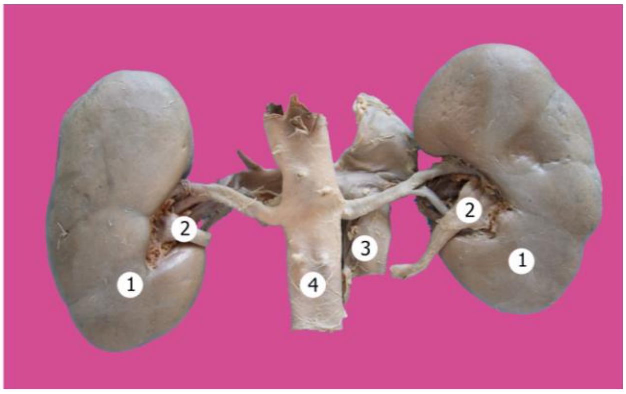


Fig. 3. Extrarenal pelvis type with opened posterior surface.

Macro specimen. The object № 13 (female 72 years). 1 - renal parenchyma; 2 - renal pelvis; 3 - inferior vena cava; 4 - abdominal part of the descending aorta.

Fig. 4. Mixed pelvis type.

Macro specimen. Object № 6, (male 64 years). 1 - renal parenchyma; 2 - renal pelvis; 3 - inferior vena cava; 4 - abdominal aorta.

A special type of pelvis is when it is anatomically absent, and the ureter itself is divided into two large elongated calyces. In our study, this type was found in one specimen, 2% of cases (fig. 5). According to the literature it is encountered in 1% of cases (M. E. Мебель, 1957).

Fig. 5. A special type of renal pelvis.

Macro specimen. Object № 3, (female 35 years). 1 – ureter; 2 - upper calyx; 3 - lower calyx; 4 – renal medulla; 5 - renal cortex.

The described above types of renal pelvis are important for diagnostic procedures and treatment strategies. The surgical procedure largely depends on the pelvis type. The current three renal type's classification is not sufficient. It is hard to make a proper conclusion based on the intrarenal, extrarenal and mixed pelvis types.

According to our research 2-3 major calyces are more common in men (22 specimens - 81%) (tab. 1). The presence of 4 major calyces were found in 5 specimens (19% of cases). In women 3 major calyces were more common, and were encountered in 11 specimens (64.7% of cases) (tab. 2). 2 and 3 major calyces can be seen quite rare. 2 major calyces were found in 3 specimens (17.6%) and 4 major calyces also in 3 specimens (17.6% cases). An example of the diversity of forms and the number of major calyces can be seen on specimens' № 4, 9, 13 (fig. 6).

Table 1

The number of major calyx of men of different age groups

Age groups*	Right kidney				Left Kidney			
	Number of kidneys	2c	3c	4c	Number of kidneys	2c	3c	4c
VIII 1	5	3	1	1	6	4	2	-
VIII 2	6	1	3	2	6	1	3	2
IX	2	1	1	-	2	1	1	-
X	-	-	-	-	-	-	-	-

Note*: The described material was organized according to the ontogenesis periodic which was adopted at the Symposium of University of age physiology in USSR (by A. A. Маркосян (1969), С. Б, Тихвинский, С. В. Хрущев (1991)), as well as R. Robacki (cited by M. Ştefaneţ el a., 2000). Females: VII – 16-20 yars, VIII 1 – 21-35, VIII 2 – 36-55, IX – 56-74 years, X – 75-90 ears. Males: VII – 17-21 years, VIII 1 – 22-35 years, VIII 2 – 36-60 years, IX – 61-74 years, X – 75-90 years.

Table 2

The number of major calyx of females of different age groups

Age groups	Right kidney				Left Kidney			
	Number of kidneys	2c	3c	4c	Number of kidneys	2c	3c	4c
VIII 1	2	-	2	-	2	1	-	1
VIII 2	3	-	1	1	3	-	2	1
IX	2	1	1	-	2	1	1	-
X	2	-	2	-	2	-	2	-

Fig. 6. Variants of major calyces (From left to right - two, three, four major calyces). Macros specimens. Objects № 13 (female 56 years), № 4 (a woman 35 years old), № 9 (female 35 years). 1 – renal pelvis; 2 - upper major calyx; 3 - lower major calyx; 4 - middle large calyx; 5 – upper middle major calyx; 6 - lower middle major calyx; 7 - renal medulla; 8 – renal cortex.

Morphology of the pelvis depends on the number of major calyces. Many authors describe the presence of 2-3 major calyces in most of the kidneys [2, 8, 10, 17, 21].

According to other researchers the number minor calyces ranges from 5 to 20, but usually is 8-9 by Harrison, 1972, 7-8 by M. Dyson, 1995 and Hollonshead, 1975. Graves, in 1986 described two primary and two transition types of renal pelvis, based on the shape of the pelvis and visibility of calyces. Type A is a Y-shaped, type B-an inverted T, type C - a ball and type D - inverted bagpipes. F.J. Sampaio, 1993 classified the location of the renal pelvis system into two groups A and B, which are subdivided into: AI, A-II, BI, B-II. In group A,-I major calyces of the upper and lower poles are primary division of the pelvis, and the median area occupied by a minor calyx, which drains into the major and minor. In A-II, these calyces are crossed. In the B-I group of minor calyces connect to the middle major calyx. In B-II many minor calyces are connected to the pelvis at different angles. According D. D. Ningthoujam, R. D. Chongtham pelvis was triangular (a triple-calyx system) in 40% of cases, muti-calyx in 30% of cases, Y-shaped (two-calyx) - 20% of cases and an unusual form occurred in 10% of cases [10].

P. Sebea, O. Traxera, 2008 described in 65% of cases, 2 major calyces, 32% - 3 major calyces, 3% one major calyx [4]. O. Мочалов points out that in 50% of cases kidney have 2 major calyces, in 30% - 3 major calyces, and in 10% of cases one major calyx. In 5% of cases, the author notes the absence of major calyces, both from right and left sides, and in 5% the absence on one side [5, 18].

According to our research dimensions of pyelocaliceal system (PCS) in the group VIII 1 in men is 5,76 x 2,9 cm of the right and 6,16 x 2,18 cm of the left kidney. In women of the same group the sizes is larger - 6,25 x 2,4 cm of the right and 6,75 x 3 cm of the left kidneys. In Group VIII 2 men dimensions are 5,83 x 1,91 cm of the right and 6,33 x 1,83 cm of the left kidney. While women in the same group have 5,66 x 1,83 cm of the right and 6,33 x 1,4 cm of the left kidney. In the age group IX dimensions of PCS in men is 5,75 x 2,75 cm of the right and 6 x 2,25 cm of the left kidney. The women in this group have 5,5 x 2 cm of the right and 5,25 x 1,85 cm of the left kidney. In groups VIII2 - IX PCS is larger in men. From these tables it is clear that the length of the renal pelvis of the left kidney is larger (in males – 0,38 cm, in females – 0,67 cm), this is explained in the literature by the fact that in the embryological period and during lifetime the liver presses the right kidney, thereby reducing its length, in turn, increases the width of the kidneys and its PCS (in males – 0,43 cm, in females – 0,27 cm) [3, 9, 16].

Table 3

Length of pyelocaliceal segment in men of different age groups

Age groups	Right kidney		Left Kidney	
	Number of kidneys	Length PCS (cm)	Number of kidneys	Length PCS (cm)
VIII 1	5	5,76	6	6,16
VIII 2	6	5,83	6	6,33
IX	2	5,75	2	6
X	-	-	-	-

Table 4

Length of pyelocaliceal segment in female of different age groups

Age groups	Right kidney		Left Kidney	
	Number of kidneys	Length of PCS (cm)	Number of kidneys	Length of PCS (cm)
VIII 1	2	6,25	2	6,75
VIII 2	3	5,66	3	6,33
IX	2	5,5	2	5,25
X	2	5,4	2	6,25

Table 5

Width of pyelocaliceal segment in men of different age groups

Age groups	Right kidney		Left Kidney	
	Number of kidneys	Width of PCS (cm)	Number of kidneys	Width of PCS (cm)
VIII 1	5	2,9	6	2,18
VIII 2	6	1,91	6	1,83
IX	2	2,75	2	2,25
X	-	-	-	-

Table 6

Width of pyelocaliceal segment in females of different age groups

Age groups	Right kidney		Left Kidney	
	Number of kidneys	Width of PCS (cm)	Number of kidneys	Width of PCS (cm)
VIII 1	2	2,4	2	3
VIII 2	3	1,83	3	1,4
IX	2	2	2	1,85
X	2	2,5	2	2,25

The current data indicates that in 58.3% of people have 8 minor calyces (top, front top, middle and bottom, posterior top, middle and bottom, bottom), in 16.6% - 7, in 17.1% - 6 and in 8% - 5 minor calyces. PCS is 3-10% larger in men than in women.

Another important method in the diagnosis of renal function is renal cortical index (RCI).

According to our research RCI was within the normal range in men except for the right kidneys of group IX. Women RCI is within normal limits except for the right kidney of X. Reduced RCI is observed with increased size of the kidneys and reduced size of the central part example - in acute renal disease. Normally, the RCI is 34 - 38% [1]. The strong increase in RCI may indicate fibrolipomatosis, hydronephrosis or chronic pyelonephritis [14].

Table 7

Renal cortical index in men of different age groups %

Age groups	Right kidney		Left Kidney	
	Number of kidneys	RCI (%)	Number of kidneys	RCI (%)
VIII 1	5	37	6	38
VIII 2	6	33	6	33
IX	2	37	2	44
X	-	-	-	-

Table 8

Renal cortical index in female of different age groups %

Age groups	Right kidney		Left Kidney	
	Number of kidneys	RCI (%)	Number of kidneys	RCI (%)
VIII 1	2	37	2	37
VIII 2	3	34	3	34
IX	2	36	2	37
X	2	42	2	34

Conclusion

We can make a conclusion that renal anatomy can be important during different medical procedures. According to our research 2-3 major calyces are more common in men 81%. The presence of 4 major calyces were found in 19% of cases. In women 3 major calyces were more common, and were encountered in 64.7% of cases. 2 and 3 major calyces can be seen quite rare. 2 major calyces were found in 17.6% and 4 major calyces also in 17.6% cases. It is important to determine 5 types of renal pelvises, because this can influence the outcome of the operation.

RCI was within the normal range in men except for the right kidneys of group IX. Women RCI is within normal limits except for the right kidney of X. Reduced RCI is observed with increased size of the kidneys and reduced size of the central part example - in acute renal disease. Normally, the RCI is 34-38%. The strong increase in RCI may indicate fibrolipomatosis, hydronephrosis or chronic pyelonephritis and thus should be considered by nephrologists and urologist.

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