

A study of the renal sinus and its application in stone surgery

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Summary. The anatomical structure of the renal sinus was studied in 160 adult cadaver kidneys. Important anatomical features were described in the capsule of the sinus fatty tissue, including capsular septum of the hilus renalis, and the distribution of the posterior pelvic transverse artery. The implications of these findings in stone surgery are discussed.

Key words: Renal sinus fatty capsule – Extrarenal pelvic space – External membrane of renal pelvis – Capsular septum of hilus renalis

Introduction

Intrahilar pyelolithotomy is the most common method for renal stone extraction. The anatomical basis and the techniques of this operation have been described by many authors [1–15], but the description of the anatomy was sometimes incomplete.

The purpose of this article is to extend our knowledge of the important anatomical features of the access route for lithotomy by studying renal sinus anatomy and to recommend the revised method of intra – hilar pyelotomy.

Material and methods

Anatomical study

Along the access route for pyelolithotomy the structure of the renal sinus was dissected posteriorly layer by layer in 160 adult cadaver kidneys. In 35 kidneys polyvinyl chloride was injected into the renal arteries and pelvis as well as into the ureter. The fatty capsule of the sinus, the extra renal pelvic space, the capsular septum of hilus renalis and the posterior pelvic transverse artery were dissected.

Patients

A total of 274 cases underwent a revised intra sinus pyelolithotomy, the technique of which was improved on the basis of the reported renal sinus anatomical study. Among them, 70 cases were intra-renal pelvic stones (25.54%); 184 cases (67.15%) of stag-horn stone with multiple pyelocalyceal stones; 10 cases of recurrent large stone in the renal pelvis after pyelolithotomy (3.64%); 10 cases of recurrent multiple pyelocalyceal stones after nephropyelolithotomy (3.64%).

Operation techniques

The main points of improvement in surgical technique are as follows:

- After the upper part of the ureter has been separated, find the level of renal sinus fatty capsule, dissect along the extra renal pelvic space beneath the renal sinus fatty capsule to the level of the hilus renalis, separate and incise the septum of the hilus renalis, enlarge the hilus of the kidney, and then bluntly dissect with finger deep down to the renal pelvis and the infundibula of the calyces.
- According to the size, shape and the site of the stone, select the site of incision on the renal pelvis. If it is a stag-horn stone, and the exposure for incision is not satisfactory, move the finger to and for carefully to separate the deep part of pelvis and infundibula of calyces, or pull the stone carefully outwards, draw out the infundibula, where the stone is incarcerated. Incise the deep part of renal pelvis and infundibula of the calyx to get a good exposure under direct vision. Separate the stone from the pyelocalyceal wall with a meningeal separator, and keep the blood vessels of the renal sinus intact. Extract the stone with the meningeal separator.
- With multiple stones in the pyelocalyceal system, after separation of the upper part of the ureter and adequate separation of the intra sinus part of the pelvis, block the upper portion of ureter with a rubber tape. Make an incision in the pelvis, then insert a F8 double lumen catheter or two F7 ureteric catheters. If it is thought that the removal of stone may be difficult, the stone can be crushed with rongeur forceps. Take out the bigger fragments first, then cover the incision with a thin rubber membrane and pack with wet gauze, evacuate the fluid within the pelvis and calyces. Take two syringes, one filled with a small amount of methylene blue plus cow's fibrinogen solution, the other filled with bovine thrombin and 10% calcium gluconate in the proportion of 10:2:1.5 respectively. Inject the content of these two syringes at the same time, withdraw the

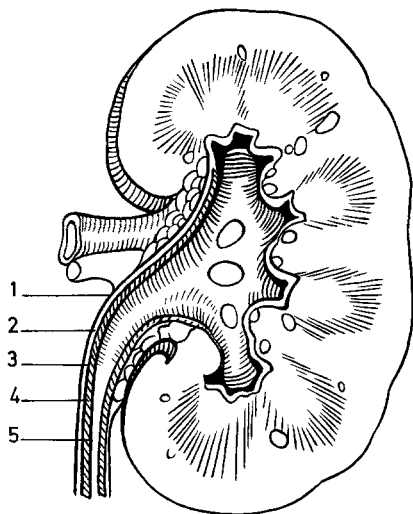


Fig. 1. The structure of renal sinus space: 1. renal sinus fat capsule; 2. extra-renal pelvic space; 3. external membrane of renal pelvis; 4. the muscular of renal pelvis; 5. the mucosa layer of pelvis

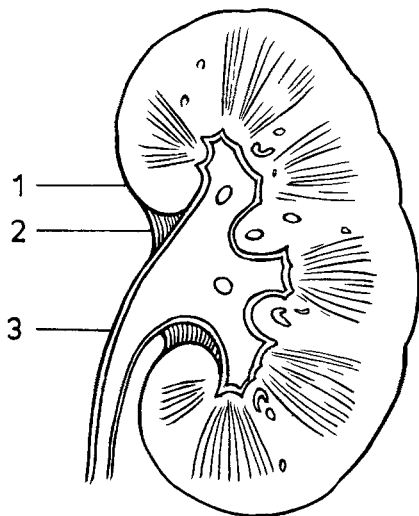


Fig. 2. The capsular septum of hilus renalis: 1. capsular septum of hilus renalis; 2. the ureter; 3. the kidney

catheter five minutes later, extend the pelvic incision up to the calyceal infundibula under direct vision and take out the coagulum together with the stone fragments.

Results

Anatomical study

The renal sinus space. The space between the renal pelvis and the renal parenchyma is called the renal sinus space (Fig. 1). The structure of renal sinus space

from the outside inwards is as follows: (1) Renal sinus fatty pad with blood vessels and nerves. The fatty pad is closely adherent to the renal parenchyma. There is an abundant network of arterial and venous vessels in it and the anastomotic branches of vessels and the nerves pass through it. The thin filaments of the coeliac nerves surrounding the adventitia of the blood vessels and accompanying the vessels enter through it into the renal parenchyma. (2) Renal sinus fatty capsule: This capsule begins at the upper part of the ureter and is a layer of condensed fibrous tissue. The fatty capsule extends to the neighborhood of the renal papillae. (3) Extrarenal pelvic space. This space is located between the renal sinus fatty capsule and the extrarenal pelvic membrane. It is filled with loose connective tissue and does not contain any blood vessels. It is easy to dissect through this space up to and around the renal papillae.

The wall of the renal pelvis. From outside inwards there are three layers in the renal pelvic wall. (1) The external membrane of renal pelvis: this layer is smooth and can be separated easily from the extra renal pelvic space. The inner surface is in close contact with pelvic muscular layer. The blood vessels supplying the external membrane of the pelvis run inside out from the muscular layer toward the external membrane, so it is difficult to divide them. (2) The muscular layer of the renal pelvis. (3) The mucosal layer of the pelvis.

The capsular septum of hilus renalis. There is a thick layer of fibrous tissue at the border of hilus renalis. This fibrous tissue surrounds the pelvis and is attached to it and to the wall of the renal artery and vein at the level of hilus renalis. This strong fibrous sheath is the so called capsular septum of hilus renalis (Fig. 2). This septum is situated just at the entry of the renal sinus and separates the renal sinus from the extraperitoneal space.

The posterior segmental artery. Among the 160 adult cadaver kidneys dissected, 159 kidneys (99.4%) have this artery. The main trunk crosses the renal sinus at the upper part of hilus renalis, crossing the posterior upper part of the renal pelvis, where usually are the junctions of the renal pelvis and the major calyces, then arching downward along the posterior renal lip and sending branches to the back of the upper part of the major and minor calyces. Finally it enters the renal parenchyma (Fig. 3).

The posterior transverse pelvic artery. Among the 160 kidney specimens with blood vessels, 84 have the posterior transverse pelvic artery (52.5%). It arises from the posterior segmental artery usually at the junction of the upper major calyces and the pelvis or at



Fig. 3. Distribution of the posterior renal artery: 1. posterior segmental stem; 2. posterior transverse pelvic artery; 3. lower calyceal artery

the inner surface of the upper lip of the kidney. The main trunk usually runs parallel to the posterior segmental artery across the back of the renal pelvis or the junction of the pelvis and the major calyces. This artery is located about 0.5–1.5 cm from the posterior lip of the kidney.

Discussion

Since intra renal sinus pyelolithotomy was improved by Gil-Vernet, attention was paid to the anatomy of the renal sinus [1–25], but the description of the renal sinus anatomy was not particularly detailed. From the observations of the anatomical structure of 160 adult cadaver kidneys, we have noted that:

- The renal sinus fatty capsule surrounding the ureter extends upward along the extra pelvic membrane and ends at the base of the renal papillae. The renal sinus fatty capsule separates the intra sinus fatty tissue from the extra pelvic membrane. The space between the renal sinus fatty capsule and extra pelvic membrane is called extra pelvic space, which is filled with loose

connective tissue without blood vessels. The connective tissue here is very easy to separate and no bleeding will occur.

- At the border of the kidney, there is a thick fibrous sheath attaching the pelvic portion at the level of hilus renalis. When this layer of fibrous sheath is incised, the hilus renalis can be significantly enlarged.

- The extra pelvic membrane covers the muscular layer of the renal pelvis. These two layers adhere with each other tightly, and are difficult to separate. Since the blood supply comes from the muscular layer of the renal pelvis, it tends to bleed and the pelvis is easily torn during separation.

- The posterior pelvic transverse artery arises from the posterior segmental artery. It runs across the back of the pelvis or at the junction of the pelvis and the major calyces at about 0.5–1.5 cm from the posterior lip of the kidney. If these arteries are injured during separation, massive bleeding will result.

The revised intra sinus pyelolithotomy consists of the following steps:

- During the separation of the intra sinus pelvis, the level of renal sinus fatty capsule at the upper part of the ureter should be identified first. Dissection should be beneath the fatty capsule along the extra renal pelvic space up to the infundibula of the calyces.

- Before dissecting the intra sinus pelvis, the capsular septum of hilus renalis should be identified and incised. If infection is present, the capsular septum usually thickens obviously, but still can be separated through the loose tissue between the inner surface of the renal sinus fatty capsule and the extrapelvic membrane. Incise the capsular septum at the lower part of pelvis from inside outwards to the renal capsule, widen the hilus renalis, and then separate extensively along the plane between the fatty capsule and the extrapelvic membrane and expose the pelvis and infundibula of calyces sufficiently. In case of a big stag-horn stone, it may be difficult to deliver it out from the intra sinus incision, so the stone may be crushed first and the bigger fragments may be taken out followed by coagulum pyelolithotomy [18–25]. Avoid unnecessary parenchymal incision or partial nephrectomy.

- During the separation of the deep portion of renal sinus, several circumstances may cause injury of the posterior segmental artery and posterior pelvic transverse artery, for example (1) rough handling in separating of the renal sinus; (2) lengthening of the pyelotomy blindly; (3) laceration of the calyces or injuries of the posterior segmental artery or the posterior pelvic transverse artery may result from forced extraction of stag-horn stones.

The practical preventive measures are as follows:

- During separation of the deep part of the renal sinus, the dissection should be done along the extrapelvic membrane, and the deep part of pelvis and the infundibula of calyces should be well exposed before making any incision. Usually pulling the stone outward is necessary and afterwards the portion of the infundibula of the calyces where the stag-horn stone is incarcerated should be drawn out, then incise the infundibula under direct vision.
- During extraction of the stag-horn stone, a meningeal extractor should be used to protect the blood vessels in the renal sinus, and the stone should be taken out of the sinus beneath the meningeal extractor.
- If the posterior segmental artery and posterior pelvic transverse artery are injured but without uncontrollable bleeding, do not use haemostats applied blind for such manoeuvre will further injure the blood vessels inside the sinus as well as the parenchyma that may exaggerate the bleeding. Bleeding usually can be stopped by pressure on the kidney. If the bleeding persists one may suture the pelvic incision first, then fix the renal pelvis to the approximate renal capsule with catgut sutures.

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