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TOPOGRAPHIC AND MORPHOMETRIC CHARACTERISTICS OF HUMAN RENAL PYRAMIDS OF THE UPPER END AT MATURE AND ELDERLY AGES

ABSTRACT. Background. New endoscopic methods of surgical treatment of kidney diseases still cause complications and require further deepening and generalization of knowledge about the peculiarities of the topographic and anatomical structure of the human kidney. **Methods.** 150 human kidneys were taken from patients of both sexes at mature and elderly age died after accidents or diseases not associated with the pathology of urinary system. Next indicators of renal pyramids were examined: diameter of the base of renal pyramid, the diameter of the renal papilla, height of renal pyramids, and volume of renal pyramids. Standard methods of anatomical study were used: preparation, macroscopy, morphometry of native kidneys, morphometry of renal pyramids in upper end based on plane-parallel topographical anatomical sections of kidney, comparative digital morphometry based on digital calibrated plane-parallel topographical anatomical sections of the upper end of the kidney, statistical processing and mathematical analysis of the data. **Results.** It was measured 634 pyramids in the upper end of 150 kidneys. There were found from 3 to 8 renal pyramids in the upper end of each kidney, an average of 4.22 ± 0.15 . All pyramids were structurally divided into two groups: 1) single (solitary), which independently form the renal papilla and drain into a minor renal calyces; 2) group (fusion), a compound of two or more single renal pyramids or large renal pyramids that looked separated, since the renal papilla. Number of single renal pyramids was from 3 to 8, on average (4.0 ± 0.54) . Number of group renal pyramids was from 0 to 4, an average (2.0 ± 0.65) . Constant superior medial pyramid (p_{ms}) - the largest significantly more than any other pyramids for all measured parameters (diameter of the base, the diameter of the renal papilla, height and volume of the pyramid). Commonly found superior lateral pyramid (p_{ls}) - has less than the previous in diameter of the base, the diameter of the renal papilla and height, but more in height. Superior anterior pyramid (p_{as}) and superior posterior pyramid (p_{ps}) - commonly found, all parameters less than the previous two pyramids, average values of parameters differ slightly. Anterior superior lateral pyramid (p_{lsa}) and posterior superior lateral pyramid (p_{lsp}) - rare pyramids, all parameters less than the previous two pyramids, average values of the parameters differ slightly. Anterior superior medial pyramid (p_{msa}) and posterior superior medial pyramid (p_{msp}) - rare pyramids, all parameters less than the previous two pyramids, the average values of the parameters differ slightly. **Conclusion.** It is perspective to study the topography of the upper end of the human renal pyramids on the basis of the proposed classification, based on their location in relation to the renal sector and parallels. Also, the classification of the pyramids, tied to small renal cups can also be used for other parts of the kidney.

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Дуденко В.Г., Вдовиченко В.Ю. Топографо-морфометрические характеристики пирамид верхнего конца почки человека зрелого и пожилого возраста.

Реферат. Были изучены 150 почек людей зрелого и пожилого возраста обоих полов. Для определения топографии была применена система топографических координат, адаптированная для оценки секторной координатной топографии почечных пирамид в локальной системе координат почки человека. Была предложена следующая классификация почечных пирамид верхнего конца почки: верхняя медиальная, верхняя латеральная, верхняя передняя, верхняя задняя, передняя верхняя медиальная, передняя верхняя латеральная, задняя верхняя медиальная, задняя верхняя латеральная пирамида. Предложенная классификация почечных пирамид может быть использована как для изучения пространственного расположения почечных пирамид, так и для исследования морфометрических параметров отдельных пирамид.

Ключевые слова: почки, почечные пирамиды, классификация пирамид, морфометрические характеристики.

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Introduction

Last years clinical practice widely implement new methods of investigation of urological patients like angiography, infusion urography, scan, ultrasound, CT and MRI, which made it possible to objectify the indications for nephron-sparing surgery such as nephrotomy and partial nephrectomy [1-6]. On the other hand, new methods of surgical treatment of kidney diseases which are carried out with the endoscopic instruments still cause complications, which also requires further deepening and generalization of knowledge about the peculiarities of the topographo-anatomical structure of human kidney [7-10].

Objective

The aim of the study was determination of the characteristics of the individual anatomy and topography of the upper end of the renal pyramids in the topographic coordinates system.

Materials and Methods

Morphological material for the study were 150 human kidney mature and elderly of both sex. All cases were associated with death from accidents or diseases not associated with the pathology of the urinary system.

The following morphometric characteristics of the renal pyramids on a range of one- and two-dimensional parameters were investigated: height of renal pyramids (h_{pr}), the diameter of the base of the renal pyramids (D_{pr}), the diameter of the renal papilla (d_{pr}), the volume of renal pyramids (v_{pr}).

To achieve the goal and the decision of tasks on the basis of the research we have shown improvement methods developed an original technique toponometry according kidney spatial computer models that allows to study the position and size of internal renal anatomical structures in the system of topographic coordinates. To determine the topography of the renal pyramids of the upper end in the horizontal plane was used geo-topographic coordinate system by MP Burykh [7,8].

Results and discussion

In the upper end of the human kidney were found from 3 to 8 pyramids, which open to the superior, anterior superior and posterior superior small renal calyx, which allowed to classify the kidney pyramids of the upper end depending on their location and the confluence of the small renal calyx (MUF).

In the superior renal calyx open: 1) the superior medial pyramid (p_{ms}); 2) the superior lateral pyramid (p_{ls}); 3) the superior anterior pyramid (p_{as}); 4) the superior posterior pyramid (p_{ps}).

In the anterior superior renal calyx open: 1) the anterior superior medial pyramid (p_{msa}); 2) the anterior superior lateral pyramid (p_{lsa}).

In the posterior superior renal calyx open: 1) the posterior superior medial pyramid (p_{msp}); 2) the posterior superior lateral pyramid (p_{lsp}) (Figure 1).

The upper medial pyramid (p_{ms}) was present in

98.0%; in 42.17% cases this pyramid is merged with p_{as} (53.22%) or p_{ps} (46.78%). The diameter of its base (D_{pms}) varied in the range 10,3-28,4 mm, average $17,8 \pm 0,77$ mm. The diameter of the renal pyramid papilla (d_{pms}) varied in the range 1,5-7,5 mm, average $3,77 \pm 0,18$ mm. The height of the pyramid (h_{pms}) varied in the range 6,8-16,8 mm, average $11,28 \pm 0,54$ mm. The volume of the pyramid (v_{pms}) varied in the range 0,319-2,469 mm³, average $1,233 \pm 0,123$ mm³.

Superior lateral pyramid (p_{ls}) was present in 70.0%; in 39.42% cases this pyramid is merged with p_{as} (41.47%) or p_{ps} (58.53%). The diameter of its base (D_{pls}) varied in the range 8,3-25,5 mm, average $16,85 \pm 0,82$ mm. The diameter of the renal pyramid papilla (d_{pls}) varied in the range 1,8-6,8 mm, average $3,75 \pm 0,18$ mm. The height of the pyramid (h_{pls}) varied in the range 7,3-19,1 mm, average $11,47 \pm 0,57$ mm. The volume of the pyramid (v_{pls}) varied in the range 0,237-2,271 mm³, average $1,148 \pm 0,056$ mm³.

Superior anterior pyramid (p_{as}) was present in 62.66%; in 71.27% cases this pyramid merged: with p_{ms} in 49.25%, with p_{ls} in 25.37% and with p_{ps} in 25.37%. The diameter of its base (D_{pas}) varied in the range 7,4-24,6 mm, average $15,57 \pm 0,778$ mm. The diameter of the renal pyramid papilla (d_{pas}) varied in the range 2,1-6,3 mm, average $3,63 \pm 0,18$ mm. The height of the pyramid (h_{pas}) varied in the range 7,7-17,7 mm, average $10,96 \pm 0,54$ mm. The volume of the pyramid (v_{pas}) varied in the range 0,213-2,515 mm³, average $0,971 \pm 0,077$ mm³.

Superior posterior pyramid (p_{ps}) was present in 68.66%; in 67.96% cases this pyramid merged: with p_{ms} in 41.42%, with p_{ls} in 34.29% and with p_{as} in 24.29%. The diameter of its base (D_{pps}) varied in the range 7,6-24,7 mm, average $15,58 \pm 0,7$ mm. The diameter of the renal pyramid papilla (d_{pps}) varied in the range 1,5-6,3 mm, average $3,52 \pm 0,17$ mm. The height of the pyramid (h_{pps}) varied in the range 6,2-18,2 mm, average $10,95 \pm 0,53$ mm. The volume of the pyramid (v_{pps}) varied in the range 0,215-2,268 mm³, average $0,937 \pm 0,091$ mm³.

Anterior superior medial pyramid (p_{msa}) was present in 18.0%; in 18.51% cases this pyramid merged with p_{lsa} . The diameter of its base (D_{pmsa}) varied in the range 8,3-16,2 mm, average $13,14 \pm 0,78$ mm. The diameter of the renal pyramid papilla (d_{pmsa}) varied in the range 2,1-5,5 mm, average $3,15 \pm 0,15$ mm. The height of the pyramid (h_{pmsa}) varied in the range 6,4-13,8 mm, average $10,17 \pm 0,49$ mm. The volume of the pyramid (v_{pmsa}) varied in the range 0,194-0,994 mm³, average $0,622 \pm 0,025$ mm³.

Anterior superior lateral pyramid (p_{lsa}) was present in 43.33%; in 7.69% cases this pyramid merged with p_{msa} . The diameter of its base (D_{plsa}) varied in the range 8,7-24,3 mm, average $13,69 \pm 0,58$ mm. The diameter of the renal pyramid papilla (d_{plsa}) varied in the range 2,2-6,3 mm, average $3,37 \pm 0,16$ mm. The height of the pyramid (h_{plsa}) varied in the range

6,7-19,1 mm, average $10,89 \pm 0,48$ mm. The volume of the pyramid (v_{plsa}) varied in the range 0,222-1,707

mm^3 , average $0,719 \pm 0,143$ mm^3 .

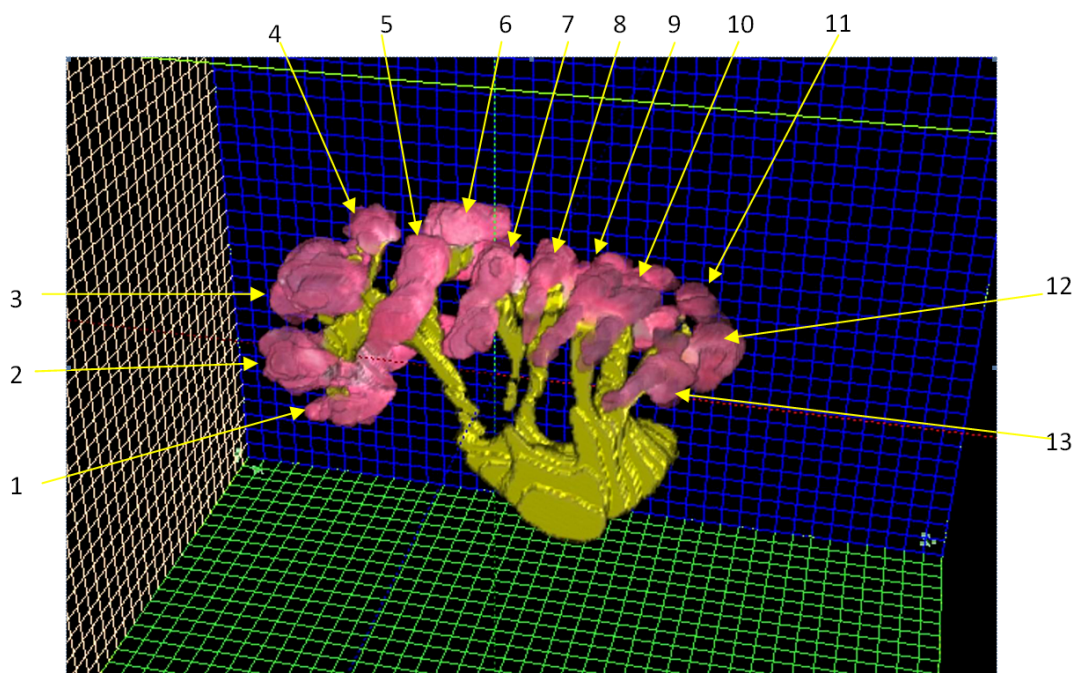


Fig. 1. The three-dimensional computer anatomical model of the renal pyramids and calico-pelvic complex according to the images of serial sections of isolated krio-fixed left kidney, front view. Calico-pelvic complex is injected. Male, 38 years old. 1 – superior anterior pyramid (p_{as}), 2 – superior medial pyramid (p_{ms}), 3 – superior lateral pyramid (p_{ls}), 4 – superior posterior pyramid (p_{ps}), 5 – group pyramid, consisting of the anterior superior medial and anterior superior lateral pyramids ($p_{msa} + p_{lsa}$), 6 – posterior superior lateral pyramid (p_{lsp}), 7 – anterior superior medial (portal) pyramid (p_{msa}), 8 – posterior superior medial (portal) pyramid (p_{msp}), 9 – group pyramid, consisting of the anterior inferior medial (portal) and the posterior inferior medial (portal) pyramids ($p_{mia} + p_{mip}$), 10 – group pyramid, consisting of the anterior inferior lateral and posterior inferior lateral pyramids ($p_{lia} + p_{lip}$), 11 – inferior posterior pyramid (p_{pi}), 12 – inferior medial pyramid (p_{mi}), 13 – inferior anterior pyramid (p_{ai}).

Posterior superior medial pyramid (p_{msp}) was present in 16.66%; in 44% cases this pyramid merged with p_{lsp} . The diameter of its base (D_{pmsp}) varied in the range 10,0-17,1 mm, average $13,66 \pm 0,75$ mm. The diameter of the renal pyramid papilla (d_{pmsp}) varied in the range 2,0-5,3 mm, average $3,3 \pm 0,17$ mm. The height of the pyramid (h_{pmsp}) varied in the range 6,2-13,3 mm, average $10,13 \pm 0,49$ mm. The volume of the pyramid (v_{pmsp}) varied in the range 0,201-0,951 mm^3 , average $0,646 \pm 0,089$ mm^3 .

Posterior superior lateral pyramid (p_{lsp}) was present in 46.0%; in 15.94% cases, this pyramid merged with p_{msp} . The diameter of its base (D_{plsp}) varied in the range 7,9-26,3 mm, average $13,99 \pm 1,02$ mm. The diameter of the renal pyramid papilla (d_{plsp}) varied in the range 1,5-6,3 mm, average $3,33 \pm 0,15$ mm. The height of the pyramid (h_{plsp}) varied in the range 7,2-16,8 mm, average $10,65 \pm 0,58$ mm. The volume of the pyramid (v_{plsp}) varied in the range 0,219-1,999 mm^3 , with an average $0,750 \pm 0,014$ mm^3 .

Conclusion

Based on the study of anatomical material we proposed a classification of the upper end of the kidney of the pyramids, which implies the presence of 8 pyramids: superior medial, superior lateral, superior

anterior, superior posterior, anterior superior medial, anterior superior lateral, superior posterior medial and superior posterior lateral.

According to the results of the macroscopic study we have identified two main forms of renal pyramids: single (solitary) and group (drain). Single pyramid form independently renal papilla and open into the renal calyx. Group are fused at the papilla single pyramid, or pyramid, which, due to splitting seem separate.

Constant superior medial pyramid p_{ms} - the largest, significantly more than any other pyramid in all measured parameters (base diameter, the diameter of the renal papilla, height and volume of the pyramid). A common superior lateral pyramid p_{ls} - less than the previous base on the diameter, the diameter of the renal papilla and height, but more in height. Superior anterior pyramid p_{as} and superior posterior pyramid p_{ps} - common in all parameters is less than the previous two, on the average values of the parameters differ slightly. Anterior superior lateral pyramid p_{lsa} and posterior superior lateral pyramid p_{lsp} - rare pyramid, on all parameters is less than the previous two, on the average values of the parameters differ slightly. Anterior superior medial pyramid p_{msa} and posterior superior medial pyramid p_{msp} - rare pyramid, on all parameters is less than the

previous two, on the average values of the parameters differ slightly.

We believe a promising study the topography of the upper end of human renal pyramids on the basis of the proposed classification based on their

location in relation to the renal sector and parallels. Also, the classification of the pyramids, tied to small renal cups can also be used for other parts of the kidney.

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Дуденко В.Г., Вдовіченко В.Ю. Топографо-морфометричні характеристики пірамід верхнього кінця нирки людини зрілого та похилого віку.

Реферат. Для вивчення морфометрії і просторового розташування пірамід нирки людини стандартними методами анатомічного дослідження були вивчені 150 нирок людей зрілого та похилого віку обох статей. Для визначення топографії була застосована система топографічних координат, адаптована для оцінки секторної координатної топографії ниркових пірамід в локальній системі координат нирки людини. Була запропонована наступна класифікація ниркових пірамід верхнього кінця нирки: верхня медіальна, верхня латеральна, верхня передня, верхня задня, передня верхня медіальна, передня верхня латеральна, задня верхня медіальна, задня верхня латеральна піраміда. Запропонована класифікація ниркових пірамід може бути використана як для вивчення просторового розташування ниркових пірамід, так і для дослідження морфометричних параметрів окремих пірамід, а також для вироблення найбільш раціональної тактики хірургічного лікування при плануванні органозберігаючих операцій на нирці.

Ключові слова: нирки, ниркові піраміди, класифікація пірамід, морфометричні характеристики.