11 Contributions to Gynecology and Obstetrics

Editor. P. J. Keller

J. Kunz

Urological Complications in Gynecological Surgery and Radiotherapy

Urological Complications in Gynecological Surgery and Radiotherapy

Jürg Kunz

Department of Gynaecology and Obstetrics,
University of Zürich, Zürich

21 figures, 3 cpl. and 35 tables, 1984

KARGER

S. Karger · Basel · München · Paris · London · New York · Sydney

Contributions to Gynecology and Obstetrics

National Library of Medicine, Cataloging in Publication
Kunz, J. (Jürg)
Urological complications in gynecological surgery and radiotherapy/
Jürg Kunz. – Basel; New York: Karger, 1984.
(Contributions to gynecology and obstetrics; v.11)
Includes bibliographical references and index.
1. Genital Diseases, Female – surgery 2. Genital Diseases, Female – radiotherapy 3. Genital Diseases, Female – etiology 4. Intraoperative Complications 5. Urinary Tract 6. Urogenital System – surgery 7. Urologic Diseases – etiology I. Title II. Series
W1 CO778RG v. 11 [WP 660 K96u]
ISBN 3-8055-3759-X

Drug Dosage

The authors and the publisher have exerted every effort to ensure that drug selection and dosage set forth in this text are in accord with current recommendations and practice at the time of publication. However, in view of ongoing research, changes in government regulations, and the constant flow of information relating to drug therapy and drug reactions, the reader is urged to check the package insert for each drug for any change in indications and dosage and for added warnings and precautions. This is particularly important when the recommended agent is a new and/or infrequently employed drug.

Printed in Switzerland by Thür AG, Offsetdruck, Pratteln
ISBN 3-8055-3759-X

Urological Complications in Gynecological Surgery and Radiotherapy

Contributions to Gynecology and Obstetrics

Vol. 11

Series Editor
P.J. Keller, Zürich

KARGER

S. Karger · Basel · München · Paris · London · New York · Sydney

Contents

Introduction

Despite the advances made in gynaecological surgery and in irradiation techniques, iatrogenic lesions affecting the efferent urinary tract are still among the risk factors of such therapy. Treatment-determined urological complications of this kind may overshadow the success of an intervention, particularly in the case of operations with a benign indication, and may have a decisive influence upon the postoperative course. The gynaecologist's aim must therefore be to minimize the incidence of these complications. To this end it is first necessary to have a knowledge of the anatomy and function of the efferent urinary pathways under normal and pathological conditions. Under the latter heading the alterations pertaining to the gynaecological sphere are particularly important. A sensible arrangement and a correct interpretation of the pre-therapeutic diagnostic examinations providing information on the anatomical and functional situation of the urinary tract are also among the preventive measures to be undertaken. If urological complications develop during or after gynaecologically indicated surgery or radiotherapy, the gynaecologist must take suitable diagnostic and therapeutic steps insofar as they fall within his sphere of competence. This phase of the treatment requires the advice of a urologist at a consultative level, who has to decide on the probable or actual processes taking place and to perform any reconstructive interventions that may be necessary. As a result of this close interdisciplinary collaboration between gynaecologists and urologists, individual treatment plans can be devised and put into effect, especially in complicated cases [648].

With this in mind, the aim of the present study was to show up the anatomical and physiological foundations of preventing the lesions of the efferent urinary pathways during gynaecological interventions or irradiation and of comprehending post-therapeutic functional disorders. To avoid erroneous interpretations of examination findings, alterations of the efferent urinary tract occurring during pregnancy and under pathological conditions, e.g. as in uterus myomatosus, dropping states of the internal genitals or endometriosis, are given particular attention. Besides the therapeutic aspects, the discussion of the complications includes above all the preventive and diagnostic measures in which the gynaecologist should be well versed.

Anatomical Foundations

Topography of the Pelvic Extraperitoneal Connective Tissue in Women

In the extraperitoneal or subperitoneal cavity, between the peritoneum, the pelvic wall, and the floor of the pelvis there is a loose connective tissue, the fascia visceralis pelvis [771, 773] or fascia endopelvina [771], also referred to in gynaecological practice as the ligamentum latum [773], the parametrium [840], the ligamentum transversum colli [595] or the ligamentum cardinale uteri [980]. In systematic anatomy the term ligamentum cardinale is derived from the pars cardinalis ligamenti lati and corresponds to the connective tissue connection between the cervix uteri and the lateral pelvis wall, i.e. the fascia of the levator ani muscle directly in front of the ischial spine [739]. The ligamentum cardinale, also known as Mackenrodt's ligament or the cervical pillar [763], forms the basis of the parametrial connective tissue adjoining in the cranial direction [739]. This is followed in the caudal direction by the paravaginal connective tissue or paracolpium [739].

The ligamentum latum thus connects the pelvic organs, the urinary bladder, the uterus, and the rectum with the lateral wall of the pelvis and divides into three prongs in the lateral to medial direction [733]. The connective tissue fibres growing thicker in the ventral direction with their intercalated smooth muscle fibres are known as bladder pillars and consist of a lateral portion running close to the pelvic wall and a medial portion also known as the ligamentum vesico-uterinum (fig. 1).

Between the lateral and the medial sections of the bladder pillar there is a loose connective tissue [739]. The entire connective tissue to the side of the urinary bladder, i.e. the bladder pillars and loose connective tissue, is known as the paracystium [763]. In the cranial direction the urinary bladder has at its disposal an extraperitoneal displacement space, the retropubic space or spatium praevesicale Retzii [922].

The band of the ligamentum cardinale going off in the dorsal direction, the rectal pillar [739], consists of a lateral portion lying against the wall of the

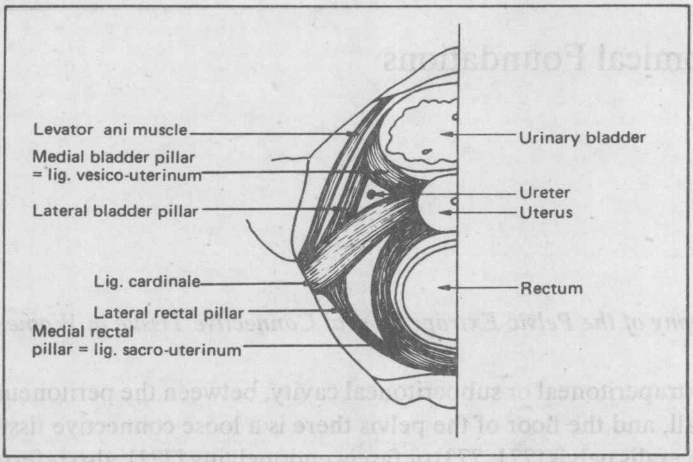

Fig. 1. Topography of the pelvic extraperitoneal connective tissue in women.

pelvis and a medial portion corresponding to the ligamentum recto(sacro)-uterinum. These two sacro-uterine ligaments form the lateral boundary of the Douglas pouch [763]. Between the lateral and the medial section of the rectal pillar there is likewise a loose connective tissue. Logically enough, the entire connective tissue situated laterally from the rectum is known as the paraproctium [763].

The medial pillar situated in the frontal plane, the parametrium, is covered ventrally and dorsally by a serous membrane which continues towards the uterus as the perimetrium. In this way the cavum serosum pelvis, the pelvic intraperitoneal space, is divided into two chambers open towards the cranium, that is into the excavatio vesico-uterina ventrally and the excavatio recto-uterina (the Douglas pouch) dorsally. In the sagittal plane the urinary tract, the genital tract, and the digestive tract are connected to one another by septa or ligaments. Ventrally of the genital tract these include the septum supravaginale (vesico-uterinum), septum vesicovaginale, and septum urethrovaginale and dorsally the septum rectovaginale (fig. 2).

The septa ensuring the medial connection of the pelvic organs consist of more or less taut connective tissue with intercalated smooth muscle fibres. The supravaginal septum constitutes a particularly taut connection between the cranial trigonum vesicae and the cervix uteri [739, 763]. The vesicovaginal and urethrovaginal ligaments adjoining in the caudal direction between the

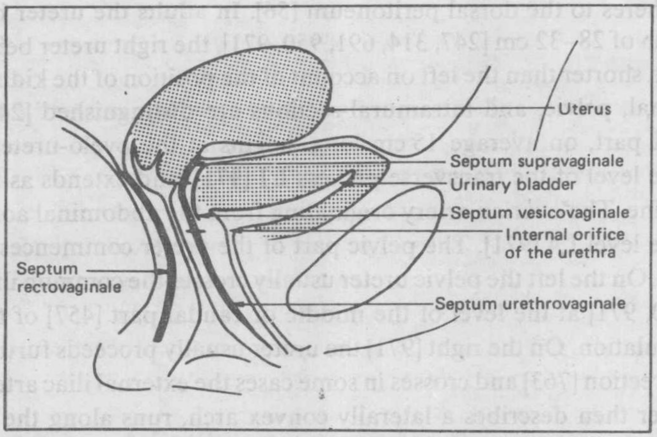

Fig. 2. Connection of the pelvic organs in the sagittal plane.

vaginal fascia and the cervical or urethral fascia, on the other hand, are loose fixation bands [542]. Very loose connective tissue fills the rectovaginal septum between the vaginal fascia and the rectal fascia [763].

In respect of the nomenclature it should be added that according to microscopic investigations [68] the said fasciae do not exist in systematic anatomy, since a fascia consists of collagenous connective tissue, contains no smooth-muscle fibres, and is associated with a skeletal muscle [542]. Despite this in everyday practice we speak of fascias, since the term can be applied to a macroscopic structure [771, 935], which is important for gynaecological surgery because it permits sparing, functional-anatomical operations [771]. The same applies to the term septum, ligament, and space, which are all used in the same way.

Topography and Vascularization of the Efferent Urinary Pathways in Women

Topography of the Ureter

The ureter is one of a pair of fibromuscular connections between the kidneys and the urinary bladder [971]. Each leaves the hilus of the kidney at the level of the 2nd to 4th lumbar vertebra [922], follows an extraperitoneal course, and adheres to the dorsal peritoneum [56]. In adults the ureter has an overall length of 28–32 cm [247, 314, 691, 950, 971], the right ureter being on average 1 cm shorter than the left on account of the position of the kidney [971]. Abdominal, pelvic, and intramural sections are distinguished [247]. The abdominal part, on average 15 cm long, begins at the pyelo-ureteral transition at the level of the transverse process L1 [971], and extends as far as the arcuate line. The ovarian artery originating from the abdominal aorta is crossed at the level L4 [971]. The pelvic part of the ureter commences at the arcuate line. On the left the pelvic ureter usually crosses the common iliac artery [481, 950, 971] at the level of the middle or caudal part [457] of the sacro-iliac articulation. On the right [971] the ureter usually proceeds further in the lateral direction [763] and crosses in some cases the external iliac artery [971]. The ureter then describes a laterally convex arch, runs along the os ileum [424, 846, 922], and lies embedded in the loose connective tissue of the rectal pillar [739, 763], medially of the internal iliac artery and the obturator nerve [763, 971]. Further in the caudal direction the broad ligament in the loose connective tissue is crossed between the bladder pillars, and the cardinal ligament is reached at the base of the broad ligament. The distance from the point of intersection of the iliac vessels and the cardinal ligament is on average 9.2 cm [971].

At the base of the cardinal ligament the ureter, passing underneath the uterine artery in a caudally convex fashion, forms the knee of the ureter, after that changes direction towards the anteromedial region [247] and forms an ascending, retrovesical branch [739] on average 1.9 cm long [971]. In adults this branch includes the on average 1.3-cm long [427], intravesically (pars intramuralis) proceeding section [763]. The knee of the ureter, i.e. the point of intersection of the ureter and the uterine artery, is 0.8–2.5 cm (in individual cases up to 4 cm) from the cervix [739, 763, 922], is situated 1.2 cm cranially of the lateral vaginal vault [922], and on average 1.8 cm medially of the ischial spine [247, 971]. Before it reaches the base of the bladder the ureter also comes closer to the anterior vault of the vagina [763]. The pelvic part of the ureter is thus composed of a descending branch and an ascending branch.

Vascularization of the Ureter. Histological Foundations

Under the optical microscope the ureter is seen to have 3 wall layers, namely the tunica (lamina) mucosa, muscularis, and adventitia [691, 763]. Individual authors [513, 691, 950] make a separate reference to a submucosa (tunica propria, lamina propria). The formerly held view that the tunica muscularis is composed of an internal loose layer of longitudinal muscle and an external solid layer of annular muscle [549, 763, 813] has been proved incorrect. It rather consists of heterogenously oriented muscle cells [360] forming a network structure [10, 551, 677, 865] and arranged like a helix in the abdominal part of the ureter [360, 374, 550, 676]. In the pelvic part the inner spirals follow a steep course and the outer spirals a nearly horizontal course, so that in cross-section an impression of an internal longitudinal and external circular arrangement of the muscle cells is obtained in the prevesical part [360]. It is still disputed whether the ureter muscles and the adventitia end at the start of the pars intramuralis [998] or further in the distal direction [902], and thus whether the ureteral tunica muscularis is separated from the vesical muscles by the adventitia. At any rate, the division does not extend as far as the opening of the ureter into the bladder, the adventitia probably proceeding into the detrusor muscle of the bladder [360]. Electron microscopic investigations have also confirmed the triple-layer structure of the ureteral wall, the mucosa consisting of two sections, a transitional epithelium 3–5 layers thick and the tunica propria 350–700 μm thick [691].

Arterial Vascularization of the Ureter

The arterial supply of the ureter has been the subject of wide-ranging investigations and controversies since the turn of the century [literature in 805]. The differentiation of two parts of the ureter, namely the abdominal and the pelvic parts, has proved to be of practical importance [741]. The transition from the abdominal part to the pelvic part is a critical point for the arterial supply [741].

The abdominal part is regularly supplied by one or two ureteral branches (a. ureterica cranialis) from the renal artery and the testicular/ovarian artery [196, 339, 741, 763, 950, 971] or directly from the abdominal aorta [374, 741]. At the point of transition from the abdominal to the pelvic part a supply is maintained, albeit irregularly, by the common iliac artery [741, 763] or the internal iliac artery [374, 741, 950, 971]. This artery, which supplies the middle part of the ureter, is also known as Feitel's artery [339].

The pelvic part contains the most important arterial supply from the superior and inferior vesical arteries [196, 374, 472, 560, 618, 630, 739, 741] and also from branches of the uterine artery [560, 739, 763], the middle rectal artery [741, 950, 971], the internal pudendal artery [560], the vaginal artery, and the artery of ductus deferens [741]. In rarer cases an arterial supply is also provided by parietal branches of the internal iliac artery [741], namely the obturator artery, the superior gluteal artery [736], and the iliolumbar artery [560, 763]. In his investigations on children's ureters in 1901, *Feitel* [272] found that the cranial section of the pelvic ureter is supplied by medial arteries and the caudal section by lateral arteries. He made the suggestion, important for practical purposes, that the pelvic ureter should be exposed in the cranial part from the lateral plane and the caudal ureter from the medial plane.

Sampson [805] called the vessels running to the ureter and originating from the major abdominal and pelvic vessels the ureterosubperitoneal arteries. These normally divide into two branches: a ureteral branch which forms the peri-ureteral plexus running through from the kidney to the bladder, and a subperitoneal branch supplying the peri-ureteral tissue and the peritoneum and anastomosed with adjacent arteries and the peri-ureteral plexus. These subperitoneal arteries are also described by *Gregoir and Triboulet* [339] and by *Poisel and Martin* [741]. From their radiological investigations on cadavers, *Daniel and Shackman* [196] concluded that certain ureters receive their arterial supply via these subperitoneal branches. This was the reason for the practical recommendation by *Ihse* et al. [448] that, bearing in mind the supply via the subperitoneal arteries, the ureter should be loosened only to the minimal degree from the peritoneum.

On the basis of investigations by the plastic injection technique [571], *Michaels* [649] assigned the arterial supply of the ureter to three generations of vessels. According to these studies the main supply is via the branches from the aorta, the common iliac artery, and the internal iliac artery:

First Generation. The branches from the aorta, the common iliac artery, and the internal iliac artery bifurcate dichotomously in the loose fatty connective tissue at the ureter into ascending and descending branches of equal calibres; in more than two thirds of ureters these branches run along the entire length and are arranged singly, more rarely in twos or in threes [196, 339, 560, 821]. These long arteries are anastomosed peri-ureterally with one another [741] and with arteries from the renal artery, the uterine artery, the vaginal artery, the superior and inferior vesical arteries, and the middle rectal artery. Branches can also run directly to the ureter from these abdominopelvic arteries. The peri-ureteral arteries of the first generation can be damaged during a preparation of the ureter. In less than one third of the ureters the external vascular picture is only of an arterial plexus with no prominent peri-ureteral arteries [339, 821].

Second Generation. These adventitial arteries are anastomoses of the vessels of the first generation with a diameter of 100–200 μm [339], are arranged in the manner of a network around the ureter, and extend from the renal pelvis to the urinary bladder.

Third Generation. This consists of arteries with a diameter of about 25 μm [339] budding into the muscularis from the second generation arteries (adventitial plexus). Anastomoses within this third generation are less common than anastomoses within the first and second generations [297, 374, 806] and cannot always be reliably detected [649]. In *Sampson's* [805] investigations these arterial anastomoses were not even found within the tunica muscularis. It should be noted, however, that to visualize the arteries, *Sampson* [805] used ultramarine granulate, which does not penetrate into the smallest vessels. A point of practical importance is that the arteries in the muscularis (third generation), in contrast to the longitudinal peri-ureteral arteries of the first generation, are protected during a preparation of the ureter and can only be destroyed by direct trauma.

Finally, arterial anastomoses are also detectable in the submucosa [950]. In all the wall layers of the ureter the vessel density increases in the craniocaudal direction [216, 374, 739].

Venous Vascularization of the Ureter

The veins run parallel to the arteries and have good anastomoses because of the peri-ureteral plexus [649, 805].

Arterial Vascularization of the Urinary Bladder

The apex and the lateral parts of the bladder are supplied by the cranial vesical artery [922]. This originates from the umbilical artery, which in turn comes from the internal iliac artery. The umbilical artery, which is obliterated further in the distal direction, continues to the navel beside the chorda urachi as the lateral umbilical fold (lateral umbilicovesical ligament) [543]. The fundus of the bladder is supplied by the caudal vesical artery, which originates from the internal iliac artery [922]. There are anastomoses between the cranial vesical artery and the caudal vesical artery.

Arterial Vascularization of the Urethra

The urethra is supplied segmentally, i.e. the cranial third via branches of the a. vesicalis caudalis, the middle third via branches of the a. vaginalis media, and the caudal third via branches of the a. pudenda. These segments are connected with one another via arterial anastomoses [374].