

# Contents

## SECTION 1

## BASICS AND ANATOMICAL ASPECTS OF ENDOSCOPIC SURGERY

<b>Chapter 1. Historical Perspectives .....</b>	<b>3</b>
<i>Liselotte Mettler, Manfred Schollmeyer</i>	
<b>Chapter 2. Clinical Anatomy for Gynecological Laparoscopic Surgery .....</b>	<b>15</b>
<i>Johannes Ackermann, Ibrahim Alkatout, Thilo Wedel</i>	
▪ Abdominal Wall and Trocar Placement	15
▪ Female Pelvic Cavity and Organs	15
▪ Anatomic Topography, Vascularization and Innervation of the Ureter	18
▪ Vascularization of the Female Pelvis	19
▪ Autonomic Innervation of the Female Pelvis	20
▪ Pelvic and Para-aortic Lymph Node Compartments	21
<b>Chapter 3. Instruments and Equipment for Laparoscopic Surgery: Apparatus and Optic Holders.....</b>	<b>25</b>
<i>Liselotte Mettler</i>	
▪ Instruments (Basic Equipment)	27
▪ Instruments for Perforation	27
▪ Dilatation Instruments	28
▪ Holding and Grasping Instruments and Screws	28
▪ Cutting Instruments	28
▪ Suction and Irrigation Instruments	29
▪ Morcellation Instruments	29
▪ Instruments for Hemostasis	30
▪ Instruments for Clamping Large Vessels: Emergency Needle	30
▪ Instruments for Drainage	30
▪ Instruments for Uterine Manipulation	31
▪ Lenses and Endoscopes	32
▪ Energy Systems for Operative Laparoscopy (Electrosurgery and Thermofusion)	33
▪ Laser	35
▪ Endocoagulation	36
▪ Harmonic Scalpel: Ultrasonic Energy	36
▪ Microendoscopy	37
▪ Robotic Endoscopic Surgery	37
▪ Articulated Instruments	38
▪ Single-port Endoscopic Entry (SEL)	40
<b>Chapter 4. Practical Approach to Instrumentation .....</b>	<b>44</b>
<i>Ibrahim Alkatout, Liselotte Mettler</i>	
▪ Laparoscopy	44
▪ Hysteroscopy	49
▪ Image Processing Systems	51
▪ Operating Team and General Instruments	57

- Special Instruments **61**
- A Few Supplementary Instruments and their Specific Uses **73**

## **Chapter 5. Current Laparoscopic Training Models ..... 78**

*Andreas Hackethal, Julia Ionesi-Pasacica, Hans-Rudolf Tinneberg*

- Pelvittraining and Video Training **78**
- Virtual Reality Training **79**

## **Chapter 6. Learning by Doing: How to Teach Laparoscopic Surgery? ..... 83**

*Carolyn Spüntrup, Marc Banerjee, Elmar Spüntrup*

- Optimized Learning and Coaching Process using Behavioral Scientific Findings **83**
- Tripartitude of Novice, Junior and Expert: Definition of Training Aims at Different Training Levels **83**
- How to Control Training Success? **84**
- Training Systems **85**
- Outlook **90**

## **Chapter 7. Training in Minimally Invasive Gynecological Surgery ..... 92**

*Abhishek Mangeshkar*

- Why Laparoscopy Needs Training? **92**
- Learning Curve for Laparoscopic Gynecological Surgery **93**
- Essentials of Curriculum-based Training **93**
- Learning Modes **93**
- Training Module **96**

## **Chapter 8. Current Training Models in Hysteroscopy ..... 98**

*Flemming Bjerrum, Lotte Clevin*

- Theoretical Curriculum **98**
- Hands-on Training Models **98**
- Assessment of Hysteroscopic Skills before Operating on Patients **101**

## **Chapter 9. Risk Assessment and Counseling Prior to Laparoscopic Surgery ..... 104**

*Ibrahim Alkatout, Liselotte Mettler*

- The Doctor–Patient Relationship is the Basis of All Fields of Interaction **104**
- Creating the Doctor–Patient Relationship **105**
- Techniques of Conducting a Doctor's Conversation with the Patient from the Viewpoint of Autonomy **106**
- Individual Requirements of the Doctor in a Patient-centered Doctor–Patient Relationship **107**
- The Doctor–Patient Relationship in Oncology **108**
- The Doctor–Patient Relationship in Obstetrics from the Invasive Point of View **110**
- Endangerment of the Doctor–Patient Relationship **111**
- Conclusion and Future Perspectives for Medical Practice **111**

## **Chapter 10. Peritoneal Access ..... 114**

*Liselotte Mettler, Bruno van Herendael, Andrea Tinelli, Antonio Malvasi, Artin Ternamian*

- Principle of Endoscopic Threaded Imaging Port (EndoTIP) **115**
- Procedure **115**
- EndoTIP Removal **116**
- Indications **117**
- Advantages **117**
- Gynecological Laparoscopy: Imaging and Capno Peritoneum **118**
- Laparoscopic Robotic Surgery **118**

- Abdominal Entry Safety Steps 119
- Abdominal Entry Possibilities 121
- Single-port Entry = Single-entry Laparoscopy (SEL) 122
- Pneumoperitoneum 124
- Closed Laparoscopic Abdominal Entry 124
- Radially Expanding Trocars 125
- Complications and Laceration Possibilities during First Access 125
- Case Report: Persistent Ductus Omphaloentericus 126
- Immediate Complications 128
- Case Report: Bowel Lesion 130
- Immediate Complications Occurring during Laparoscopy 130
- Prevention of Complications and Future Developments 134

## **Chapter 11. Risk Management in Gynecological Endoscopy..... 139**

*Artin Ternamian, MacLeod Natalie*

- Commitment to Risk Management 141
- Risk Severity Index 144
- Consenting 145
- Adverse Effects to be Included in Risk Management Initiatives 146
- Training 148
- Disclosure 148
- Information Technology Risk Management 149
- Risk Assessment 149
- Useful Terms 151

## **Chapter 12. Female Pelvis Innervation and Vascularization in Laparoscopy ..... 156**

*Andrea Tinelli, Radmila Sparić, Saša Kadija, Svetlana Spremović Radjenović,  
Ospan A Mynbaev, Michael Stark, Antonio Malvasi*

- Laparoscopy in Extra-peritoneal Spaces 156
- Vascularization and Lymphatic System in Laparoscopy 159
- Female Pelvic Nervous System 161

## **Chapter 13. Suturing and Ligature Techniques at Laparoscopy ..... 169**

*Liselotte Mettler, Goentje Peters, Tamer Seckin, Ibrahim Alkatout*

- Hemostasis by Loop Ligatures 169
- Hemostasis by Endoligature or Endosuture and Extracorporeal Knotting 169
- Hemostasis by Endosuture with Intracorporeal Knotting 171
- Hemostasis by Suture and Tying Knot with Half Hitch 173
- Needles and Sutures 173

## **Chapter 14. General Surgery Conditions and Techniques for Gyne-endoscopic Surgeons..... 181**

*John E Morrison*

- Abdominal and Pelvic Wall: Hernias 181
- Visceral Pathologies 190
- Other Topics 195

## **Chapter 15. Pneumoperitoneum: Known and Lesser-known Perspectives—Scope and Considerations..... 199**

*Douglas E Ott*

- So It Begins . . . 199
- Gas Chemistry: CO<sub>2</sub> Effects 201
- Physics: Intra-abdominal Pressure 202

- Jet Streaming **202**
- CO<sub>2</sub> Absorption **202**
- Hypothermia: Very Dry Gas, Temperature Differential and Evaporative Effects **203**
- Fulcrum Effect **204**
- Peritoneal Fluid **204**
- Adhesion Formation is a Misnomer: The Peritoneal Healing Process is Normal **205**
- Normal Changes due to a Surgical CO<sub>2</sub> Pneumoperitoneum **206**
- Complications **207**
- Subcutaneous Emphysema, Pneumomediastinum and Pneumothorax **208**
- Abdominal Wall Lifting—No Advantages **210**
- Facts about the Pneumoperitoneum **210**

**SECTION 2****SPECIFIC GYNECOLOGICAL LAPAROSCOPIC PROCEDURES****Chapter 16. Benign Ovarian Tumors..... 221***Saeed Alborzi, Bahareh Hamed*

- Preoperative Evaluation **221**
- Surgical Approach **222**
- Specific Considerations **222**
- Ovarian Torsion **226**
- Borderline and Malignant Ovarian Tumors **227**
- Ovarian Tumors in Pregnancy **227**
- Suturing in Ovarian Surgery **228**
- Laparoscopy Complications **228**

**Chapter 17. Ectopic Pregnancy..... 235***Ibrahim Alkatout, Liselotte Mettler*

- Etiology and Risk Factors **237**
- Diagnostics **237**
- Differential Diagnosis **241**
- Treatment **241**
- Preoperative Management **243**
- General Operative Beginning **243**
- Surgical Treatment of Tubal Pregnancy **244**
- Surgical Technique for Nontubal Ectopic Pregnancy **247**
- General Operative Steps after the Removal of Ectopic Pregnancy **252**
- Medical Treatment **252**
- Follow-up and Prognosis **253**
- Future Fertility and Risk of Recurrence **254**
- Tips of the Experts **254**

**Chapter 18. Laparoscopic Surgery in Pregnancy ..... 257***Wael Sammur, Liselotte Mettler*

- Indications for Laparoscopic Surgery during Pregnancy **257**
- Practical Considerations **259**
- Laparoscopic Management of Benign Adnexal Mass **259**
- Complications and Benefits of Laparoscopic Procedures in Pregnancy **260**

<b>Chapter 19. Extragenital Findings in Gynecological Laparoscopy .....</b>	<b>265</b>
<i>Ibrahim Alkatout, Frederike Egberts, Manfred Schollmeyer, Liselotte Mettler</i>	
▪ Step 1	<b>265</b>
▪ Step 2	<b>266</b>
▪ Step 3	<b>266</b>
▪ Step 4	<b>270</b>
▪ Step 5	<b>271</b>
▪ Step 6	<b>272</b>
▪ Step 7	<b>273</b>
▪ Step 8	<b>273</b>
▪ Step 9	<b>278</b>
<b>Chapter 20. Tubal Surgery .....</b>	<b>284</b>
<i>Sanjay Patel</i>	
▪ Types of Tubal Surgery	<b>284</b>
▪ Hysteroscopic Tubal Cannulation	<b>284</b>
▪ Laparoscopic Tubal Microsurgery	<b>285</b>
▪ Laparoscopic Salpingo-ovariolysis and Fimbrioplasty	<b>293</b>
<b>Chapter 21. Endoscopy Techniques for Tubal Sterilization .....</b>	<b>297</b>
<i>Parul Kotdawala, Janesh Gupta, Munjal Pandya</i>	
▪ Laparoscopic Route	<b>297</b>
▪ Transcervical or Transuterine Route	<b>297</b>
▪ Laparoscopic Techniques	<b>297</b>
▪ Hysteroscopic Sterilization or Transcervical Sterilization	<b>304</b>
▪ Other Methods of Historical Importance	<b>307</b>
<b>Chapter 22. Tubal Torsion: The Diagnostic Dilemma .....</b>	<b>311</b>
<i>Ibrahim Alkatout, Ivo Meinhold-Heerlein, Liselotte Mettler</i>	
▪ Operative Steps	<b>312</b>
▪ Summary and Complications	<b>316</b>
<b>Chapter 23. Endometriosis .....</b>	<b>318</b>
<i>Maria Fernanda Brancalion, Ibrahim Alkatout, Liselotte Mettler</i>	
▪ General Considerations	<b>319</b>
▪ Surgical Technique	<b>321</b>
<b>Chapter 24. Adenomyosis Treatment .....</b>	<b>336</b>
<i>Ibrahim Alkatout, Liselotte Mettler</i>	
▪ Epidemiology and Pathology	<b>337</b>
▪ Clinical Manifestations and Diagnosis	<b>338</b>
▪ Adenomyosis and Infertility	<b>339</b>
▪ Treatment	<b>341</b>
▪ Surgical Treatment of Adenomyosis of the Uterus	<b>344</b>
▪ Intrafascial Hysterectomy with Preservation of Existing Structures	<b>349</b>
▪ Postoperative Management	<b>379</b>
▪ Anticipated Problems	<b>380</b>

<b>Chapter 25. Surgical Aspects and Therapeutic Modalities of Deep Infiltrating Diagnosis .....</b>	<b>386</b>
<i>Ingo von Leffern</i>	
▪ Surgical Approaches and Instruments	387
▪ Die and Fertility	390
▪ Die of Sacrouterine Ligament	390
▪ Die Involving Nerves	391
▪ Die of the Ureter	393
▪ Die of the Bladder	395
▪ Die of the Recto-vaginal Space and Vagina	398
▪ Die of the Diaphragm or Pericardium	399
▪ Die of the Fallopian Tube	402
<b>Chapter 26. Adenomyoma Resection in Infertility.....</b>	<b>406</b>
<i>Sanjay Patel</i>	
▪ Classification	406
▪ Transvaginal Ultrasonography	406
▪ Adenoma on Laparoscopy	406
▪ Adenoma on Hysteroscopy	406
▪ Coexisting Pathologies	406
▪ Preoperative Adenoma Mapping	406
▪ Aim of Adenoma Resection	407
▪ Technique of Adenomyoma Resection	407
▪ Technique of Endosuturing: Intracorporeal Slip-knot Technique	408
▪ New Advancement	408
<b>Chapter 27. Diagnosis of Bowel Endometriosis.....</b>	<b>415</b>
<i>J Marek Doniec, Mathias SS Löhnert</i>	
▪ Is Endoscopic Screening Sufficient?	415
▪ Endorectal Ultrasound: Anatomic Structures and Findings in Endometriosis Patients	416
▪ Management of Rectal Endometriosis	418
<b>Chapter 28. Sentinel Lymph Node Detection .....</b>	<b>421</b>
<i>Andreas Hackethal, Hans-Rudolf Tinneberg</i>	
▪ Sentinel Node Biopsy in Clinical Use	421
▪ Conventional Sentinel Node Marker	422
▪ Gynecological Cancers	423
<b>Chapter 29. Laparoscopic Myomectomy .....</b>	<b>427</b>
<i>Alfonso Rossetti, Alessandro Loddo</i>	
▪ Operative Indications	428
▪ Preoperative Evaluation, Testing and Preparation	429
▪ Patient Positioning in the Operating Suite	431
▪ Operative Technique	433
▪ Operating Steps	434
▪ Results and Outcome	441
<b>Chapter 30. Specific Features of Myomectomy .....</b>	<b>445</b>
<i>Ibrahim Alkatout, Liselotte Mettler</i>	
▪ Genetics of Fibroids, Genotype and Phenotype	446
▪ Microscopic Facts and Fibroid Viability	446

- Costs of Fibroids **447**
- Why Hysterectomies in Fibroid Patients? **447**
- Review of All Uterine-preserving Treatment Possibilities for Fibroids **447**
- Counseling and Informed Consent **449**
- Myomectomy **449**
- Hysterectomy as Treatment for Myomas **455**

## **Chapter 31. Laparoscopic Myoma Therapy ..... 462**

*Garri Tchartchian, Bernd Bojahr, Khulkar Abdusattarova, De Wilde RL*

- Plastic Uterus Reconstruction after Laparoscopic Myomectomy **462**
- Laparoscopy-assisted Combined Hysterectomy (LACH) for Large Uteri with Changeover Technique **466**
- Laparoscopy-assisted Supracervical Hysterectomy (LASH) with Changeover Technique **468**

## **Chapter 32. Fertility-enhancing Endoscopic Surgeries..... 477**

*Meenu Agarwal*

- Polycystic Ovary Syndrome **477**
- Pelvic Adhesions **478**
- Myomectomy **479**
- Endometriosis **480**
- Hydrosalpinges **481**
- Hysteroscopic Surgeries **482**

## **Chapter 33. Technique of Routine Total Laparoscopic Hysterectomy with a Dissection of Uterine Vessels at Internal Iliac Level and Using a Uterine Manipulator..... 487**

*Bernd Holthaus, Susanne Denny*

- Preparation **487**
- Trocars, Instruments and the Start **487**
- Opening of Pelvic Sidewall **487**
- Identification and Dissection of Uterine Vessels at Internal Iliac Level **488**
- Dissection of Parametria and Sacrouterine Ligaments **489**
- With or Without Bilateral Salpingo-oophorectomy **489**
- Removal of Uterus **489**

## **Chapter 34. Total Laparoscopic Hysterectomy ..... 493**

*Liselotte Mettler, Ibrahim Alkatout, Mohamed Elessawy*

- Teaching Yesterday and Today **493**
- How to Learn Laparoscopic Hysterectomy? **494**

## **Chapter 35. Stepwise Approach to Total Laparoscopic Hysterectomy ..... 506**

*Ibrahim Alkatout, Liselotte Mettler*

- Total versus Subtotal (Supracervical) **511**
- Will the Fallopian Tubes or Ovaries be Removed in Hysterectomy? **518**
- Development of Laparoscopic Hysterectomy Techniques and Instruments **519**
- Preoperative Considerations and Preparation **519**
- Prerequisites **520**
- Laparoscopic Total Hysterectomy **528**
- Laparoscopic Subtotal Hysterectomy **538**
- Anticipated Problems **553**

<b>Chapter 36. Hysterectomies: Laparoscopic Subtotal Hysterectomy .....</b>	<b>559</b>
<i>Bernd Bojahr Pasacica, Garri Tchartchian, Khulkar Abdusattarova</i>	
▪ Surgical Procedure	<b>559</b>
▪ Complications	<b>569</b>
▪ Risk of Cervical Stump Cancer	<b>571</b>
▪ Risk of Unsuspected Malignancy	<b>572</b>
<b>Chapter 37. Transvaginal Natural Orifice Transluminal Endoscopic Surgery .....</b>	<b>576</b>
<i>Jan F Baekelandt</i>	
▪ Procedures	<b>576</b>
<b>Chapter 38. Overview of Endoscopic Pelvic Floor Defect Corrections.....</b>	<b>587</b>
<i>Guenter K Noé</i>	
▪ Sacral Fixation	<b>587</b>
▪ Bilateral Suspension	<b>589</b>
▪ Native Tissue Repair	<b>590</b>
<b>Chapter 39. Critical Evaluation of Mesh-supported Vaginal and Endoscopic Pelvic Floor Surgery .....</b>	<b>593</b>
<i>Bernd Holthaus, Haytham Elmeligy</i>	
▪ Symptoms	<b>593</b>
▪ Diagnosis	<b>593</b>
▪ Management	<b>594</b>
▪ Surgical Intervention	<b>594</b>
▪ Evaluation of Mesh	<b>595</b>
▪ German Guidelines	<b>596</b>
<b>Chapter 40. Surgery for Pelvic Floor Defects .....</b>	<b>598</b>
<i>Shanti I Mohling, CY Liu</i>	
▪ Anatomy	<b>599</b>
▪ Preoperative Evaluation	<b>600</b>
▪ Recognize Enterocele Prior to Surgery for Pelvic Organ Prolapse	<b>600</b>
▪ Laparoscopic Uterosacral Ligament Suspension for Pelvic Organ Prolapse	<b>601</b>
▪ Technique	<b>601</b>
▪ Postoperative Considerations	<b>605</b>
<b>Chapter 41. Laparoscopic Pectopexy .....</b>	<b>608</b>
<i>Guenter K Noé</i>	
▪ Preoperative Considerations	<b>608</b>
▪ Procedure	<b>609</b>
▪ Postoperative Treatment	<b>612</b>
▪ Equipment	<b>612</b>
<b>Chapter 42. Esthetic Aspects of Pelvic Floor Repair.....</b>	<b>616</b>
<i>Rupinder Kaur Ruprai, Alexandros Bader</i>	
▪ Pelvic Floor and Tissue Remodeling	<b>616</b>
▪ Biomolecular Changes and Clinical Impacts	<b>618</b>
▪ Histological Changes with Tissue Remodeling	<b>620</b>
▪ Traditional Undertaking of Pelvic Floor Repair: Addressing Repairs of Defects, Vaginal Length	<b>621</b>
▪ External Genitalia: Brief on Anatomy and Vascular Landmarks	<b>621</b>
▪ Surgical Correction: Objectives of Pelvic Floor Repair	<b>624</b>



- Common Esthetic Surgical Corrections **625**
- Pubic Enhancement **631**
- Practice Tips during Common Surgical Repairs **631**
- Bridging the Gap from Esthetics to Functionality: Tissue Remodeling Manipulation **634**
- Therapeutic Parameters **635**
- Classification of Devices **636**
- Clinical Applications of Energy-based Devices on Female Genitalia **637**
- Tips and Tricks with Laser **648**
- Optimizing Esthetic Results **649**
- Role of Hormones as Tissue Modulators **652**
- Role of Regenerative Medicine: Stem Cells, PRP **653**

## **Chapter 43. Oncologic Surgery on the Ovary ..... 663**

*Ivo Meinhold-Heerlein*

- Laparoscopy for Ovarian Malignancies **664**
- Indication and Preoperative Workup **667**
- Laparoscopic Procedures **668**
- Complications and Handling **669**

## **Chapter 44. Oncologic Surgery on the Uterus ..... 674**

*Shailesh Puntambekar, Seema Puntambekar, RM Sathe, Sambit Nanda, Raviraj Tiruke, Tejashree Bakre, Meenakshi Chate, Aishwarya Puntambekar*

- Laparoscopic Radical Hysterectomy **674**
- Laparoscopic Nerve-sparing Radical Hysterectomy **678**
- Anterior Exenteration **679**
- Posterior Exenteration **684**
- Total Pelvic Exenteration **685**
- Robotic Radical Hysterectomy **686**
- Single-incision Laparoscopic Radical Hysterectomy **688**

## **Chapter 45. Robot-assisted Surgery in Gynecology ..... 691**

*Kubilay Ertan*

- Global Application of the DaVinci® Systems **695**
- Recent Literature on DaVinci® Operations **696**
- Current Situation of Robot-assisted Laparoscopic Operations in Gynecology **700**

### **SECTION 3**

### **SPECIFIC HYSTEROSCOPIC PROCEDURES**

## **Chapter 46. Diagnostic and Office Hysteroscopy ..... 705**

*Lotte Clevin*

- Instruments and Equipment **705**
- Preparations **707**

## **Chapter 47. Laparoscopy and Hysteroscopy as Complementary Procedures ..... 717**

*Ibrahim Alkatout, Liselotte Mettler*

- Basic Concept **717**

## **Chapter 48. Operative Hysteroscopy ..... 747**

*Thomas Römer*

- Instrumentation and Technical Equipment **747**
- Technique and Procedure **747**
- Staff Requirements **747**

- Surgical Interventions **748**
- Diagnostics and Therapeutic Management in the Case of Suspected Intrauterine Adhesions **750**
- Postoperative Management after Intrauterine Electrosurgical Adhesiolysis **750**
- Bipolar Hysteroscopy **752**
- General Complications of Operative Hysteroscopy: Management and Prevention **753**

**SECTION 4****COMPLICATIONS IN LAPAROSCOPIC AND HYSTEROSCOPIC SURGERY****Chapter 49. Laparoscopic Complications and Management..... 757***Ibrahim Alkatout, Liselotte Mettler*

- Counseling and Informed Consent **757**
- Preconditions of Trocar Placement **757**
- Complications in Port Placement **759**

**Chapter 50. Complications of Hysteroscopy ..... 771***Parul Kotdawala, Nidhi Nagar*

- Incidence **771**
- Anesthesia **772**
- Patient Position **772**
- Distension Media **772**
- Tips to Prevent Media-related Complications **774**
- Mechanical or Traumatic Complications **775**
- Electrosurgical Complications **776**
- Postoperative and Late Complications **777**

*Index..... 779*

# Clinical Anatomy for Gynecological Laparoscopic Surgery

*Johannes Ackermann, Ibrahim Alkatout, Thilo Wedel*

## INTRODUCTION

Knowledge of human anatomy is a fundamental part in medical education of every physician. In particular, before disturbing the integrity of human body by surgical interventions, an awareness about anatomical structures and landmarks is of utmost importance. This prerequisite holds true especially for laparoscopic procedures in which anatomical structures are approached and addressed differently as compared to open surgery. Thus, the aim of this chapter is to highlight the topographic anatomy of female pelvis, providing a basis for both efficient and safe laparoscopic operations.

## ABDOMINAL WALL AND TROCAR PLACEMENT

Abdominal wall is the first natural barrier to be penetrated to gain access to peritoneal cavity or retroperitoneal space. Typical entry sites are predetermined by the topographic architecture of muscles, fasciae and blood vessels. The anterior abdominal wall is composed of three lateral muscles (external and internal oblique muscles, transverse abdominis muscle) and one ventral muscle (rectus abdominis muscle) on both sides separated along the midline by a connective tissue band (linea alba). From inside, abdominal musculature is covered by fascia transversalis, preperitoneal fat and peritoneum itself. Below umbilicus, the peritoneal layer displays five folds: median umbilical fold (obliterated urachus), two medial umbilical folds (obliterated umbilical arteries) and two lateral umbilical folds (inferior epigastric vessels) (Fig. 2.1).<sup>1</sup>

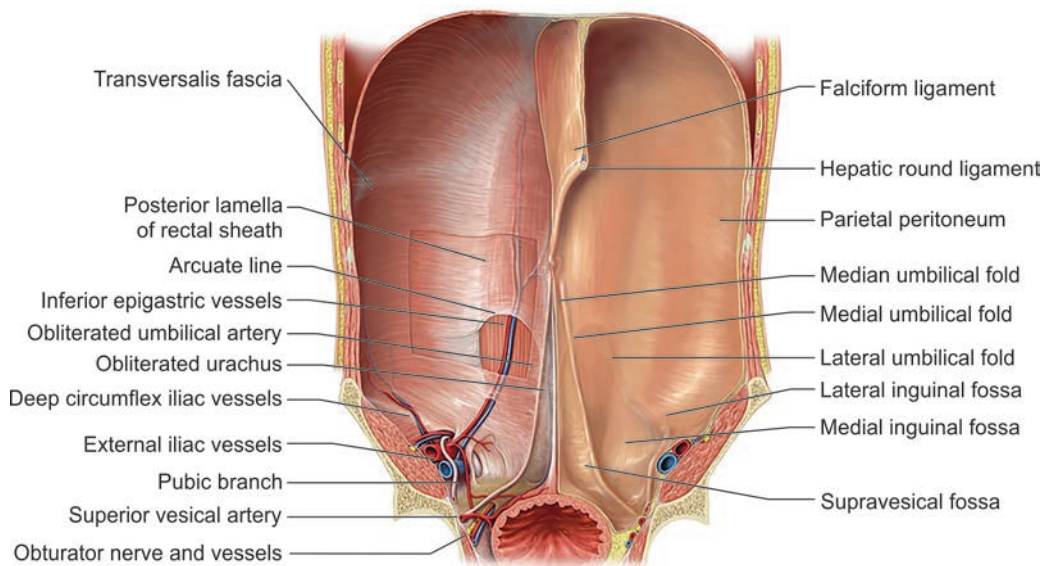
The first trocar entry to create pneumoperitoneum is usually performed at the lower part of

umbilicus. After the incision of cutis and subcutis, abdominal wall is lifted up and Veress needle is placed at a 45° angle to penetrate into abdominal cavity. Other systems provide an ability of direct entrance without the use of Veress needle. Nevertheless Veress needle represents state of the art for entering abdominal cavity. While crossing the abdominal wall layers, two successive losses of resistance ("jolts") are perceived, as the needle or trocar pierces muscular fascia and peritoneum. This twofold loss of resistance indicates correct access into peritoneal cavity avoiding a false inflation of pre- or extraperitoneal space.<sup>2</sup>

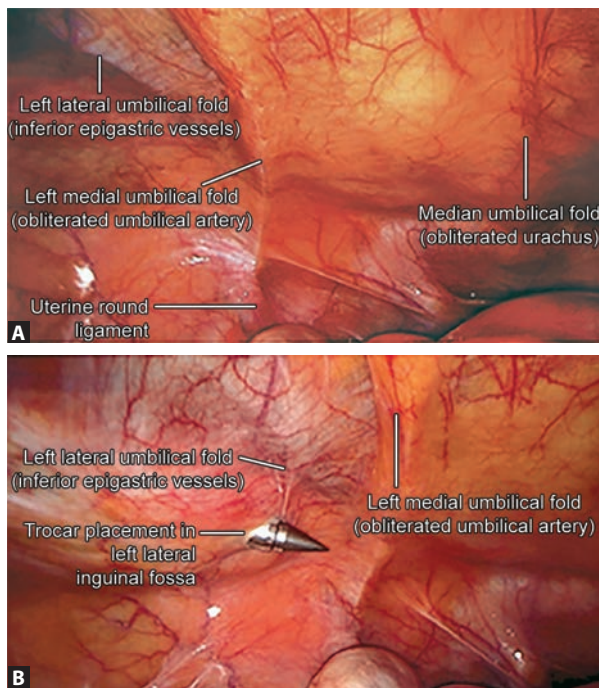
Placement of additional trocars depends on different procedures to be performed. Normally, trocars are placed in a triangle 10–15 cm lateral and inferior of umbilicus in the region of inguinal fossa. During passage of the abdominal wall, care has to be taken not to injure urinary bladder, especially when not completely emptied or closely attached to the abdominal wall by adhesions and intestine, in particular when peritoneal adhesions are present (Figs. 2.2A and B). Moreover, inferior epigastric vessels are at risk for injury, which can lead to significant bleeding.<sup>2</sup> Inferior epigastric vessels originate medially to the deep inguinal ring and ascend underneath the peritoneum and transversalis fascia to reach and enter rectus abdominis muscle.

## FEMALE PELVIC CAVITY AND ORGANS

The female pelvic cavity is divided into three compartments: an anterior compartment with urinary bladder and urethra, a middle compartment with uterus, adnexa and vagina, and a posterior compartment with rectum and anal canal (Fig. 2.3).<sup>1–4</sup> The *anterior compartment* is delimited in front by pubic



**Fig. 2.1:** Back side of the anterior abdominal wall.  
Reproduced from Schünke et al.<sup>13</sup>



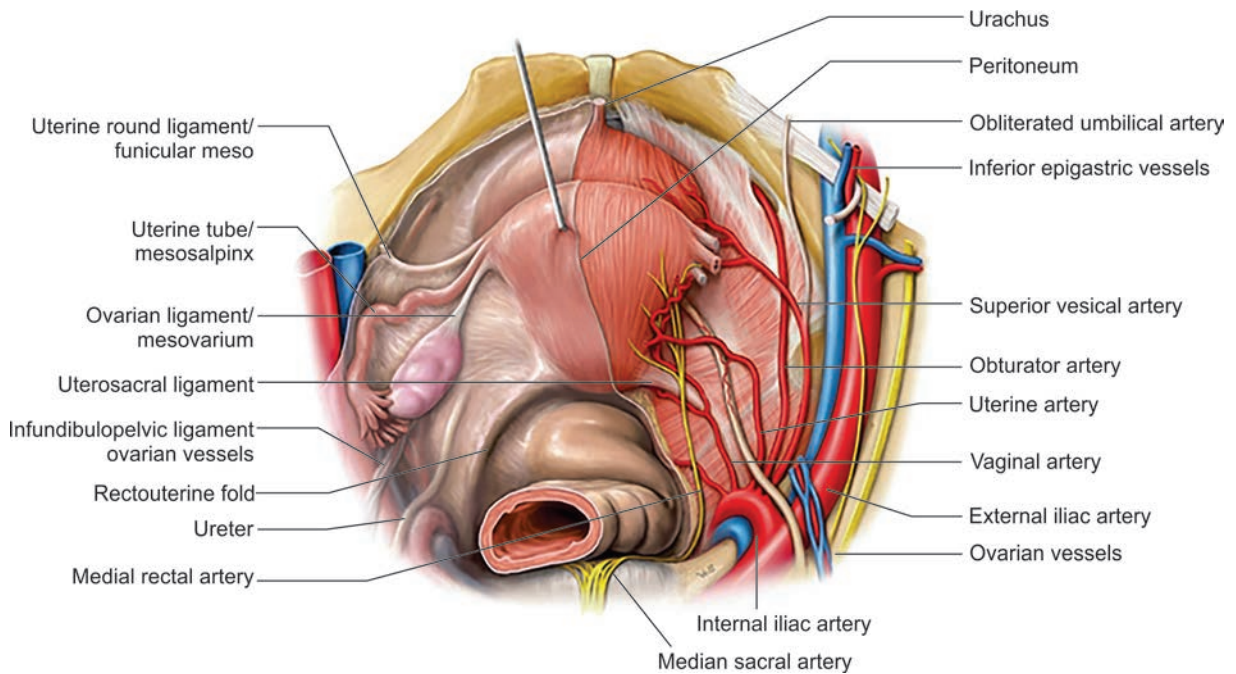
**Figs. 2.2A and B:** Laparoscopic view onto the left anterior abdominal wall. The three umbilical folds are discernible (A); the entry site of the trocar (B) is lateral to the lateral umbilical fold.

bone and prevesical space and laterally by pelvic sidewall comprising pectineal ligament (Cooper's ligament) and internal obturator muscle. Between the dorsal wall of urinary bladder and urethra and the anterior vaginal wall extends the vesicovaginal/urethrovaginal septum. The *middle compartment* extends between vesicovaginal/urethrovaginal septum and rectovaginal septum and contains uterus,

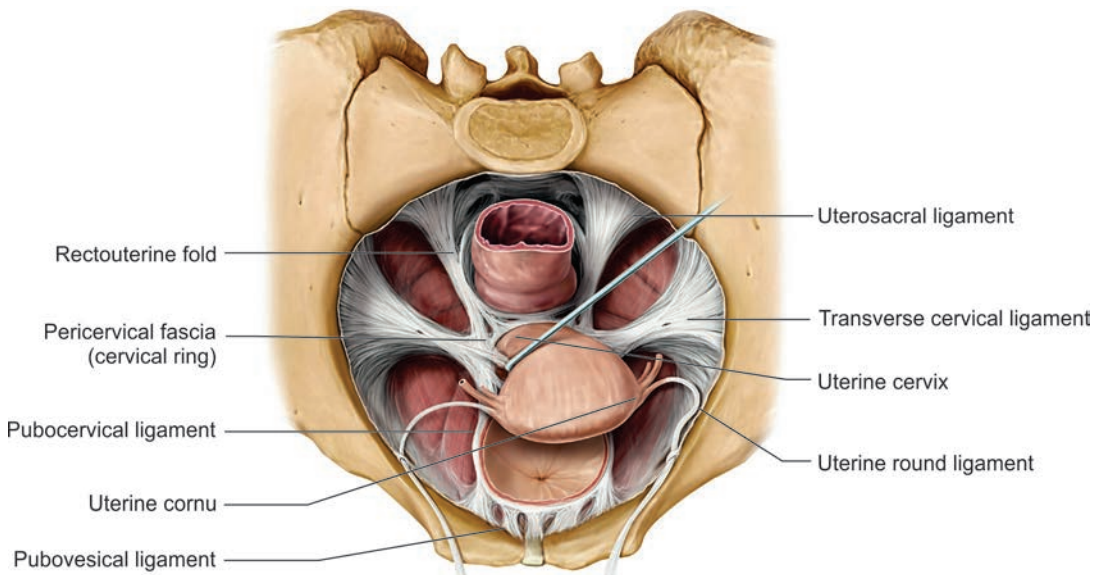
uterine tubes, ovaries and vagina. Ureter crosses the middle compartment at the level of uterine cervix to reach vesical trigonum. Behind rectovaginal septum extends the *posterior compartment* containing ano-rectum surrounded by perirectal fascias. The dorsal compartment is delimited posteriorly by the concave surface of the sacral bone covered by presacral fascia and blood vessels.<sup>5</sup>

The uterovaginal complex is supported by pelvic floor and additionally fixed to pelvic wall by *uterine ligaments* (Fig. 2.4). Uterine ligaments comprise broad ligament, uterine round ligament, transverse cervical ligament, uterosacral ligament and pubo-cervical ligament. The *broad ligament* is a wide-stretched connection between the middle pelvic compartment and pelvic sidewall. It displays three peritoneal folds on each side converging from different origins of inner abdominal and pelvic walls toward the uterine cornu. These folds include funicular meso (anterior fold), mesosalpinx (middle fold) and mesovarium (posterior fold). The *uterine round ligament* extends from uterine fundus below and lateral to uterine cornu to deep inguinal ring and is accompanied by a branch from uterine artery and lymphatic vessels draining into superficial inguinal lymph nodes. The *transverse cervical ligament* (*cardinal ligament of Mackenroth*) connects uterine cervix and vaginal fornix to pelvic sidewall. Besides its mechanical function, it represents a main route of vascular, lymphatic and nervous supply to uterus. The *uterosacral ligament* attaches to uterine cervix and upper vagina and extends along rectal sidewall





**Fig. 2.3:** Cranial view into the female pelvic cavity. The peritoneum, uterine adnexa and parametrial tissue are removed on the right side to expose the pelvic arteries, ureter and pelvic autonomic nerves. Reproduced from Schünke et al.<sup>13</sup>



**Fig. 2.4:** Uterine ligaments. The rectum and urinary bladder are cut transversely, the uterus is shifted to the left side. Reproduced from Schünke et al.<sup>13</sup>

toward sacrum before inserting at lower sacral vertebrae. The *pubocervical ligament* connects the pubic bone with uterine cervix running along urethra and bladder neck.<sup>6-9</sup>

*Mesometrium* is an embryologically defined tissue compartment comprising the neurovascular supply and major lymphatic drainage routes of the uterus. The clinical significance of mesometrium

has received special attention after the introduction of total mesometrial resection (TMME) for uterine cancer. Mesometrium can be subdivided into vascular mesometrium containing the uterine blood vessels and surrounding lymphofatty tissue with mesometrial lymph nodes and ligamentous mesometrium corresponding to uterosacral ligaments and rectovaginal septum. Surgical approach is based on

the concept that tumor spread is initially confined to permissive ontogenetic compartments and its corresponding lymph node basins, so that complete removal of these embryologically defined tissue compartments results in an optimal tumor control with low morbidity.<sup>10,11</sup>

## ANATOMIC TOPOGRAPHY, VASCULARIZATION AND INNERVATION OF THE URETER

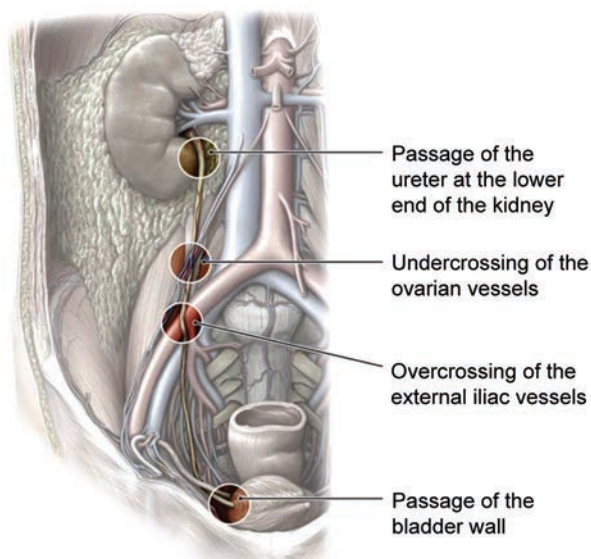
As ureter crosses the middle pelvic compartment, knowledge of its topographic anatomy and relationship to other organs and structures is essential for safe and considerate laparoscopic surgery. Reasons for high vulnerability of ureter are its considerably long course (25–30 cm) along the interface between retro- and intraperitoneal space, its morphological appearance and size similar to vascular structures, as well as relatively common congenital anomalies (e.g., ureter duplex, ureter fissus, crossed ureter, retrocaval ureter).<sup>2,12</sup>

*Abdominal segment* (Fig. 2.5) originates from renal pelvis and extends to pelvic brim in front of psoas muscle. The course of ureter may vary from a paravertebral position close to either the vena cava or aorta to a lateral position along the outer border of psoas muscle. Ureter is crossed anteriorly by ovarian blood vessels and posteriorly by genitofemoral nerve. On the left side, ureter additionally under-

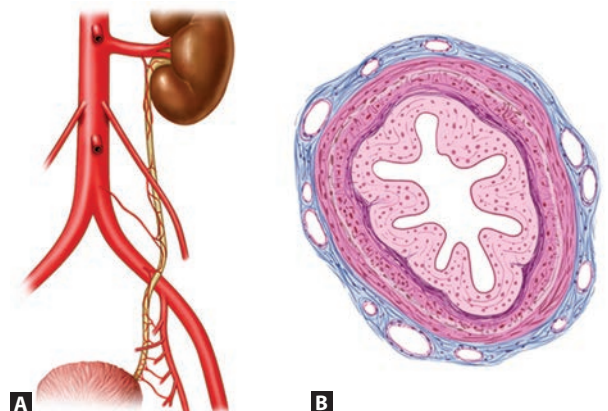
crosses the root of sigmoid mesocolon and inferior mesenteric pedicle. On both sides, there is a close relationship between ureter and infundibulopelvic ligament. Thus, care should be taken to protect ureter underneath its peritoneal fold when mobilizing uterine adnexa.<sup>12</sup>

The *pelvic segment* (Figs. 2.3 and 2.5) enters pelvic cavity anterior to common iliac artery on the left side and anterior to external iliac artery on the right side. Ureter further descends underneath peritoneum and is related laterally to the branches of internal iliac artery (obturator, superior vesical and uterine artery) and obturator nerve and medially to uterosacral ligament and its corresponding rectouterine fold as well as to inferior hypogastric plexus (*see* Fig. 2.8). Before reaching urinary bladder via vesicouterine ligament, the ureter has to undercross uterine artery in anterior oblique direction at the angle of vaginal fornix (para- cervix). Because of its close relationship to uterine cervix and artery, great attention has to be paid to this area for the integrity of the ureter.<sup>13</sup>

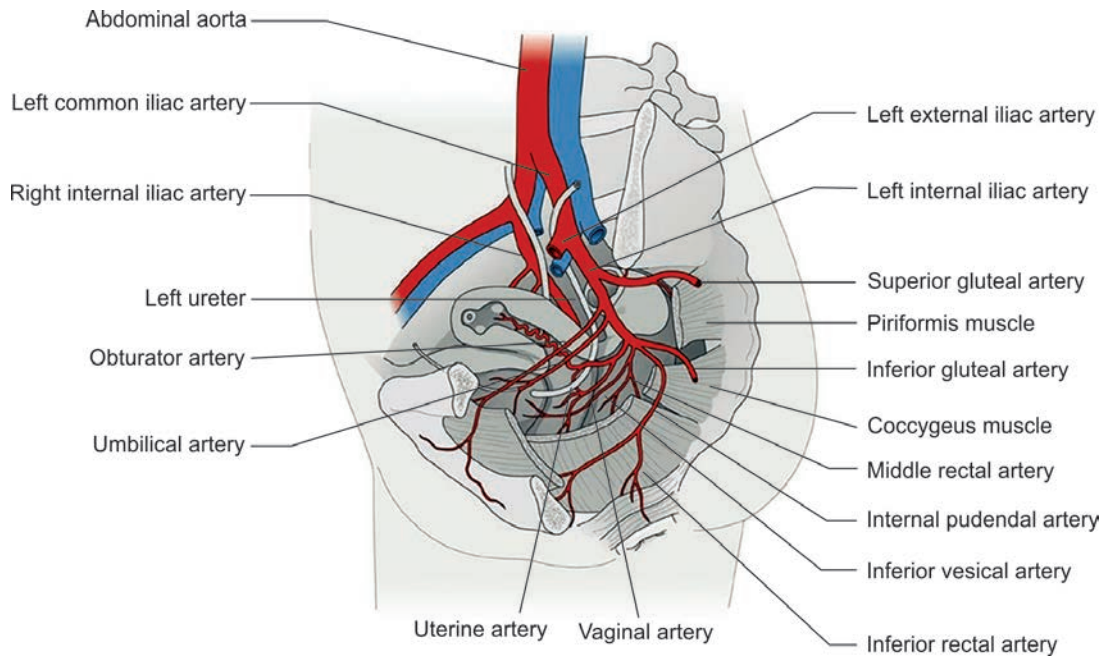
*Vascularization of ureter* is supplied by various sources of blood vessels due to its considerable length, including branches from aorta, renal, ovarian and internal iliac arteries. Whereas arteries approach the abdominal segment of ureter from the medial side, the pelvic segment is supplied by arteries originating from the lateral side (Figs. 2.6A and B). Consequently, when mobilizing or dissecting ureter, this principle has to be taken into consideration to preserve the blood vessels. Although interruption of one of many blood supply sources can be compensated by an anastomotic system running within the adventitial layer, excessive denudation of ureter over a long distance should be avoided.<sup>2</sup>



**Fig. 2.5:** Anatomical relationships of the ureter. Localization of common ureteric injuries.  
Reproduced from Schünke et al.<sup>13</sup>



**Figs. 2.6A and B:** Vascularization of the ureter (A); cross-section of the ureter (B).



**Fig. 2.7:** Branches of the internal iliac artery in the female pelvis. Reproduced from Schünke et al.<sup>13</sup>

Nerve fibers responsible for the *autonomic innervation* of ureter derive from renal, superior and inferior hypogastric plexus mediating its peristaltic movements and pain perception. Furthermore, to prevent urinary bladder dysfunctions due to injury of vesical nerve plexus, manipulation of distal ureter at the region of vesicoureteric junction and vesical trigone should be avoided.<sup>12</sup>

## VASCULARIZATION OF THE FEMALE PELVIS

Female pelvic organs are mainly supplied by internal iliac arteries (Fig. 2.7). The common iliac arteries originate at aortic bifurcation in front of the left side of fourth lumbar vertebra. They pass along the medial borders of psoas major muscle without giving off major branches and diverge into external and internal iliac arteries. Whereas external iliac arteries follow psoas major muscle until traversing lacuna vasorum through femoral ring to reach the lower limb, internal iliac arteries descend into pelvic cavity in a posterocaudal direction and then divide into anterior and posterior trunk. To expose internal iliac artery, the adjacent and sometimes overlying infundibulopelvic ligament and ovary have to be shifted upward. The common, external and internal iliac veins are located medially or dorsomedially to their arterial counterparts.<sup>3</sup>

The anterior trunk of internal iliac artery comprises the following branches: superior vesical artery, uterine artery, vaginal artery, middle rectal artery, obturator artery, internal pudendal artery and inferior gluteal artery (Fig. 2.7). Frequently, an anastomotic connection between obturator and inferior epigastric artery is provided by a pubic branch running across the pubic bone over pectineal ligament. This anastomotic branch is also termed as corona mortis ("crown of death"), because in earlier times of surgery, an inadvertent injury of this vessel led to serious bleedings during inguinal or femoral hernia repair.<sup>3</sup> The posterior trunk of internal iliac artery comprises iliolumbar artery, lateral sacral arteries and superior gluteal artery (Fig. 2.7).<sup>3</sup>

As a general rule, larger veins such as the common, external and internal iliac veins follow the course of their arterial counterparts. In most cases, veins run medially or dorsomedially to arteries. The same observation holds true for most of the parietal branches (e.g., obturator, pudendal, gluteal veins) of internal iliac artery; whereas visceral branches display different features: urinary bladder, uterus and vagina are drained by venous plexus, which are interconnected with each other and release blood into multiple vesical, vaginal and uterine veins. These veins do not strictly accompany and run parallel to the arteries until they enter internal iliac vein.<sup>3</sup>



It has to be emphasized that during laparoscopic surgery requiring pneumoperitoneum, pelvic veins often collapse due to intraperitoneal pressure exerted onto the thin venous walls. Thus, special care must be taken to clearly identify and respect pelvic veins, because injury may occur inadvertently and lead to troublesome bleeding sometimes only evident after diminishing the intraperitoneal pressure.<sup>2</sup>

## AUTONOMIC INNERVATION OF THE FEMALE PELVIS

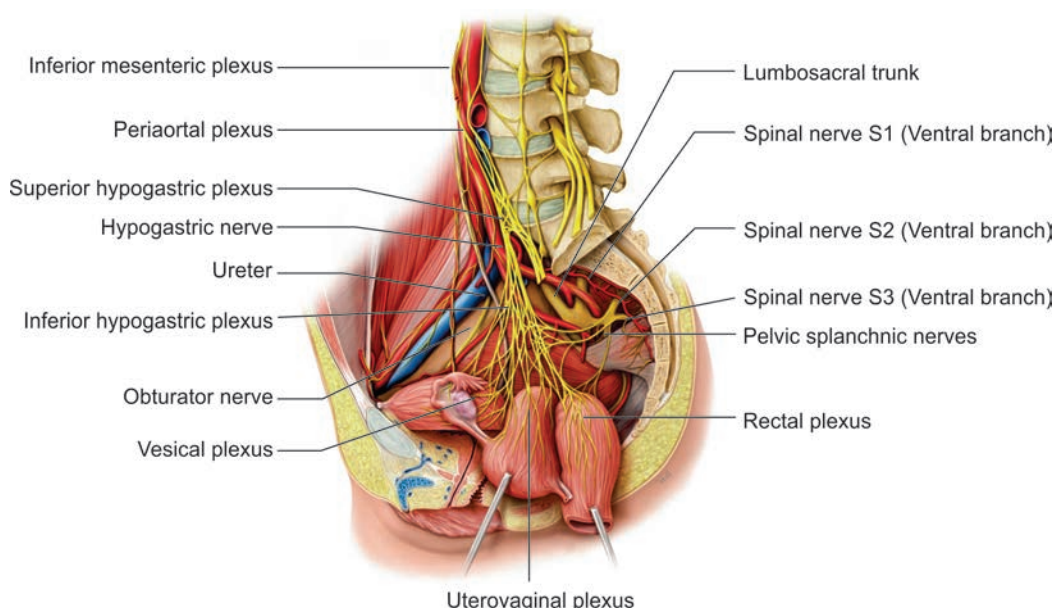
The challenge of oncologic surgery is to aim at the highest radicalness to ensure curative therapy and lowest loss of function to maintain quality of life after surgery. Therefore, it is essential to take care of the preservation of pelvic sympathetic and parasympathetic nerves. The integrity of this autonomic nervous system is essential for the maintenance of urinary continence and urinary bladder function as well as of sexual and anorectal functions.<sup>14,15</sup>

The preganglionic *sympathetic nerve fibers* emerge from lower lumbar and upper sacral spinal cord segments and pass along aorta on both sides as periaortic trunks. The periaortic nervous network fuses ventrolaterally to aorta to form inferior mesenteric and superior hypogastric plexus. In front of promontorium and slightly left to midline, superior hypogastric plexus divides into left and right hypogastric nerves. Hypogastric nerves often consist

of various nerve bundles and are embedded within parietal pelvic fascia extending in front of the sacral concavity. Gentle traction of hypogastric nerve will lift up this fascial sheath in a tent-like fashion thereby enabling to follow its course along the pelvic sidewall down to inferior hypogastric plexus (Fig. 2.8).<sup>16</sup>

*Parasympathetic nerves* derive from sacral part of the parasympathetic nervous system residing in sacral spinal cord. Together with ventral branches of sacral spinal nerves S2–S4, these pelvic splanchnic nerves leave ventral sacral foramina and pierce parietal pelvic fascia on both sides to join the hypogastric nerves. Pelvic splanchnic nerves coming from dorsocaudally and the hypogastric nerves coming from dorsocranially converge to form inferior hypogastric plexus (Fig. 2.8).

*Inferior hypogastric plexus* is a mixed autonomic nerve plexus composed of both sympathetic and parasympathetic nerves and is embedded within parietal pelvic fascia covering the pelvic sidewalls. The nervous meshwork extends medially to internal iliac artery and gives off multiple branches to the pelvic organs. Posteriorly, *rectal plexus* diverges at the level of rectal ligaments and enters the rectal wall accompanied by middle rectal artery. Anteriorly, inferior hypogastric plexus releases a lateral and medial trunk. Lateral trunk corresponds to vesical plexus running toward the bladder—lateral and underneath the ureter. The nerve bundles follow branches of vesical artery and further ramify to innervate distal ure-



**Fig. 2.8:** Autonomic nerve supply of female pelvic viscera. Uterus and rectum are shifted to the left side to expose the pelvic autonomic nerve plexus.

Reproduced from Schünke et al.<sup>13</sup>