Hubert John
Peter Wiklund *Editors*

Robotic Urology

Second Edition

Springer

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Editors
Hubert John
Department of Urology
Kantonsspital Winterthur
Winterthur
Switzerland

Peter Wiklund
Department of Urology
Karolinska Hospital
Stockholm
Sweden

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Robotic Urology

Foreword I

With the introduction of the robot-assisted minimally invasive surgery a new era started for urologic surgery. Robotic-assisted surgery allowed a more precise removal of tumourous organs in the pelvis. It was important at the very beginning to differentiate robotic-assistance using intelligent assistance systems, which modify and improve the surgeons' movements from the actual use of robots with a predefined working schedule (where the surgeon does not actually operate), which has been used and abandoned by other disciplines such as orthopaedic surgery. In urology, robotic surgery has been a success and the current second edition bears an excellent testimony to that. Initially mainly used for radical prostatectomy, indications have successfully been expanded to other oncological surgeries such as cystectomy, partial nephrectomy, adrenalectomy as well as reconstructive surgery such as urinary diversion and upper urinary tract reconstruction.

What have we learned since the first reports erupted more than a decade ago in urology?

We have seen that an intelligent assistance system does whatever the surgeon wants it to do; however it must be remembered that even the best vision, highest precision and smooth movements of the hands do not make a perfect surgeon. A comparison of robotic, laparoscopic and open surgeons doing the same procedure is dependent on their respective experience with each surgical technique. In other words: There is plenty of literature where an experienced open surgeon will out-perform a mediocre robotic surgeon and vice versa. Only randomized series with surgeons with a defined minimum case load might be more informative as to whether one or the other technique (and for which type of cases) is better both in the short and long-term outcome.

Robot-assisted surgery increases the price of each procedure considerably using the currently available technology. Health authorities on the other hand are increasingly only willing to pay this price if there is evidence for a decrease in the overall costs of a hospital stay and a measurable improvement of the long-term oncological and functional outcome. But in some countries none of the current literature fulfils the requirements necessary for the authorities to be convinced to fully compensate the additional costs. We therefore as urologists need to create prospective and – if possible – randomized data to better delineate the benefits.

There are signs such as from the Canadian Health Technology Association that they are willing to pay the additional costs for subsets of prostate cancer patients [1].

With more than a decade of experience in robotic assisted surgery in the pelvis as well as in the retroperitoneum and in disciplines other than urology it is clear that this type of surgery will stay and will not be a "fashion fad". Future developments will now focus on a simplification of the current technology. These could include bringing the surgeon back to the OR-table, having a better posture of the surgeon and introduction of vision-based navigation, intraoperative fluorescence guidance and precision destruction systems such as laser into the intervention [2–4]. Several research groups have been working on haptics in order to overcome one of the often-cited disadvantages when compared to open surgery: the feeling of tumors, organs and structures. All these developments are based on intelligent assistance systems and do not make any sense for open surgery and will not really improve it. Thus the more these developments find their way into routine clinical applications, the more robotic-assisted surgery will become indispensable.

Tübingen, Germany Prof. Arnulf Stenzl, M.D.

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Preface

Hubert John and Peter Wiklund in the Swiss Alps, 7th March 2010, when they decided to re-edit this book

Urology has traditionally been a technically driven specialty. Minimally invasive surgical procedures aim to reduce collateral surgical damage while optimizing functional and oncological results.

Ten years ago, when both editors began robotic urology in 2002, it was unexpected that this technology would revolutionize surgical approaches in urology. In the last decade, no other operative technology has had a stronger influence in urology than the master–slave robotic system "DaVinci" (Intuitive Surgical, Sunnyvale, Calif.) Robotic technology has overcome the limitations of conventional laparoscopy and brought challenging laparoscopic interventions from a few experts' hands to a broad spectrum of urologists and patients who can profit worldwide.

The second edition of this book in 2012 is therefore very timely. The authors have invested great effort and personal experience in order to support other robotic teams around the world. The book highlights the standards of robotic urology today of the kidney and adrenals, the ureter, bladder and prostate and also reviews some possible future indications and techniques that are today still in clinical evaluation. We are happy that the second edition has come to a fruitful conclusion after 2 years of hard work. Our thanks go especially to Dörthe Mennecke-Bühler from Springer (Heidelberg) and to Kevin Horton (Winterthur), who helped to advance this project in a significant way. We are especially grateful to our families for their support and tolerance of our high professional workload.

Winterthur, Switzerland
Stockholm, Sweden

Prof. Hubert John
Prof. Peter Wiklund

Contents

Part I

Kidneys

Surgical Anatomy of Kidneys and Adrenals

1

Ibrahim M. Karam, Alexandre Oliver, and Jacques Hubert

1.1 Introduction

In this chapter, surgical anatomy of kidneys and adrenals is described in detail. Their anatomical relationships and preoperative evaluation of retroperitoneal anatomy are illustrated for providing anatomic information necessary to plan the surgical procedure. This evaluation is crucial, in robotic surgery, for detecting vascular anomalies and helps the surgeon to easier dissect atypical renal or adrenal vessels. We also describe the practical surgical options of dissection to give to the operator the capacity to anticipate difficulties and overcome them.

I.M. Karam (✉)
Department of Urology,
Nancy-Brabois University Hospital,
Allée du Morvan,
545111 Vandœuvre les Nancy, France

Department of Anatomy, Faculty of Medicine,
University of Nancy, 9 Av de la Forêt de Haye,
54500 Vandœuvre les Nancy, France
e-mail: karam_ibrahim@yahoo.fr

A. Oliver
Department of Radiology,
Nancy-Brabois University Hospital,
Allée du Morvan,
545111 Vandœuvre les Nancy, France

J. Hubert
Department of Urology,
Nancy-Brabois University Hospital,
Allée du Morvan,
545111 Vandœuvre les Nancy, France

INSERM-IADI (U947),
Allée du Morvan,
54511 Vandœuvre les Nancy, France

1.2 Description and Anatomical Relationships

1.2.1 Retroperitoneum and Gerota's Fascia

The retroperitoneum is divided into the anterior pararenal space, the perirenal space, and the posterior pararenal space. The perirenal space is defined by the anterior and posterior layers of the perirenal fascia (Gerota). This fascial layer encloses the kidney and adrenal in their covering of perirenal fat (Fig. 1.1). It was originally described as being made up of two separate entities, the posterior fascia of Zuckerkandl and the anterior fascia of Gerota [1].

1.2.2 The Adrenal Glands

The adrenal glands are paired structures medially located to the upper poles of the kidneys. They are covered by the perirenal (Gerota's) fascia and are surrounded by an adipose and connective tissue that forms a pseudocapsula, facilitating surgical dissection [2]. The *right adrenal* is usually lower than the left. It lies above the upper pole of the right kidney, between the liver and the diaphragm, and forms the

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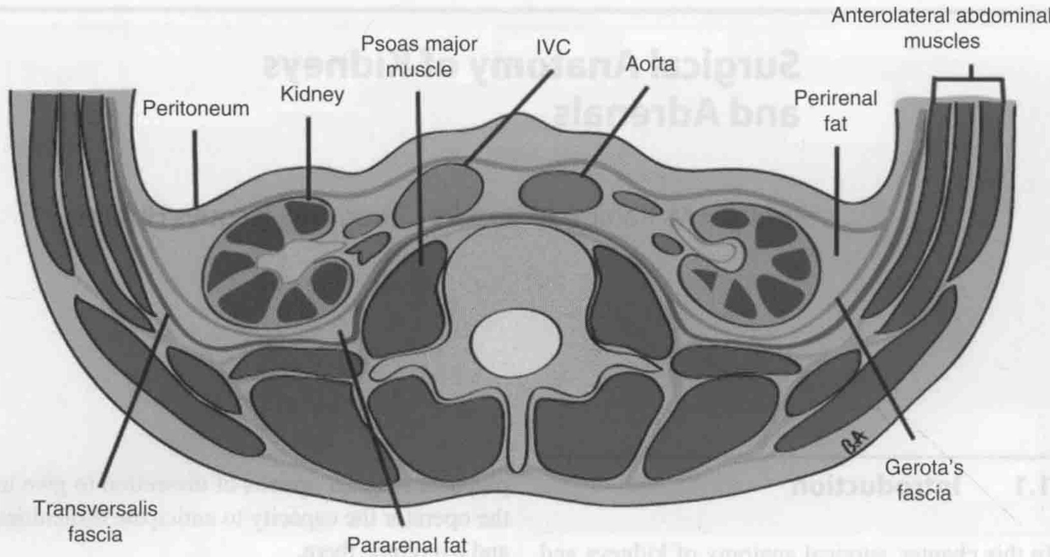


Fig. 1.1 Organization of the perirenal space and fascia

impressio suprarenalis on the liver surface, just to the right of the inferior vena cava. Surrounding structures include the liver anterolaterally, the duodenum anteromedially, and the inferior vena cava (IVC) medially. The *left adrenal* lies within the perirenal fat along the medial or superomedial border of the left kidney. It is more closely related to the kidney than is the right one, and it is more easily drawn down with the kidney because its central vein drains into the midpoint of the left renal vein, while on the right the central vein fixes the gland high on the inferior vena cava. It is more crescent-shaped and medial to the upper pole of the left kidney. The upper and anterior aspects are related to the stomach, tail of the pancreas, and splenic vessels.

The adrenal arterial supply originates from three sources: The inferior branches are issued from the ipsilateral renal artery, while the middle branches originate directly from the aorta, and finally the superior adrenal pole is irrigated by branches from the inferior phrenic artery (Fig. 1.2). The venous drainage varies by side, the left principal adrenal vein joins the inferior phrenic vein, and the other enters the cranial aspect of the left renal vein. On the right side, the adrenal vein enters the IVC directly on its posterolateral aspect.

1.2.3 The Kidneys

The kidneys are paired retroperitoneal organs that parallel the psoas muscle on either side of the lumbar spine. The left kidney is usually slightly higher than the right one and is slightly more medially located. Posteriorly, the diaphragm covers the upper third of each kidney. Medially the lower two-thirds of the kidney lie against the psoas muscle, and laterally the quadratus lumborum and aponeurosis of the transversus abdominis muscle are encountered. Anteriorly, the right kidney is bordered by the liver and attached to it by the hepatorenal ligament. On the medial aspect, the descending duodenum is intimately related to the hilar renal structures. The left kidney is bordered superiorly by the tail of the pancreas and the splenic vessels adjacent to its upper pole. The splenorenal ligament attaches the left kidney to the spleen. It can lead to splenic capsular lesions if excessive downward pressure is applied on the left kidney. Superior to the pancreatic tail, the posterior gastric wall can overlie the kidney.

The renal arteries typically arise from the aorta slightly below the origin of the superior mesenteric artery. The right renal artery has a long downward course to the relatively inferior right kidney, traversing behind the inferior vena cava.

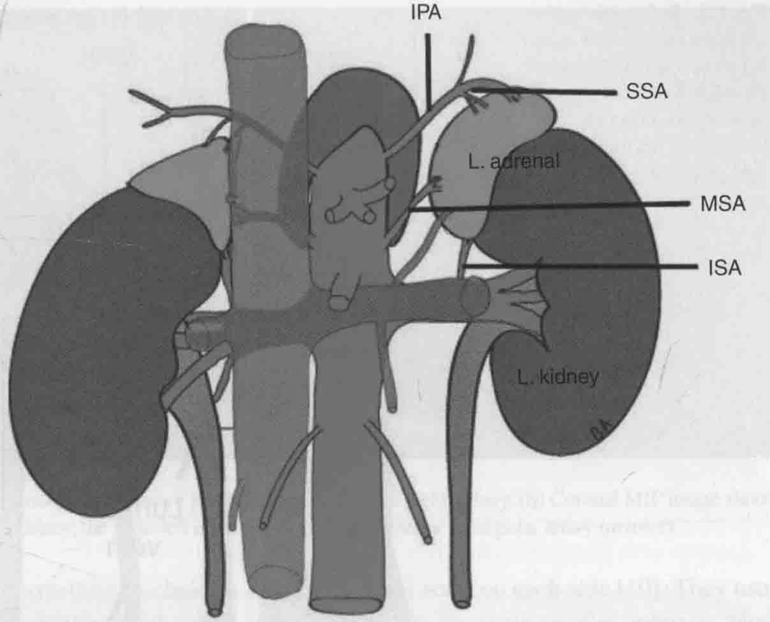


Fig. 1.2 The arterial supply to the adrenal gland originates from three sources: Superior suprarenal arteries (*SSA*) from the inferior phrenic artery (*IPA*), middle suprarenal arteries (*MSA*) originate directly from the aorta and inferior suprarenal arteries (*ISA*) issue from the ipsilateral renal artery

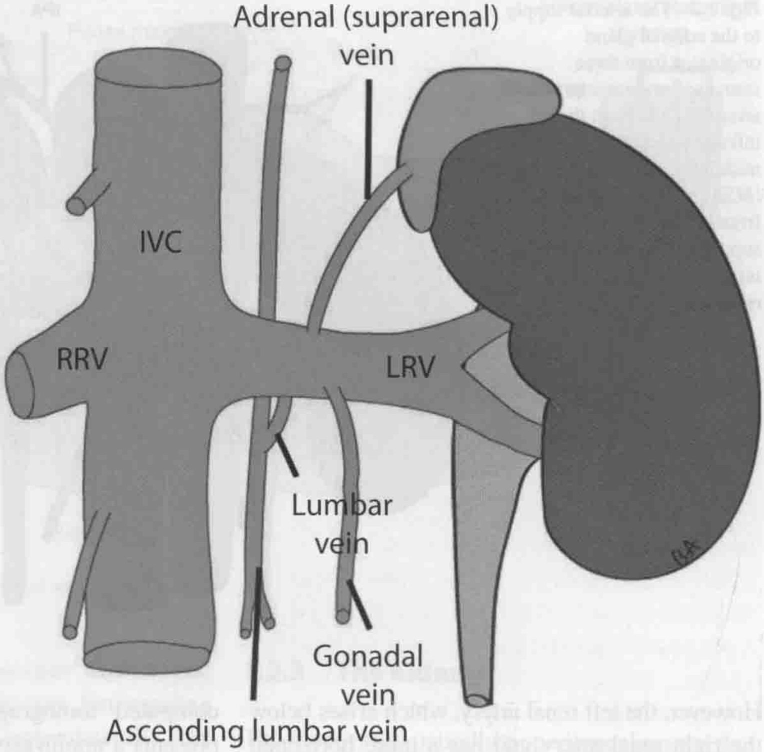
However, the left renal artery, which arises below the right renal artery and has a more horizontal orientation, has a rather direct upward course to the superiorly positioned left kidney. The renal vein usually lies anterior to the renal artery at the renal hilum. The left renal vein is almost three times longer than the right renal vein. It runs anteriorly between the superior mesenteric artery and the aorta before emptying into the medial aspect of the IVC. Unlike the right renal vein, the left renal vein receives several tributaries before joining the inferior vena cava. It receives the left adrenal vein superiorly, the left gonadal vein inferiorly, and a lumbar azygos vein posteriorly (Fig. 1.3).

1.3 Radiological Anatomy

CT angiography, performed with volume rendering and multiplanar reconstructions, is extremely accurate in the preoperative evaluation of renal vascular anatomy. It has replaced conventional angiography in most institutions. Comprehensive preoperative evaluation of retroperitoneal anatomy is crucial for detecting vascular anomalies and for providing anatomic information necessary to plan the surgical procedure [3]. The multidetector computed tomographic (*MDCT*) angiography presents a noninvasive imaging modality for the evaluation of adrenal and renal vascular anatomy. In addition to assessing the vessels, anatomic definition of the collecting system is important [4]. The number, size, branching pattern, course, and relationship of the renal arteries and veins are easily demonstrated by MDCT angiography [5]. The 3D imaging provides high-quality images that make intraoperative anatomic analyzes more accessible to those nonspecialized in imaging mainly urologists. Preoperative knowledge of minor venous variants such as a lumbar or gonadal vein may facilitate the dissection of these veins and help to avoid hemorrhagic complications during surgery. Dual-phase MDCT combined with maximum intensity projection (*MIP*) reconstruction can provide a minimally invasive, accurate preoperative evaluation of kidney donor candidates in a single study (Fig. 1.4).

The accuracy of MDCT angiography in detecting accessory arteries, early branching, and renal vein anomalies are 95, 90–95, and 95–100 %, respectively [6]. The most common venous anomaly is a circumaortic left renal vein. The larger veins can be evaluated with the volume-rendering technique (*VRT*); however, to find all smaller

Fig. 1.3 Before joining the inferior vena cava (*IVC*), the left renal vein (*LRV*) receives the left adrenal vein superiorly, lumbar vein posteriorly, and left gonadal vein inferiorly. The right renal vein (*RRV*) typically does not receive any branches



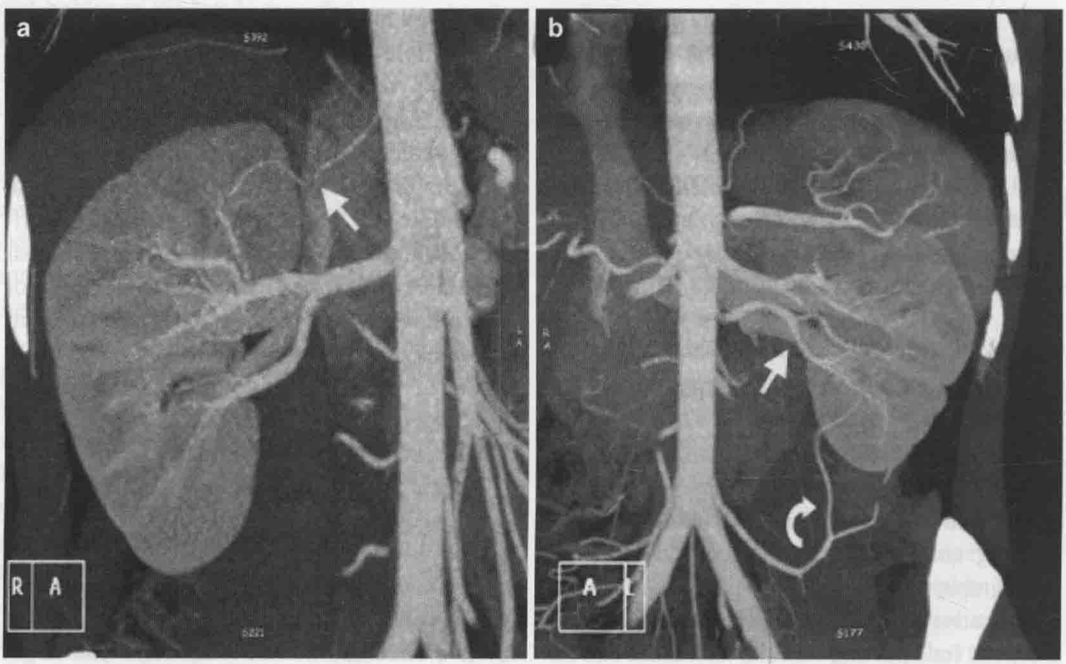


Fig. 1.4 Oblique maximum intensity projection images, of a man undergoing preoperative renal donor evaluation, show accessory polar renal arteries to the right and left kidneys (*arrows*). The superior branch of the inferior mesenteric artery (*curved arrow*), which courses toward the left kidney, mimic the appearance of an accessory renal artery