

## RENAL EXCRETORY SECTORS (OR SEGMENTS) IN APPLICATION TO PARTIAL RESECTION

M. P. Burykh

*Department of Clinical Anatomy and Technology of Surgical Operations,  
Kharkov State Medical University, Kharkov, Ukraine*

### ABSTRACT

One thousand and ninety-four normal human kidneys and 18 abnormal ones (with duplication of the ureter) were studied by a corrosion method and pyelography followed by topometric and mathematic analyses. It has been found out that renal pelvis is a calicopelvic complex built-up of renal calices, urinary ducts, and renal pelvis itself. Before opening into the renal pelvis, renal calices join together forming urinary ducts (superior and inferior; or superior, middle and inferior; or superior, middle anterior, middle posterior and inferior) transporting urine to the container, the renal pelvis. It can be seen that groups of renal calices with pyramids and a cortical substance surrounding them form the renal excretory sectors of the kidneys where the processes of uropoiesis and transportation of urine through elements of the nephron and calicopelvic complex take place. These are two (superior and inferior), three (superior, middle and inferior) or four (superior, middle anterior, middle posterior and inferior) renal excretory sectors. The existence of renal excretory sectors is proved by a congenital anomaly of the calicopelvic complex such as duplication of the ureter where urinary ducts of the superior and inferior renal excretory sectors do not form a renal pelvis but run separately to the urinary bladder. Based on anatomical data obtained, renal excretory sectors may be distinguished by analogy to bronchopulmonary segments in lungs. These data about the renal excretory sectors will contribute to further improvement of the operative technique of renal partial resections as well as of the anatomical nomenclature.

**Key words:** kidney pelvis, renal calices, urinary ducts, structure, topometry

### INTRODUCTION

Anatomy is the most vulnerable aspect in urological operations for nephrolithiasis and a number of other surgical diseases of the kidney (8,9,13). That is why there are still such complications as hemorrhage, renal infarction and extravasation of urine through a nephrostoma (11,14,20). Analysis of kidney structure shows that calices and renal pelvis are extremely variable in their shape, number and location (6,10,12,17). Unfortunately, it is these structures that are very important for the urologist, but routine excretory urograms show only one plane. The purpose of the present investigation is to give topographic anatomical substantiation to certain details in the structure of the initial part of the extrarenal urinary pathways.

### MATERIAL AND METHODS

The study covered 1094 kidneys taken from corpses of individuals of both sexes and various age (from infancy to 90

years and older), who died due to accidents or diseases having no connection with renal damage. Eighteen abnormal kidneys with duplication of the ureter were studied, too. The calicopelvic structure of the kidney was investigated by means of roentgenography and corrosion casts as well as by our original technique of topometry (1,2). The topometric data obtained (3) were analyzed on the basis of a systemic approach (4,7,16) that concerns the calicopelvic structure as a subsystem of mutually communicating reservoirs and ducts accomplishing the function of urine accumulation and transportation.

### RESULTS AND DISCUSSION

Aggregated renal calices connect one to another before emptying into the renal pelvis, forming urinary ducts that transport the urine to the renal pelvis. We found out, too, that in spite of the type of connection with the renal pelvis, the renal calices are located in space by groups according to the parts of the kidney. The analysis of the distribution of the number of calices with respect to these parts shows that the statistical model of the spatial location of the calices is 3-2-3: the lower end of the kidney has an inferior (I), anterior inferior (A<sub>1</sub>) and posterior renal calyx (P<sub>1</sub>); the middle part of the organ has an anterior middle (A<sub>2</sub>) and posterior middle calyx (P<sub>2</sub>), and the upper end of the kidney has a su-

#### Address for correspondence:

M. P. Burykh, Dept. of Clinical Anatomy and Technology of Surgical Operations, Kharkiv State Medical University, 4, Lenine Avenue, 61022 Kharkiv, Ukraine  
E-mail: meduniver@univer.kharkov.ua

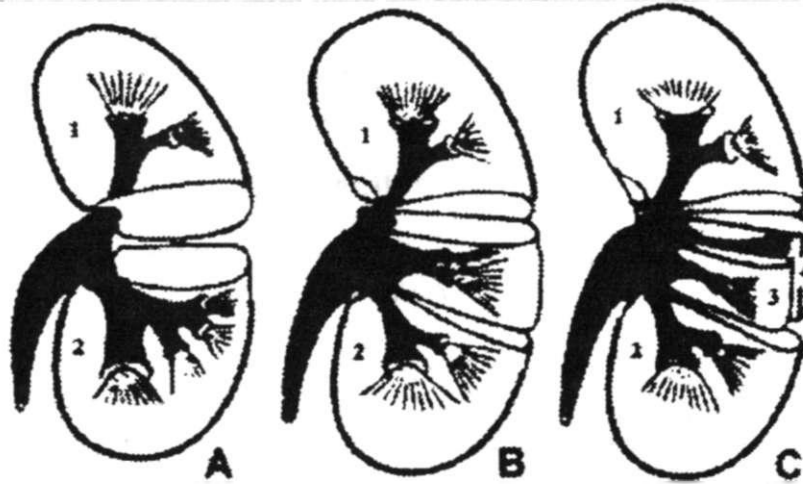


Fig. 1. Renal excretory sectors of the human kidney

A - Two-sector kidney: 1 - superior excretory sector; 2 - inferior excretory sector; B - Three-sector kidney: 1 - superior excretory sector; 2 - inferior excretory sector; 3 - middle excretory sector; C - Four-sector kidney: 1 - superior excretory sector; 2 - inferior excretory sector; 3 - middle anterior excretory sector; 4 - middle posterior excretory sector

perior (S), anterior superior (A<sub>3</sub>) and posterior superior calyx (P<sub>3</sub>).

According to the grouping of renal calices we distinguish the following urinary ducts: superior and inferior, middle, anterior and posterior. We use this terms for the first time (by analogy with bile ducts) to describe the elements of the urinary tract that follow the renal calices.

Modern textbooks of anatomy state that a confluence of 2-3 minor renal calices forms a major renal calyx. Our rejection of the term 'major renal calyx' is based on the following grounds. First, the major calyx has no anatomical connection with the renal pyramids and its structure is not analogous to the minor calyx that is a significant distinctive sign. Therefore, the major renal calyx does not fulfill the function of receiving the urine from the renal pyramid. Second, the major calyx occupies an intermediate position between the minor renal calices and the renal pelvis, essentially performing the function of urine transportation: it is a urinary duct that connects separate groups of renal calices with the renal pelvis. Ampullary and branched forms of the calicopelvic complex can be distinguished (10,12,17-19).

Table 1. Scheme of terms in Latin and English

Sectores excretorii renis	Renal excretory sectors
Sector excretorius superior	Superior excretory sector
sector excretorius medianus	Middle excretory sector
sector excretorius medianus anterior	Middle anterior excretory sector
sector excretorius medianus posterior	Middle posterior excretory sector

The branched form includes two-, three-, and four-group renal calices. Based on the data obtained from the application of a topometric and systemic approach, as well as taking into consideration the functional unity of the intrarenal and extrarenal urinary tract, the renal parenchyma can be described as divided into certain morphofunctional areas, which we call excretory sectors (Table 1).

The possible existence in the kidney of territories analogous to the bronchopulmonary segments of the lungs has been expressed by many authors (5,10,15). According to the architectonics of the calicopelvic complex, two-, three-, and four-sector kidneys can be distinguished. We conclude that the renal excretory sector is a morphologically and functionally isolated region of the organ where the processes of uropoiesis and urine transportation through elements of the nephron and calicopelvic complex take place (Fig. 1).

This area of the renal parenchyma is an indivisible macro-microscopic unit that consists of the cortical and medullary substance from the capsule of the glomeruli to the tops of the renal papillae, while outside the renal parenchyma this unit includes elements of the calicopelvic complex such as a group of calices and corresponding urinary duct.

The existence of renal excretory sectors is confirmed by the congenital renal anomaly of duplication of the ureter. The data presented here will contribute to a further improvement of the methodology of anatomically substantiated kidney resections.

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