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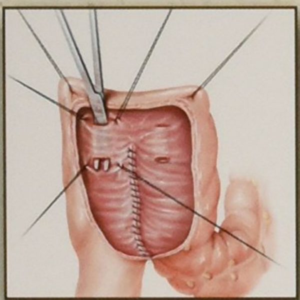
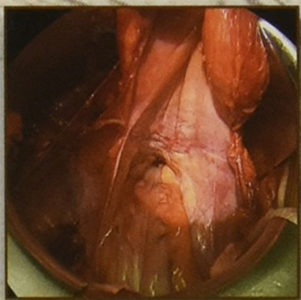
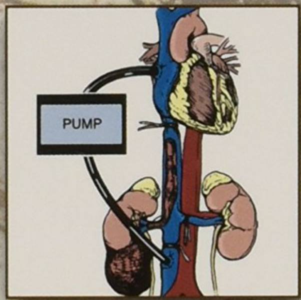
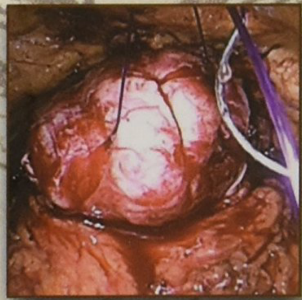
Fourth Edition

HINMAN'S ATLAS OF UROLOGIC SURGERY









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Dedication

Professor John Fitzpatrick was for decades one of the best-known urologists in the world. He was a major contributor to the field, and he was unparalleled in his conviviality. His gregarious nature and ubiquitous presence around the world permitted him to present and discuss his work at many major universities and as part of virtually every major urology meeting. His own department in Dublin was widely respected and thrived under his leadership. He served as editor of the *British Journal of Urology International*.

John Fitzpatrick was without question a bon vivant but he was also recognized as a premiere surgeon. In recognition of what he had contributed to urologic surgery and the respect with which he was viewed, John was asked to write the Foreword for the third edition of *Hinman's Atlas of Urologic Surgery*. His words perfectly provided valuable context on the role of the text in urologic surgery.

Tragically, he passed away suddenly on May 14, 2014.

All of the editors knew John, had enormous respect for him, and considered him a friend. We are honored to dedicate this edition to his memory.

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Foreword

The present 4th edition of *Hinman's Atlas of Urologic Surgery* is once again a great achievement by the editors as well as the authors of its chapters. It hardly seems possible, but this edition is in many respects even better than its predecessor. Many chapters have been updated and new chapters added without deviating from one of the main reasons for the prior success of *Hinman's Atlas*, the step-by-step description of surgical procedures accompanied by didactically perfect illustrations. Despite its covering all relevant urologic procedures, the present edition does not provide a mere overview, but a comprehensive, richly illustrated atlas, with all its chapters written by masters in the fields of their subspecialties. It is therefore not only an excellent urologic surgery textbook for junior urologists, but also a useful reference book for experienced surgeons. And, the e-textbook-version allows a quick search of the text and figures as well as online access to the procedural videos.

While this edition of *Hinman's Atlas of Urologic Surgery* again achieves perfection in the teaching of urologic surgery procedures and will certainly help younger urologists to attain results approaching those of the masters in the field, some basic principles essential to successful surgery cannot be illustrated in a textbook, but must be equally respected. Principles such as:

- Know where you are anatomically, in which plane, and where adjacent structures such as vessels or ureters are.
- Know what you want to do, what your next surgical step must be, and then be sure to finish it. Do not be tempted to start another easier step before you have finished the step you are on.
- Do not begin the next surgical step just anywhere, but start along known anatomic structures, such as vessels, bones, or muscle layers.
- Dissect parallel to known structures such as nerves and veins and not perpendicular to them.
- Never try to see what will happen if you cut further and if you are not sure what it is you are cutting. Rather stay along known structures. Approach the unknown or the stuck mass from another side.
- In case of an unexpected acute bleeder take a large gauze (and not the sucker) and compress it, get your instruments or sutures ready, and then remove the gauze starting on one side only until the cause of bleeding is located and can be treated adequately.
- Minimize surgical trauma by making sharp incisions instead of tearing the tissue and by using bipolar instead of monopolar electrocautery.
- Minimize unnecessary damage to adjacent tissues and organs or to their neurovascular supply.
- Significantly reduce blood loss and postoperative complications by counteracting the anesthesia/analgesia-induced vasodilation with continuous administration of vasoactive agents instead of overhydrating the patient with electrolyte solutions that can cause interstitial edema, an important cause of postoperative complications.
- Patient care does not end when surgical gloves are removed, it ends when the patient leaves the hospital. Don't wait for postoperative complications to occur before reacting; proactive management is essential, irrespective of the surgical technique or instruments used.

Such principles – and many more – are prerequisites to keeping the complication rate low after urologic surgery. To ensure success, however, the surgical procedure itself must adhere to a meticulous step-by-step technique. And this could not have been better explained than has been done in this 4th edition of *Hinman's Atlas of Urologic Surgery*. The editors are to be commended for having rejuvenated and updated this surgical atlas, which once again sets new standards in the field of urologic surgery.

Urs E. Studer, MD
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Preface

A surgical atlas provides the perfect example of how much things change but also how much they remain the same. Surgical principles are timeless and apply regardless of surgical approach. Further, they are not altered for different surgical procedures. Nonetheless, the operations performed in urologic surgery change constantly. Sometimes this is because of new instrumentation or novel surgical approaches. But it is also true that knowledge continues to evolve about disease processes and surgical treatment adapts accordingly.

Hinman's Atlas of Urologic Surgery has served for three decades as an essential text for both novice and experienced surgeons who perform procedures involving the genitourinary system. This fourth edition continues the tradition of *Hinman's* as the most up-to-date and comprehensive reference for urologic surgery. Although the third edition was published only 5 years ago, enough has occurred that a new edition was needed to keep pace.

Hinman's has always relied upon the quality of the illustrations and drawings to convey the information about surgical steps. This edition makes even more use of color in the illustrations. It offers more operative photographs and supplements them with corresponding illustrations. In addition, there are videos to expand upon the information provided in the text.

This is a how-to surgical atlas. Authors take the reader through each important step of the operation and describe in the narrative text as well as the illustrations and photographs the sequential techniques for safe and successful completion of the procedure. Importantly, preoperative evaluation and key postoperative management strategies are presented. An essential part of the book is the commentary that accompanies each chapter. Perspective is provided by a recognized expert to put the chapter in context and to underscore key points.

A number of new chapters are included. Robotic radical cystectomy and urinary diversion, procedures becoming more widely adopted, are described in detail. The landscape of prostate cancer treatment is changing; the techniques for MRI targeted biopsy and for methods of focal therapy are included. The male sling procedure is now commonly performed and is covered. Botox injection has drastically changed management of many aspects of voiding dysfunction and now is covered in a dedicated chapter. Chapters on simple retropubic and suprapubic prostatectomy remain but the book now includes a chapter about robotic simple prostatectomy. These are just some of the examples of new materials. Virtually all of the chapters included in the last edition have been revised and updated significantly.

Methods of communication in society as well as medicine are changing at an almost unimaginable rate. Nonetheless, the necessity for a surgical atlas such as *Hinman's* has not changed. Videos of operations are available through the internet or educational programs from many of the urological organizations. Somehow, though, neither videos nor operative photographs alone substitute for quality illustrations and drawings when it comes to describing surgical steps. The opportunity to study an illustration and match it with the corresponding narrative description can often provide better clarity than watching video of an operation.

In addition, urologic surgery becomes more complex every year. Some decades ago, a urologic surgeon could reasonably be expected to be competent or adept at virtually all of the procedures performed in the specialty. That is now an unrealistic prospect. This heightens the significance of a surgical atlas. A novice surgeon can study the steps of the various procedures and understand why they are important. An experienced surgeon even more appreciates the nuances that can be learned from review and descriptions of surgical technique and steps.

This is a weighty text, both literally and figuratively. Producing a comprehensive atlas of this magnitude requires the dedicated effort of many people. I am indebted to the Associate Editors of this 4th edition of *Hinman's Atlas of Urologic Surgery:* Roger R. Dmochowski, Glenn M. Preminger, and Stuart S. Howards. They all played essential roles in planning and review of the book. The greatest appreciation goes to the authors of the chapters. They have been willing to put forth the effort to inform and instruct colleagues. The commentators have provided the authority and perspective needed to place each chapter in contemporary context. Finally, our partners at Elsevier have done a great job of keeping the book on track but, even more important, providing wise counsel of how best to construct it.

The ultimate goal of *Hinman's Atlas of Urologic Surgery* is to help surgeons obtain the best results possible. A covenant of trust exists between a patient and a surgeon. Part of that trust is expectation that the surgeon will do everything possible to have the knowledge, proficiency, and skills to conduct a specific operation. That is what the editors of this 4th edition of *Hinman's Atlas of Urologic Surgery* want to help achieve.

Joseph A. Smith, Jr., MD
Editor

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Surgical Basics CHAPTER 1

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STRATEGY AND TACTICS

Perhaps at no time since the advent of transurethral prostatectomy by Dr. Hugh Hampton Young more than a century ago has the repertoire of urologic techniques advanced as rapidly as during the last decade. Today's urologist has access to a vast array of ever-expanding technologies, with seemingly novel iterations presented every week. Minimally invasive approaches have replaced several time-honored fundamental urologic procedures. The manual and mental skills required to appropriately evaluate and perform these advanced procedures has generated a substantial increase in expectations for urologists and their patients. For the contemporary urologist, choosing a correct operative strategy now incorporates not only appreciation of historical methods but also a critical evaluation of current evidence. Additionally, in this era of expanding oversight and scrutiny, understanding quality measures and grading of complications has now become a fundamental aspect of surgical practice.

This atlas is designed primarily to assist the urologic surgeon in developing an appropriate tactic to approach the myriad technical issues involved with urologic operative procedures. However, the limitations to this type of didactic lesson are readily apparent and surgical skill is gained primarily through experience at the operative table. Several axioms heard—usually rather stridently—during surgical training are worth repetition as they represent fundamental principles to drive superior technique and should become second nature to the experienced surgeon. These elemental strategies were eloquently and enthusiastically described by Dr. Hinman in the prior edition of his atlas and are paraphrased and expanded below.

Foremost, having a strategy involves knowledge of your patient and their pathology. Although unexpected findings are frequent during surgery, attention to detail and preoperative knowledge of the patient and the disease process can minimize the element of surprise, which could affect patient outcomes. Be compulsive about detail. Dr. Hinman counseled us to ensure adequate exposure; fend off difficult planes and vascular traps; use delicate technique; irrigate debris; obtain good hemostatis; close dead spaces; and provide adequate drainage. We are directed to have a plan, promote a team effort, and be gentle, but not indecisive. Dr. Hinman reminds us to tie sutures just to approximate the tissue; dissect and follow the natural tissue planes; work from known to unknown; keep tissues moist and covered; and above all, to keep calm and conduct yourself like a leader. Even with the technical advances that have almost revolutionized urologic surgery, these fundamental principles of preparation and technique remain applicable.

With these mentoring concepts, the continued mission of this atlas is to share the knowledge, and admonitions, of experts with pronounced and specialized surgical experience. Reviewing the chapters prior to embarking on a particular procedure should provide the urologist with access to not only a critical resource in step-by-step technique but also serve as a caution for the pitfalls of which one must beware. Surgery is an apprenticeship learned literally at the shoulder of those who have chosen to impart their skills. Foremost, the ultimate goal of this atlas is to serve and benefit our patients.

Initiatives to improve quality of surgical care have translated globally into enhanced safety and outcomes for urology patients. Spearheading this initiative is the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP). ACS NSQIP is the preeminent nationally validated, risk-adjusted, outcomes-based program to measure and improve the quality of surgical care, with particular emphasis on the private sector. ACS NSQIP encompasses a variety of customizable tools, training, and data management that may be utilized by your hospital or health delivery system. ACS additionally provides an online risk calculator to determine risk of potential complications from surgical interventions based on their expansive database. (http://www.riskcalculator.facs.org/)

The Joint Commission is an independent, not-for-profit organization that accredits and certifies the majority of health care organizations and programs in the United States. Accreditation by the Joint Commission reflects an organization's commitment to meeting defined performance measures. In collaboration with the Centers for Medicare and Medicaid Services (CMS), the Joint Commission have developed national initiatives for quality benchmark metrics including the Surgical Care Improvement Project (SCIP). SCIP is a national program aimed at reducing perioperative complications, including timely use and discontinuation of perioperative antibiotics, initiation of venous thromboembolism prophylaxis, as well as perioperative beta-blocker administration. Many hospitals have implemented SCIP measures in preoperative "time-out" procedures as well as integrated these quality metrics into care pathways. Several of the current SCIP measures are discussed in the following sections and may be accessed at http://www.jointcommission.org/assets/1/6/SCIP-Measures-012014.pdf.

The American Urological Association (AUA) has additionally embarked on a collaborative initiative with the American Board of Internal Medicine (ABIM) Foundation to optimize utilization of resources, which may be particularly valuable for perioperative planning. In 2013, the American Urological Association (AUA) joined the Choosing Wisely campaign, designed to reduce overuse of tests and procedures, and support patients in their efforts to make smart and effective care choices. To this aim, the AUA has released a list of specific urologic tests and procedures that are commonly ordered but not always necessary. In 2015, the AUA expanded its list with an additional five recommendations. The full list identifies targeted, evidence-based recommendations that can support conversations between patients and physicians about what diagnostic testing or procedures are truly indicated. (https://www.auanet.org/resources/choosing-wisely.cfm)

PREOPERATIVE EVALUATION

With explosively expanding medical knowledge, the complete evaluation of the patient prior to undertaking any operative procedure, except in the most dire of circumstances, merits substantial consideration. As limits are pushed of both young and advanced age in the urology patient cohort, sufficient preoperative knowledge can dramatically impact the operative outcome and allow more efficient communication with colleagues from other medical and surgical disciplines.

Evaluation of Risks

The American Society of Anesthesiology (ASA) has created a Physical Status Classification System to describe preoperative physical condition and group patients at risk for experiencing an adverse event related to general anesthesia (Table 1.1). ASA I represents a normal, healthy individual; ASA II, a patient with mild systemic disease; ASA III, a patient with severe systemic disease that is not incapacitating; ASA IV, a patient with an incapacitating systemic disease that is a constant threat to life; ASA V, a moribund patient who is not expected to survive for 24 hours with or without an operation; and ASA VI, a brain-dead organ donor. This classification system was recently updated by the ASA to include pertinent examples of each of the classes to assist both the surgeon and anesthesiologist in appropriate risk stratification and patient counseling.

Although cardiac status has long been appreciated as a significant risk factor for perioperative mortality, the past decade has witnessed remarkable changes in the evaluation and management of the cardiac patient. Important considerations regarding the widespread utilization of coronary revascularization, anticoagulation, and beta-blocker administration are of particular concern for the contemporary surgeon.

Of paramount consequence in the context of considering surgical interventions is the management of an ever-expanding repertoire of antithrombolytic medications. Oral anticoagulant (AC) and oral antiplatelet (AP) therapies require comprehensive attention in the perioperative period to avoid complications with surgical hemorrhage as well as the potential systemic repercussions of titration of these pharmaceuticals. To provide urology-specific directives for AC and AP management, the American Urologic Association (AUA) in collaboration with the International Consultation on Urological Disease (ICUD) have created a pragmatic review on "Anticoagulation and Antiplatelet Therapy in Urologic Practice" to provide guidance for the safe and effective use of oral agents in the periprocedural period. Key parameters addressed include discontinuation of AC/AP agents for elective to emergent surgery, procedures that can be safely performed without discontinuation of anticoagulation, and strategies to balance risks of surgical bleeding versus thrombotic events. Eighteen specific recommendations are provided by the AUA/ICUD to accommodate multiple considerations, along with several illustrative cases common to many urologic practices. Suggested procedures for discontinuation of AC/AP agents in the perioperative window is additionally outlined (Table 1.2). Although this exceptional review provides an outstanding base for decision making, with the complex patient requiring urologic intervention maintained on AC/AP therapy, guidance from a multidisciplinary team including cardiology and primary care is often prudent to ensure optimal care is accomplished.

Much contradictory evidence has been published regarding utilization of β-blocker therapy and perioperative mortality

TABLE 1.1 AMERICAN SOCIETY OF ANESTHESIOLOGY PHYSICAL CLASSIFICATION SYSTEM

Classification	Definition	Example, Including, but Not Limited to:
ASA I	A normal healthy patient	Healthy, nonsmoking, no or minimal alcohol use
ASA II	A patient with mild systemic disease	Mild disease only without substantive functional limitations. Examples include (but not limited to: current smoker, social alcohol drinker, pregnancy, obesity (30<BMI<40), well-controlled DM/HTN, mild lung disease
ASA III	A patient with severe systemic disease	Substantiative functional limitations; One or more moderate to severe diseases. Examples include (but not limited to): poorly controlled DM or HTN, COPD, morbid obesity (BMI ≥ 40), active hepatitis, alcohol dependence or abuse, implanted pacemaker, moderate reduction of ejection fraction, ESRD undergoing regularly scheduled dialysis, premature infant PCA <60 weeks, history (3 months) or MI, CVA, TIA, or CAD/stents.
ASA IV	A patient with severe systemic disease that is a constant threat to life	Examples include (but not limited to): recent (<3 months) MI, CVA, TIA, or CAD/stents, ongoing cardiac ischemia or severe valve dysfunction, severe reduction of ejection fraction, sepsis, DIC, ARD, or ESRD not undergoing regularly scheduled dialysis.
ASA V	A moribund patient who is not expected to survive without an operation	Examples include (but not limited to): ruptured abdominal/thoracic aneurysm, massive trauma, intracranial bleed with mass effect, ischemic bowel in the face of significant cardiac pathology or multiple-organ/system dysfunction.
ASA VI	A declared brain-dead patient whose organs are being removed for donor purposes	

From Dripps RD. New classification of physical status. Anesthesiol. 1963;24:111. http://www.asahq.org/resources/clinical-information/asa-physical-status-classification-system, 2014.

TABLE 1.2 PERIOPERATIVE MANAGEMENT OF ANTICOAGULATION/ANTIPLATELET THERAPIES

Anticoagulant Therapy	Time to Maximum Effect	Low-Risk Surgery: Normal Renal Function	High-Risk Surgery: Normal Renal Function	Notes
Warfarin	5–7 days for therapeutic INR			Circulating vitamin K–dependent factors (II, VII, IX, X)
Unfractionated heparin	Immediate IV; within 6 hours SQ			Renal clearance: effective reversal with protamine
Low-molecular-weight heparin	3–6 hours			Renal clearance: partial reversal with protamine
Fondaparinux	2 hours			Renal clearance: not reversed with protamine
Dabigatran	1.25–3 hours	Last dose 2 days before surgery	Last dose 3 days before surgery	Nonreversible; 80% renal clearance
Rivaroxaban	2–4 hours	Last dose 2 days before surgery	Last dose 3 days before surgery	Nonreversible; 86% renal clearance
Apixaban	1–3 hrs	Last dose 2 days before surgery	Last dose 3 days before surgery	Nonreversible; 25% renal clearance

From Culkin DJ, Exaire EJ, Soloway MS, et al. Anticoagulation and antiplatelet therapy in urologic practice: ICUD and AUA review paper. *J Urol.* 2014 Oct;192(4):1026-34. https://www.auanet.org/education/guidelines/anticoagulation-antiplatelet-therapy.cfm, 2014.

following noncardiac surgery. Current recommendations from the American College of Cardiology and American Heart Association updated in 2014 principally suggest continuation of β-blocker therapy for patients already managed with such agents for chronic conditions, but the routine administration of β-blocker preoperatively in patients lacking significant cardiac risk is not advisable (Box 1.1). Initiating β-blocker therapy on naïve patients should require the expertise of a cardiologist or anesthesiologist more suited to evaluate the risk parameters involved.

Issues with pulmonary function and postoperative recovery from intubation are most frequently a consequence of preexisting conditions that place the patient at particular pulmonary risk. In patients with obstructive lung disease or severe asthma, it is best to consult with the pulmonologist or anesthesiologist about the safest route to provide the surgical intervention. Intubation may be avoidable, but regardless, appropriate counseling requires recognition of the hazards. Patients who smoke should be counseled not only on their risks for multiple malignancies but additionally for the jeopardy of prolonged respiratory failure and poor wound healing.

Nutrition

Special emphasis should be given to assessment of the patient's preoperative nutritional status as many urology patients, particularly those with malignancy or renal dysfunction, may have recent weight loss or nutritional deficits related to chronic illness. Preoperative evaluation of risk factors may include both serum laboratories in addition to consultation with nutrition specialists for high risk individuals. Indeed, the Joint Commission requires nutritional assessment occur within 24 hours of hospital admission. Nutritional deficiency can predispose the patient to issues with poor wound healing as well as hematologic and immunologic compromise. In severe cases, hyperalimentation may be required to overcome the nutritional barrier preventing safe operative management. Evolving literature across surgical disciplines is migrating practice to early enteral feeding regimens as part of comprehensive care pathways to expedite patient recovery and hospital discharge.

Venous Thromboembolism (VTE) Prophylaxis

Of increasing concern in the perioperative period is the incidence of thromboembolic complications and the associated repercussions including pulmonary embolism. With recognition of the heightened risk in the surgical patient, the American College of Chest Physicians created extensive guidelines detailing pharmacologic and mechanical strategies for prevention of deep vein thrombosis (DVT). For consideration of urology-specific needs, the AUA best practice policy statement "Prevention of Deep Vein Thrombosis in Patients Undergoing Urologic Surgery" was developed (Table 1.3). This policy statement integrates available evidence from the urologic and surgical literature into treatment strategies for pharmacologic and mechanical prophylaxis for each

BOX 1.1 PERIOPERATIVE BETA-BLOCKER ADMINISTRATION

In patients undergoing surgery who have been taking β-blockers for chronic conditions, β-blockers should be continued (class I; level of evidence B).

It is reasonable for the management of β-blockers after surgery to be guided by clinical circumstances independent of when the β-blocker was started (class IIa; level of evidence B).

In patients with intermediate- or high-risk myocardial ischemia noted in preoperative risk stratification tests, it may be reasonable to begin perioperative β-blockers (class IIb; level of evidence C).

In patients with 3 or more Revised Cardiac Risk Index risk factors, it may be reasonable to begin β-blockers before surgery (class IIb; level of evidence B).

In patients with a compelling long-term indication for β-blocker therapy but no other Revised Cardiac Risk Index risk factors, initiating β-blockers in the perioperative setting to reduce perioperative risk is of uncertain benefit (class IIb; level of evidence B).

In patients in whom β-blocker therapy is initiated, it may be reasonable to begin perioperative β-blockers long enough in advance to assess safety and tolerability, preferably more than 1 day before surgery (class IIb; level of evidence B).

β-Blocker therapy should not be started on the day of surgery (class III [harm]; level of evidence B).

From Fleisher LA, Fleischmann KE, Auerbach AD, et al. 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery. J Am Coll Cardiol. 2014;64(22):e77-e137.

TABLE 1.3 VENOUS THROMBOEMBOLISM PROPHYLAXIS RECOMMENDATIONS

Patient Risk Stratification	Description	Prophylactic Treatments
Low risk	Minor surgery in patient <40 years with no additional risk factors	No prophylaxis other than early ambulation
Moderate risk	Minor surgery in patients with additional risk factors Surgery in patients aged 40–60 years with no additional risk factors	Heparin 5000 units every 12 hours subcutaneous OR Enoxaparin 40 mg subcutaneous daily OR Pneumatic compression device if risk of bleeding is high
High risk	Surgery in patients >60 years Surgery in patients aged 40–60 years with additional risk factors	Heparin 5000 units every 12 hours subcutaneous OR Enoxaparin 40 mg subcutaneous daily OR Pneumatic compression device if risk of bleeding is high
Highest risk	Surgery in patients with multiple risk factors (e.g., age >40 years, cancer, prior VTE)	Enoxaparin 40 mg subcutaneous daily AND adjuvant pneumatic compression device OR Heparin 5000 units every 8 hours subcutaneous AND adjuvant pneumatic compression device

From Forrest JB, Clemens JQ, Finamore P, et al. AUA Best Practice Statement for the prevention of deep vein thrombosis in patients undergoing urologic surgery. J Urol. 2009; 181: 1170-7, updated 2014. https://www.auanet.org/common/pdf/education/clinical-guidance/Deep-Vein-Thrombosis.pdf

category of urologic surgery and include patient risk stratification. It is imperative to review these best practice recommendations and incorporate them into an inclusive perioperative approach to diminish the risk for DVT and PE.

Anesthesiology Evaluation

Issues involving anesthesia evaluation are becoming more prevalent with the continual amplification of patient acuity and procedure complexity, many of which are now managed on an outpatient basis. Appropriate attention is mandated to control preoperative hypertension and electrolyte abnormalities as these may become more pronounced during general anesthesia. The preoperative anesthesia evaluation is designed to assess basic cardiac, pulmonary, and systemic risk factors that may influence tolerance and recovery from both anesthesia and the surgical procedure. Although frequently there are mechanisms in place to notify the surgeon of any abnormalities uncovered by these tests, it remains the responsibility of the operative surgeon to review all available data prior to the procedure and assess the fitness of the patient to proceed with the planned surgical procedure.

BOX 1.2 PREOPERATIVE CHECKLIST FOR SURGEONS

- Assess Operative Risk
  - Nutrition
  - Immune competence
  - Medications (anticoagulants, corticosteroids, antibiotics)
  - Pulmonary dysfunction
  - Wound healing (anemia, irradiation, vitamin deficiency)
  - Obesity
- Patient preparation
  - Informed consent
  - Blood banking
  - Site marking
  - Skin preparation
  - Bowel preparation
  - Preanesthetic medication
  - Blood transfusion
  - Hydration
  - Medications
  - Antibiotics

PREPARATION FOR SURGERY

Outpatient Surgery

Many contemporary urologic surgeries are amenable to performance on an outpatient basis. Indeed, even for major procedures such as radical prostatectomy, length of hospital stay barely exceeds 24 hours. Therefore, special consideration must be given to patient preparation and counseling in advance of the date of surgery. Thoroughly informing the patient and family on the general pragmatic concerns and recovery expectations can noticeably decrease patient anxiety, ease work flow on the day of surgery, and expedite discharge planning.

Although overall most patients amenable to outpatient surgery have fewer risk factors than patients slated for hospital admission, preoperative evaluation by anesthesia in advance of the day of surgery is recommended. Outpatient surgeries are particularly suited for the pediatric population as they are generally well tolerated and allow the child to recover in their home environment.

PREPARATION OF THE OPERATIVE SITE

The preoperative checklist presented in Box 1.2 details the majority of items surgeons should consider prior to proceeding to the operating room.

Marking

Because of national safety initiatives, currently most hospitals and surgery centers require marking of the surgical site before proceeding to the operating room. This safety measure is of particular significance in urology, where intervention on one of dual organs is performed routinely. The critical nature of this reassurance to the surgeon and the patient cannot be underestimated as wrong-site surgery is considered by most organizations as a “never occur” event. For cases involving midline structures, such as penile or vaginal surgeries, site marking may not be required.

Shaving and Epilation

Shaving increases bacterial colonization and should be done as near to the time of operation as feasible. Electric clippers with replaceable cartridge blades are now often mandated by hospital committees as they provide less opportunity than razors for skin damage and subsequent bacterial colonization. In select cases, epilation of skin that will be incorporated into the urethra may be necessary and can be accomplished by needle or laser ablation.

Skin Preparation

Once the patient is appropriately positioned and shaved, a mechanical wash should be performed to exfoliate skin and expose bacteria so they can be reached by topical antiseptic agents. Recent Cochrane review of data for clean cases reports lower surgical site infection with skin preparation demonstrating a modest preference for 0.5% chlorhexidine in methylated spirits compared with an alcohol-based povidone-iodine solution. However, the panel concedes that the data were not robust enough to provide conclusive evidence; therefore, this issue remains one of surgeon preference. What remains critical is excellent technique for the presurgical scrub and prep, often with preference for prolonged scrub up to 10 minutes for urologic prosthetics.

Draping

Adhesive drapes are barriers to bacteria and also form a thermal barrier. Particularly in pediatric populations more susceptible to hypothermia, attempt to decrease the time between the skin prep and draping. Cover the areas adjacent to the site of the incision with sterile dry towels and keep them in place with towel clips. Try to keep these towels dry to reduce irritation and heat wicking due to moisture adjacent to skin. Nonabsorbent, plastic stick-on drapes may reduce contamination but foster bacterial proliferation under them, particularly if moisture is trapped, unless they are porous to vapor. If the drapes do not have self-contained pockets, fold the covering drape upon itself to form a lateral pocket for instruments and drainage. Creation of a drape pocket is particularly important for vaginal and perineal surgery where the patient is in lithotomy position and the surgeon is seated.

Contamination

Bacteria colonize the shedding superficial cells of the skin and hair follicles. Contamination from the surgeon and staff comes less from the hands than from hairs falling into the wound. Appropriate coverings for the head and neck reduce contamination of the operative field. Although several novel alcohol-based agents now exist for preoperative hand decontamination, it is recommended that at least the primary wash of the day be a traditional mechanical scrub with soap, scrub brush, and nail cleaning.

Bowel Preparation

For patients undergoing procedures in which the potential for bowel injury exists, but the anticipated procedure does not involve bowel reconstruction, a brief mechanical cleansing with agents such as bisacodyl or magnesium citrate are appropriate, sometimes combined with an antibiotic course. For cases where the operation involves opening of bowel, a more vigorous mechanical prep with a polyethylene glycol electrolyte lavage solution such as GoLytely, in combination with a modified Nichol's antibiotic prep, is favored. Though there has been significant debate regarding the merits of mechanical cleansing and oral antibiotic preparation, recent data on colorectal surgery from the aforementioned ACS NSQIP database indicate significant decrease in surgical site infections and anastomotic leak with aggressive combined bowel preparation.

Vascular Access

The preoperative holding room nursing staff or anesthetist can comfortably obtain vascular access by percutaneous methods in the vast majority of cases with the use of topical anesthetic. If central venous access is required, subclavian or internal jugular vein cannulation is typically preferred on an immediate basis. Central venous lines are usually placed following the induction of general anesthesia. Occasionally, patients with a history of difficult vascular access may benefit from peripherally inserted central catheter (PICC) placement. PICC lines are often placed with ultrasound guidance prior to the day of surgery. For surgery on critically ill patients, or when substantial blood loss is anticipated, the anesthesia team will often place an arterial line for accurate monitoring of blood pressure and blood gases.

Perioperative Antibiotics

The AUA has published best practice guidelines specifically addressing antibiotic prophylaxis in urologic surgery, available at auanet.org (Table 1.4). This evidence-based approach to perioperative antibiotic utilization incorporates the contemporary recommendations of the National Surgical Infection Prevention Project and provides a practical outline for antibiotic therapy. Reference to this exhaustive review will enlighten many urologists, particularly those at institutions who may cling to outdated, costly, and potentially detrimental practices with regards to antibiotic use. The AUA guidelines also specifically address special situations such as antibiotic prophylaxis for mechanical cardiac valves, endourologic, and office-based procedures.

Protection During Surgery

Room temperature in the operating room must be a balance between surgeon comfort and maintenance of appropriate patient warmth. For children and infants, room temperature must be elevated substantially to reduce the insensible loss of body heat.

The appropriate position for the patient is shown in this atlas for each operation, but the details for protection of the patient vary. Be thorough in placing foam padding over all bony prominences to avoid damage to adjacent nerve trunks, especially the ulnar and peroneal nerves. Of specific concern for urologists is the patient in lithotomy position where sustained pressure may result in not only neuropraxia but compartment syndromes. Movement of the stirrups every few hours may release pressure points and prevent such dire consequences. When the patient is in the lateral position, place a pad in the axilla to protect the brachial plexus. Avoid positions that put a strain on the muscles, ligaments, and joints. For minor procedures in children, use a restraining wrap (papoose board).

Choice of irrigation fluids utilized during endoscopic surgery is critical. Intravascular absorption of hypotonic solutions may manifest in a heterogeneous array of symptoms primarily due to hyponatremia which are commonly referred to as transurethral resection syndrome (TUR syndrome). Although classically described for transurethral prostate resection, TUR syndrome and fluid overload may occur with any endoscopic procedure including cystoscopy, bladder tumor resection, ureteroscopy, and percutaneous nephrolithotomy.

General principles to reduce fluid overload include in the lower tract use of non-electrolyte solutions with osmolality similar to serum, most commonly 1.5% glycine. For upper tract interventions, use of 0.9% sodium chloride is frequently employed and should be appropriately warmed to prevent hypothermia. Use of the lowest-pressure irrigation possible will additionally help prevent fluid absorption through open venous sinuses or the perirenal space.

TABLE 1.4 ANTIBIOTIC PROPHYLAXIS FOR UROLOGIC PROCEDURES

Procedure	Prophylaxis Indicated	Antimicrobial(s) of Choice	Duration of Therapy
Lower Tract Instrumentation			
Catheter removal	If risk factors	Fluoroquinolone Trimethoprim-sulfamethoxazole	≤24 hours
Simple cystourethroscopy, cystography	If risk factors	Fluoroquinolone Trimethoprim-sulfamethoxazole	≤24 hours
Urodynamics	If risk factors	Fluoroquinolone Trimethoprim-sulfamethoxazole	≤24 hours
Cystourethroscopy with manipulation	All	Fluoroquinolone Trimethoprim-sulfamethoxazole	≤24 hours
Prostate brachytherapy or cryotherapy	Uncertain	First-generation cephalosporin	≤24 hours
Transrectal prostate biopsy	All	Fluoroquinolone Second/third-generation cephalosporin	≤24 hours
Upper Tract Instrumentation			
Shock-wave lithotripsy	All	Fluoroquinolone Trimethoprim-sulfamethoxazole	≤24 hours
Percutaneous renal surgery	All	First/second-generation cephalosporin Aminoglycoside + Metronidazole or clindamycin	≤24 hours
Ureteroscopy	All	Fluoroquinolone Trimethoprim-sulfamethoxazole	≤24 hours
Open or Laparoscopic Surgery			
Vaginal surgery	All	First/second-generation cephalosporin Aminoglycoside + Metronidazole or clindamycin	≤24 hours
Without entering urinary tract	If risk factors	First-generation cephalosporin	Single dose
Involving entry into urinary tract	All	First/second-generation cephalosporin Aminoglycoside + Metronidazole or clindamycin	≤24 hours
Involving intestine	All	Second/third-generation cephalosporin Aminoglycoside + Metronidazole or clindamycin	≤24 hours
Involving implanted prosthesis	All	Aminoglycoside + first/second-generation cephalosporin or Vancomycin	≤24 hours

From Wolf, J. S., Jr., Bennett, C. J., Dmochowski, R. R., Hollenbeck, B. K., Pearle, M. S., Schaeffer, A. J: Best practice policy statement on urologic surgery antimicrobial prophylaxis. J Urol. 2008; 179: 1379. Updated 2014. https://www.auanet.org/education/guidelines/antimicrobial-prophylaxis.cfm

ANESTHESIA

Fluid and Electrolyte Replacement

Fluid losses increase during surgery because of myriad factors in addition to blood loss, including anesthesia, operating room lights, skin exposure, and visceral organ exposure. Inflammatory responses secondary to the insult of surgery provoke fluid accumulation in tissues outside of the vascular space. The anesthesia team should carefully provide sufficient fluid to replace these insensible losses and volume depletion due to third-spacing. By monitoring blood loss during the case and communicating this information, you can help the anesthesia team stay prepared and ahead of any possible physiologic derangements that may occur. The patient's hydration status can be monitored both by blood pressure and urinary output when appropriate, as well as supplemented by visual inspection of the operative field by the surgeon. Monitoring of urinary output, serum electrolytes, blood glucose, and hematocrit are considered routine. For more complex cases, central venous pressure monitoring may be required.

Local Anesthesia

Several urologic procedures are comfortably performed with the use of local anesthesia. Injections of local agents at the conclusion of numerous cases performed under general anesthesia can assist significantly with postoperative pain management. Regional blocks are usually accomplished with bupivacaine (Marcaine) 0.5–1.0 mg/kg of a 0.25% solution. The addition of epinephrine 1 : 200,000 decreases local blood flow and rate of absorption of the agent, with resulting prolongation of anesthesia and reduction in area blood loss. However, epinephrine can produce systemic effect and may potentiate infection by diminishing local perfusion. It is not recommended epinephrine be used on any tissue with end-organ perfusion such as the distal penis. Caution must also be used to prevent introducing bupivacaine into the vascular system as this agent can have devastating cardiac effects. For use of substantial quantities of agents such as bupivacaine it is prudent to perform the procedures under anesthesia care where the patient may be appropriately monitored and briskly treated for adverse effects. In addition, sedation with agents such as benzodiazepines may substantially improve patient comfort.

General Anesthesia

Common in the modern operating room are monitoring of body temperature, electrocardiogram, heart rate, blood pressure, and oxygen saturation via pulse oximetry. Major procedures may benefit from additional monitoring of central venous pressure as well as use of an arterial line for precise monitoring of blood pressure and blood gases.

Temperature is often assessed via a rectal or esophageal thermoprobe. Malignant hyperthermia is a rare, but exceedingly serious, complication of certain anesthetic agents in predisposed patients that requires prompt and definitive treatment with hyperventilation, alkalinization, cooling with ice packs, and administration of dantrolene and diuretics. From the surgeon's perspective, dark blood in the wound may herald the onset of malignant hyperthermia or at least poor oxygenation, and should be promptly reported to the anesthesia provider.

OPERATIVE MANAGEMENT

Assistance

The importance of an attentive and competent first assistant cannot be overstated. In an academic setting frequently the house staff frequently fills this role, allowing the resident to gradually incorporate an understanding of the steps of the procedure as well as the critical importance of excellent exposure. In many contemporary laparoscopic cases, skills of the first assistant can make an enormous difference in the ease of the procedure. Excellent spatial orientation, particularly in the pelvis and retroperitoneum, becomes critical. The first assistant is charged with the majority of exposure, use of suction and irrigation, and handling the transfer of sutures, clips, and specimens. All these tasks can be areas of great hindrance if the assistant is not facile with the procedure.

Protection of the Surgical Team From Viral Infection

Universal precautions are now considered standard for all surgical procedures. Preoperative testing for infectious diseases such as human immunodeficiency virus (HIV) or hepatitis B and C is rarely performed. Thus, the assumption the surgeon must make is that every patient would test positive and it is the surgeon's responsibility to not only provide service to the patient, but to protect themselves from inadvertent inoculation.

Surgeons, anesthetists, and scrub personnel should wear protective glasses during invasive procedures and should wear protective boots or impervious shoe coverings routinely. This is particularly important in many endourologic cases where irrigation fluids may end up on the operating room floor. The risk to surgeons who operate with open skin lesions is unknown, but covering any small cuts or abrasions on your hands with sterile Tegaderm seals them in the event of glove puncture.

When wearing gloves that have been contaminated, take care to not handle objects in the operating room that may not receive routine cleanings such as cell phones, door handles, or computer keyboards. One should remove all gowns, gloves, and shoe covers before leaving the operating room. Exposed skin surfaces should be washed with detergent immediately after contamination with blood or body fluids. Hands should be washed immediately after gloves are removed at the end of a procedure.

Extreme caution should be exercised with needles and sharp instruments. Meticulous technique is required both in the immediate operative field and entire operating room to minimize accidental exposure to infectious agents. Extreme care should also be taken to avoid needle stick injuries with hollow bore needles. Most needles are now equipped with safety devices to prevent the user from attempting to recap the needle and we caution not to remove these safety devices just because they are deemed cumbersome. After use, needles and disposable sharp instruments should be immediately placed in puncture-resistant containers for disposal.

Of increasing awareness is radiation exposure for both the patient and the surgeon during urologic procedures requiring intraoperative fluoroscopy. Appropriate training and attention to personal shielding and monitoring of radiation exposure is a critical aspect of contemporary urologic practice. Particularly during endoscopic procedures such as ureteroscopy and percutaneous nephrolithotomy, the as low as reasonably achievable (ALARA) principle of radiation exposure should be followed. Pulsed fluoroscopy should be set at the lowest possible frames per second that provide an adequate image quality with the intensifier as close to the patient as possible and collimated over the direct area of interest. If feasible, a drape placed over or under the patient may be used to reduce scatter radiation.

Surgical Technique

Good surgical technique is essential to expedite complicated procedures. It is recognized by the absence of wasted motion and wasted time. Continually think ahead to the next step. Don't wait until you need another kind of instrument or suture; ask for it ahead of time so the scrub technician will have it ready. Often when a team has worked together for a time, the scrub can anticipate the surgeon's needs and a seamless transfer of items occurs with few words uttered. Accomplished surgeons keep moving yet at the same time they watch every detail and are not afraid to stop during the procedure to consider alternatives.

Dissection

The tissue, the organ, and what needs to be executed determine how each instrument is applied. For a node dissection, a sweeping motion with a sucker or closed scissors may do the job. For a pyeloplasty, careful dissection is done by supporting the tissues with stay sutures, occasionally applying fine smooth forceps and sharply incising structures. Sometimes a little hand traction or finger dissection can be useful, but beware of blind finger dissection as it often leads to peril, and the lack of exposure makes control difficult. Don't cut what you can't see as the structures holding up your progress are too often vascular and buried deep beyond your capacity to manage.

Handle the tissues gently and attempt to preserve as much vascular supply as possible to potentiate healing and reduce the risk of infection. Utilize stay sutures and skin hooks as even the most delicate of forceps can crush tissue. Be prudent with cautery or other tissue coagulation devices as all create some degree of devitalized tissue.

Visibility

The intensity of the light in the wound determines visual acuity. At least two light sources are usually required, overhead operating room lighting and a surgical headlamp worn by the surgeon or assistant. Focused beams should be able to reach the bottom of the wound without interference. The use of headlights is particularly important in deep pelvic surgery where the overhead lights can rarely penetrate into the recesses needing visualization. For vaginal surgery, a headlight or lighted suction device are especially useful.

Incision

Cut with a single stroke through the skin and subcutaneous tissue, using an adequate-sized scalpel. Multiple small cuts injure the vulnerable subcutaneous tissue and promote infection. A pure cut cautery current separates tissue more readily than a blended current but provides less hemostasis. Cautery is particularly useful for incising muscle tissue.

Hemostasis and Contemporary Hemostatic Aids

Focused use of coagulation is quicker and can produce less tissue destruction than suture ligation. Try to specifically identify, isolate, and elevate vessels needing coagulation and prevent painting the surface of a structure, which can cause substantial damage and raise the risk of infection. Bipolar forceps produce minimal damage to adjacent tissues and are preferred in delicate environments.

In the contemporary operating room, a variety of nonsuturing techniques are employed to provide hemostasis. Tissue sealants have gained increasing appreciation as important tools in the urologist's armamentarium for providing hemostasis in many formerly troublesome areas. These sealants and glues have shown particular utility when applied in nephron-sparing surgery, and are frequently used for open prostatectomy, urethral reconstruction, and even percutaneous nephrolithotomy. Numerous products with differing mechanisms of action are currently available and outlined in Table 1.5. Novel vessel sealing and tissue cutting devices have also dramatically increased in use, particularly in laparoscopic surgery.

Blood Loss and Transfusion

Because 7% of body weight is blood, a man weighing 70 kg has a circulating blood volume of about 5000 mL. A loss during surgery of up to 15% of this volume rarely affects the patient's hemodynamic parameters. Unless other fluid losses are occurring, transcapillary refill and other compensatory mechanisms restore blood volume. A volume loss between 15% and 30%, representing 800–1500 mL of blood, results in tachycardia, tachypnea, and a decrease in pulse pressure. A loss of more than 30% (2000 mL) of blood volume may produce a measurable drop in systolic blood pressure.

Initially replace blood loss with an isotonic replacement fluid such as lactated Ringer's or Plasma-Lyte with a bolus of 1–2 L in adults or 20 mg/kg in children. If the signs are not reversed or only transiently improved and if urinary output remains low, proceed to transfusion with packed red blood cells. Some guidelines recommend transfusion if hemoglobin levels are below 7 or 8 or if a patient develops hemodynamic signs of blood loss.

Coagulopathy becomes a progressive issue after as few as 6 units of blood have been replaced, primarily because of hemodilution. If a screen for clotting factors finds significant deficiencies, transfusion with platelets or fresh-frozen plasma may be necessary. Hypothermia exacerbates clotting abnormalities; therefore, warm all fluids and gases, provide warm blankets, and irrigate the abdominal cavity with warm saline.

Fluid overload may occur even though the central venous pressure has not reached normal levels. In addition to monitoring the central venous pressure and other hemodynamic parameters, watch for return of adequate perfusion by observing urinary output, skin color, and return of pulse rate and blood pressure to within normal limits. Use diuretics prudently, recognizing their impact on accurate measurement of urine output as a guide and the risk of precipitating hypovolemia.

Drains

Drainage tubes may have several harmful effects to consider, but these are usually outweighed by their benefits in urologic surgeries. Drains may render the tissue more susceptible to bacterial invasion and provide a direct route for bacterial entry from the skin and external environment. However, drains also facilitate the exit of potentially contaminated urine, serum, and blood. The most common purpose for a drain is prophylaxis by preventing the accumulation of blood, serum, or urine that can potentially become infected. Currently, two types of drains are prominently used: passive drains such as the Penrose, and active-suction devices such as the closed-drain Jackson-Pratt or open-sump Hemovac. Passive drainage is sufficient for many urologic cases involving the scrotum or superficial tissues where fluid accumulation can be particularly problematic. Active drains are often more appropriate for intra-abdominal and retroperitoneal surgeries and can usually be removed prior to hospital discharge.

Catheters and Urinary Drainage Tubes

Catheters are often inserted prior to the start of surgical procedures to measure urine output, empty the bladder to avoid injury during entry, to fill the bladder for identification, to instill antibacterial or antineoplastic agents, or to allow identification of the urethra and vesical neck. For most occasions, a 16F urethral catheter is sufficient, although if one anticipates significant clot formation, a larger-bore catheter is preferable. Always carefully

TABLE 1.5 COMMON HEMOSTATIC AGENTS USED IN UROLOGIC SURGERY

Material	Commercial Names	Mechanism of Action	Requirements
Fibrin glue	Tisseel, Crosseal, Hemaseel CoStatis, Dynastat, Vivostat	Mixes fibrinogen, thrombin, and factor XIII to generate clot	Must be warmed prior to use CoStatis requires dry surface
Thrombin	Thrombinar, Thrombin JMI	Interacts with fibrinogen in blood to form a fibrin clot	Circulating fibrinogen must be present in tissue
Collagen	Avetine, FloSeal, TachnoComb	Promotes platelet aggregation by providing physical matrix	Requires circulating fibrinogen
Absorbable gelatin	Surgifoam, SurgiFlo, Gelfoam	Initiation of clotting cascade through contact activation	Requires clotting factors
Cellulose	Surgicel	Cellulose fibers initiate clotting through contact activation	Functional clotting cascade

From Pursifull N.F., Morey A.F. Tissue glues and nonsuturing techniques. Curr Opin Urol. 2007; Nov;17(6):396-401.

TABLE 1.6 CLAVIEN-DINDO CLASSIFICATION SYSTEM FOR SURGICAL COMPLICATIONS

Grade	Definition
Grade I	Any deviation from the normal postoperative course without the need for pharmacologic treatment of surgical, endoscopic, and radiologic intervention. Allowed therapeutic regimens are drugs as antiemetics, antipyretics, analgesics, diuretics, electrolytes, and physiotherapy. This grade also includes wound infections opened at the bedside.
Grade II	Requiring pharmacologic treatment with drugs other than such allowed for Grade I complications. Blood transfusions and total parenteral nutrition are also included
Grade III	Requiring surgical, endoscopic, or radiologic treatment
Grade IIIa	Intervention not under general anesthesia
Grade IIIb	Intervention under general anesthesia
Grade IV	Life-threatening complication requiring ICU management
Grade IVa	Single organ dysfunction (including dialysis)
Grade IVb	Multiorgan dysfunction
Grade V	Death of a patient
Suffix “d”	Patient with complication at the time of discharge

From Demartines N, Clavien PA. Classification of surgical complications. A new proposal with evaluation in a cohort of 6,336 patients and results of a survey. Ann Surg. 2004;240(2):205–213.

secure the catheter in a flexible manner to the patient, usually to the leg, to help prevent the inadvertent trauma from unanticipated removal.

Suprapubic Drainage

Placement of a suprapubic (SP) tube may be considered after many operations involving the bladder or urethra. An SP tube has several advantages over a transurethral catheter. It allows for cystography and a trial of voiding prior to removal. This type of drainage is particularly useful for reconstructive urethral surgery and in patients anticipated to have difficulty with postoperative bladder emptying. Several types of catheters are commonly used for SP tube drainage, including the self-retaining Malecot catheter and the balloon catheter. An SP catheter may be placed during an open operation or indirectly positioned via the urethra.

Postoperative Nerve Block

Even for patients undergoing general anesthesia, a local block with an agent such as bupivacaine can markedly reduce postoperative pain. This is particularly useful in the pediatric population and for outpatient surgery. Caudal blocks are routinely used in children and can provide many hours of comfort.

POSTOPERATIVE MANAGEMENT

For complex cases, be particularly vigilant about instrument and sponge counts. For any discrepancy, obtain a radiograph in the operating room prior to the patient’s emergence from anesthesia so any required intervention will be less traumatic.

Operative Report

The operative report is a key document for patient care, billing purposes, and medico-legal issues. The note should be sufficiently complete such that another surgeon could assume patient care with adequate knowledge of the key findings at surgery and the procedure performed. Variations in anatomy should be described, intraoperative findings outlined, and complications or difficulties documented.

Avoidance of Postoperative Complications

Inevitably, some patients will have complications, but many of these can be prevented with careful attention to detail. Prevention is the purpose of the Morbidity and Mortality conferences held at most institutions. There is much to learn from reviewing cases and considering what you or others may have done differently. In this atlas, many of the prevalent and important postoperative problems are described at the end of the surgical protocols. Therefore, be sure to review the possible complications before starting and have a system in place to ensure steps have been taken for prevention of the most common problems encountered for each procedure.

In order to quantify and classify surgical complications, many practices have begun to utilize the Clavien-Dindo scoring system (Table 1.6). Indeed, the NSQIP database has been evaluated for urologic procedures with regards to Clavien-Dindo classifications of adverse events to provide benchmarking standards that may eventually have national applications.

Fluid Requirements

Volume depletion is signaled by weakness, orthostatic hypotension, tachycardia, weak pulse, dry mucous membranes, and poor urine output. The blood urea nitrogen level is disproportionately high in relation to the serum creatinine level. Replacement of the fluid deficit should occur gradually depending on clinical signs. Use hypotonic solutions in patients with elevated sodium levels and isotonic saline solution for the others. Fluid overload may result in edema, often accompanied by dyspnea, tachycardia, venous engorgement, and pulmonary congestion.

Hypotonic hyponatremia occurs in surgical patients after third-space losses and results in low urine volumes associated with high osmolarity. Replace the losses with saline solutions. Hypovolemic hypernatremia results from unreplaced renal or gastrointestinal water losses, producing thirst, hypotension, and lethargy.

Pain Management

Nerve Blocks

Postoperative pain may be reduced by bupivacaine nerve blocks and wound infiltration to provide enough time for the patient to start oral pain medication. As mentioned previously, local blocks may also be helpful to decrease patient use of intravenous narcotic analgesia.

Continuous epidural anesthesia is advocated by many anesthesia providers and can be particularly versatile for both induction and maintenance of general anesthesia and as a method of postoperative pain relief. However, caution must be applied to this method in the urology population where early postoperative ambulation and voiding are often required since the epidural can induce a motor as well as a sensory block.

Other side effects of epidural anesthesia include hypotension, pruritis, drowsiness, infection of the catheter, and the aforementioned weakness in the lower extremities. Respiratory depression is uncommon and usually resultant from overdose. The benefits include excellent pain control, decreased analgesic requirements, and decreased nausea.

Caudal block is especially useful in the pediatric population for circumcision, hypospadias repair, hernia repair, orchiopexy, and hydrocelectomy. The caudal block enjoys an excellent safety record and may also be utilized in several lower torso operations on adults.

Postoperative Analgesia

Providing adequate postoperative pain control to the patient is a primary responsibility of the surgeon. The need for analgesic medications varies widely depending on the surgical procedure and patient characteristics and needs. As a general rule, sufficient analgesic should be provided so that the patient's recovery is comfortable while recognizing that there are side effects of analgesic medications and methods.

Oral medicines are appropriate in some patients and acetaminophen with or without oral codeine derivative is commonly used. Nonsteroidal anti-inflammatory drugs provide good pain relief but may increase the risk of bleeding. Aspirin-containing drugs should be avoided in the postoperative period.

Agents such as morphine, meperidine, or hydromorphone are frequently used intravenous narcotic agents. These medications can be administered by nursing staff on an as needed basis or self-administered via a patient-controlled anesthesia pump. To reduce narcotic use in select patients, adjunct use of ketorolac may be administered for several doses although long-term use is discouraged. A loading dose of ketorolac of 30 mg in the recovery room followed by 15 mg every 6 hours for up to 4 additional doses can dramatically improve postsurgical pain control. When bowel function returns and a diet started, transition the patient to oral medications. Efforts to limit narcotic use can facilitate resolution of postoperative ileus.

Postoperative Bleeding

Postoperative bleeding may be from disruption of a suture line, an unrecognized and uncontrolled artery or vein, or diffuse oozing from a raw tissue surface area. Some vessels may not be actively bleeding at the time of surgery because of vasospasm. Medication that could precipitate bleeding should be excluded and coagulopathy must be considered. Serum hematocrit may not be a reliable indicator of acute blood loss as an intravascular equilibrium must be established.

Postoperative Infections

Fevers occurring during the first or second postoperative day are likely to originate from the respiratory tract. Although substantiation for incentive spirometry (IS) use is limited, most surgeons routinely provide a device for performance of IS to provide feedback to the patient to promote deep breathing and pulmonary toilet following general anesthesia. After the first few postoperative days, urinary infections, abscesses, and extravasation of urine should be high on the differential diagnosis.

Wound infections are a problematic aspect of every urology practice, and several prevalent risk factors such as uncontrolled diabetes and obesity put surgical patients at particularly high risk. For closure of wounds in the obese patient, skin staples provide a more flexible option than subcuticular stitching in the event of wound infection such that only a portion of the wound often needs to be opened to allow sufficient drainage. Antibiotic treatment is appropriate conservative management for superficial cellulitis, but for suspicion of any deeper infection the wound must be interrogated to prevent possible fascial breakdown and dehiscence.

Several problems can arise with the rampant use of antibiotics in the hospital environment, including the development of resistance patterns and the more ominous opportunity for superinfections. For postoperative diarrhea, examine the stool for *Clostridium difficile* toxin and treat aggressively to prevent the substantial sequela of *C. difficile* infection.

Wound Management

Most skin edges are closed primarily with either absorbable suture or surgical staples. Remove staples within 10–14 days to prevent tissue ingrowth, which will make removal painful and difficult. Superficial dehiscence may be managed with placement of adhesive strips or by secondary healing. Drainage of peritoneal fluid into a midline wound indicates fascial disruption which may progress to wound dehiscence and even evisceration. In the absence of infection or severe compromise of the patient's immune or nutritional status, fascial dehiscence usually represents a technical issue that may be avoided by a careful running closure supplemented with internal retention, or in high-risk patients, external retention sutures. Early fascial disruption should be operatively managed by repeat primary closure, but repair of late incisional hernias may require application of synthetic mesh.

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Suture Techniques

CHAPTER 2

Lee Ponsky, Matthew Bream

The aim of suturing is to hold tissues together with the least interference with their blood supply. Apply the technique most suitable for the tissue, but use the smallest size and, for economy, the fewest types of sutures.

KNOT-TYING TECHNIQUES

There are three basic knots: square, surgeon's, and double throw (Fig. 2.1).

- *Square knot* (see Fig. 2.1A). The simple square knot holds in polyglactin and polyglycolic acid sutures if they are uncoated (Dexon). If coated sutures (Vicryl and Dexon S) are used, an additional throw is needed (see Fig. 2.1B). Care must be taken to lay each throw square to the last.
- The *surgeon's knot* (see Fig. 2.1C) allows the suture to hold the tissue without slipping after placement of the first throw but is no more secure than the square knot, requiring, except with Dexon, additional throws.
- The *double-throw knot* (see Fig. 2.1D), essentially a double surgeon's knot, has the greatest knot-holding ability for all suture materials. Only polydioxanone (PDS) and nylon (Ethilon, Dermalon) require an extra throw. Polyglyconate (Maxon) was found to be the best for knot-holding capacity and breaking force. To be absolutely safe, tie synthetic absorbable sutures (SASs) with three knots. Monofilament nonabsorbable sutures (NASs) may require six or even seven extra throws, all placed flat.

Tie a suture while holding it near its free end; the suture may thus be used twice, saving suture material and time. Instrument ties are somewhat slower to make but use appreciably less suture material.

SUTURES

Selection

Individual surgeons have their own preferences for sutures, but two important variables must be considered: the persistence of strength and the degree of tissue reactivity. The initial strength is proportional to size, but the rate of loss of strength is a function of the suture material. The rate of absorption also depends on the suture material, but it is not directly related to the rate of loss of strength. In general, the strength of the suture is lost much more rapidly before it has been absorbed. A suture must maintain sufficient strength to ensure adequate apposition of tissue until the wound can withstand stress without mechanical support. Decrease in the strength of a suture during healing should be no more than proportional to the gain in wound strength. Relative absorption of suture material in the subcutaneous tissues: catgut—1 month; polyglactin (Vicryl)—2–3 months; polyglycolic acid (Dexon plus)—4 months; PDS—6 months; polyglyconate (Maxon)—7 months. Bladder regains 70% of tensile strength in 2 weeks, fascia 50% in 2 months, and skin 30% in 3 weeks.

Reactivity of the tissue to the foreign body depends on the size and type of suture material and the type of reaction it invokes. The larger the size, the greater the reaction:

Most Reactive	→	Catgut Cotton Silk	→	Synthetic absorbable Multifilament nonabsorbable	→	Nylon Steel Polyethylene Polypropylene	→	Least Reactive

Absorbable and nonabsorbable sutures have different effects. Plain catgut (PCG) and chromic catgut (CCG) sutures, being absorbed by proteolytic enzymes, have quite a variable absorption time and incite the most reaction in the tissue. In addition, they vary in tensile strength, which is generally lower than that of synthetic sutures. SASs, in contrast, are removed by hydrolysis and have moderate tissue reactivity and predictable absorption times. Those made from polyglycolic acid (Dexon, Vicryl) retain 20% of their strength at 14 days, and those made from PDS retain 50% of their strength at 4 weeks, but neither is absorbed for several months. In infected urine, catgut sutures retain the most strength. NAS as monofilaments stimulate the least reaction in the tissues and have the least attraction for bacteria; when braided, they handle better and tie more securely. They are unsuitable in the presence of bacteria or urine. Silk and cotton rapidly lose their strength after the second month but probably are useful in the outer layer of an intestinal anastomosis and in the mesentery. Nylon is a polyamide, Dacron is a polyester, and polyethylene and polypropylene are polyolefins; of these, nylon loses its strength first.

A recent addition to the suture armamentarium are the barbed suture varieties. A bidirectional barbed suture made by Quill Medical Inc. was approved by the Food and Drug Administration (FDA) in 2004, and a unidirectional barbed suture made by Covidien (V-Loc) was approved in 2009. These sutures are manufactured with tiny barbs etched onto a monofilament suture and spaced approximately 1 mm along the entire length of the suture. Sutures are monofilament and come in a variety of absorbable and nonabsorbable materials, and come in a variety of needles for specific uses. Once the suture is passed through tissue, the barbs provide anchoring and prevent backward slipping of the previously thrown sutures. With each individual barb to tissue connection contributing to the overall strength of the closure, less tension is placed on the knot(s) holding together a traditional closure. Their ease of use also includes a decreased need for slack management as an assistant instrument is not needed to follow and maintain tension on the closure. These sutures have gained popularity among surgeons, especially within the fields of laparoscopy and robotics where knot-tying has increasing difficulty and surgical exposure is more limited. Two common uses include the renorrhaphy closure in partial nephrectomy and the vesicourethral anastomosis in radical prostatectomy.

Table 2.1 summarizes the characteristics of several sutures. In general, polyglycolic acid sutures are preferable to PCG or CCG for urologic surgery, except in cases of infected urine and for the skin. Because of expense, use as few different sizes and kinds of

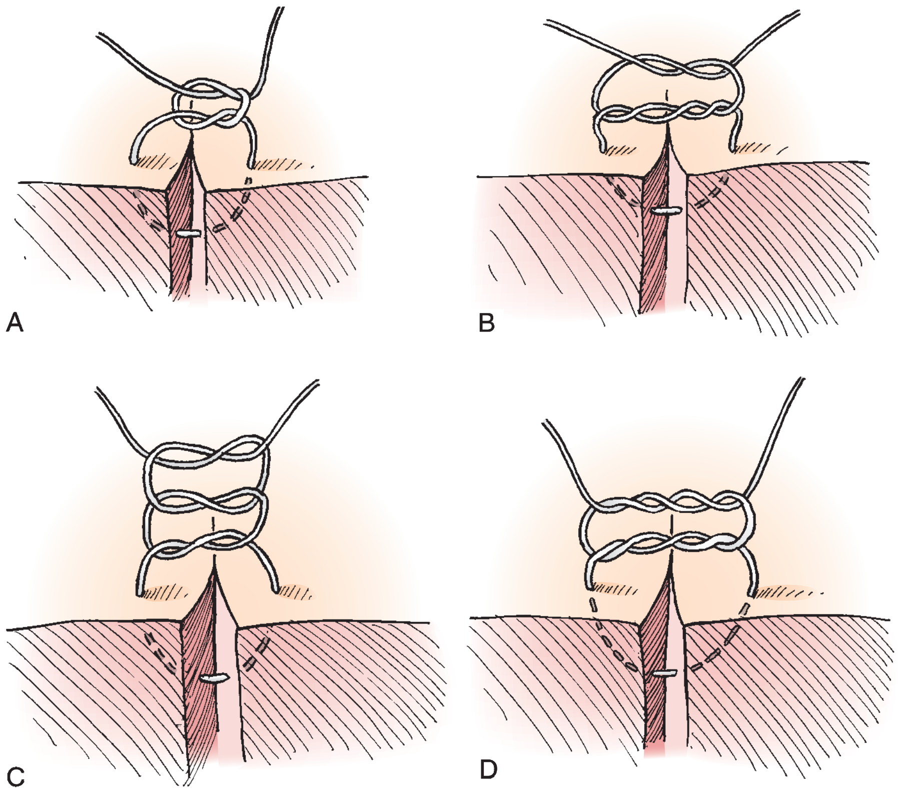

FIGURE 2.1 (**A**–**D**) Basic knots.

TABLE 2.1 SUTURE TYPES

		TRADE NAME	
		Ethicon	*Covidien*
Absorbable			
Synthetic Braided			
Polyglactin	Coated Uncoated	Vicryl	Polysorb Dexon S
Polyglycolic acid	Coated		Dexon plus
Synthetic Monofilament			
Polyglyconate			Maxon
Polydioxanone		PDS	
Gut			
Plain gut		Plain gut	Plain gut
Chromic gut		Chromic gut	Chromic gut
Nonabsorbable			
Synthetic Braided			
Polyester	Uncoated	Mersilene	Ti-Cron
Nylon	Coated		Surgilon
Synthetic Monofilament			
Nylon	Uncoated	Ethilon	Dermalon
Polypropylene		Proline	Surgilene
Barbed Locking Sutures			
Absorbable and Non-Absorbable Monofilament Polymers			
		Stratafix	V-Loc

Adapted from Edlich RF, Rodeheaver GT, Thacker JG. (1987). Considerations in the choice of sutures for wound closure of the genitourinary tract. J Urol 137(3):373.

sutures as possible in a given case. Even though suture selection is a matter for the individual surgeon, certain practical guidelines can be considered.

Fascia

Regardless of what suture is used, the immediate strength of the wound is only 40%–70% of the intact structure. With NASs, reduced strength persists at least for the 2 months or so that it takes for the wound to heal completely. For an absorbable suture, the initial strength is the same as that of a nonabsorbable one if an equivalent size is used, but in 1 or 2 weeks the strength declines appreciably. However, by that time, the wound itself has gained enough strength that it balances the diminished strength of the sutures. Thus the wound is most vulnerable to separation during the second week. For this reason, NASs are often used for closure of wounds subjected to stress, such as those of abdominal and flank incisions.

For contaminated wounds, the process of absorbing the sutures stimulates macrophage activity with resultant low tissue oxygen tension. This activity also reduces endothelial migration and capillary formation, thus providing a suitable environment for anaerobic bacterial growth. Polyglycolic acid sutures foster the least inflammatory response of absorbable sutures, and the degradation products themselves may be antibacterial. Conversely, NASs, especially monofilaments, produce the least reaction, but once infected they may stay infected because they remain in the wound. Polypropylene is the best choice in contaminated wounds, much better than silk or cotton. For a debilitated patient, in whom poor healing is expected, use either an NAS or an absorbable suture that retains its strength the longest (i.e., PDS). Retention sutures of heavy nonabsorbable material (polypropylene or wire) may be needed in a debilitated patient, especially if the wound is contaminated. Bolsters cut from a red rubber catheter reduce damage to the skin.

Subcutaneous Tissue

The subcutaneous tissue layer is the site of most wound infections because of the weak defense mechanisms in the fatty areolar tissue. Do not use sutures here unless necessary, and then use the finest minimally reactive absorbable suture of polyglycolic acid. Avoid PCG or CCG.

Skin

Waterproof tape is best if it is not subjected to too much tension. Staples, if not too tight, are the next best choice because they do not penetrate the wound, but they cost more and require subsequent removal. A subcuticular stitch of monofilament nonabsorbable material leaves a better wound but must be removed. Polyglycolic acid sutures subcuticularly can remain until resorbed, at the same time producing little reaction. This material is not suitable when placed through the skin as interrupted sutures because absorption depends on hydrolysis, and so it persists on the dry surface.

Urinary Tract

Urothelium covers the suture line within 5 days. Ureteral and vesical wounds gain strength more rapidly than those in the body wall; normal strength is reached in 21 days. The type of suture material is not as critical here, but absorbable sutures cause less reaction than nonabsorbable ones in the long term. Although more subject to encrustation, absorbable sutures are usually gone before stones can form. Polyglycolic acid sutures are less reactive than CCG sutures, and they have a more predictable rate of absorption. Although polyglycolic acid sutures are not completely absorbed before 28 days, they are usually the better choice, with one exception. In the presence of *Proteus* infection, resorption is much too rapid and catgut should be used.

Intestine

Use interrupted NAS, reaching through the muscularis well into the submucosa. If a hemostatic layer is desired, place a running absorbable suture in the mucosa-submucosa. CCG is suitable for sutures penetrating the lumen; otherwise, use SAS. Controlled-release needles speed the process of suturing. In general, place continuous sutures if the tissue is of good quality and interrupted sutures if tissue quality is poor.

Vascular

Monofilament synthetic NASs are strongest and least reactive.

Size and Type

The size and type of suture and the appropriate needle for various structures are listed in Table 2.2.

SKIN SUTURE TECHNIQUES

Alternative skin suture techniques include a subcuticular suture, interrupted sutures, staples, and tapes.

Subcuticular closure (Fig. 2.2)*:* Use a 4-0 SAS or a monofilament pull-out NAS.

Start the stitch from a buried knot at one end (see Fig. 2.2A). Pull the subcutaneous tissue forward with a fine skin hook, and drive the needle point well into the dermis in a plane parallel to the surface, entering exactly opposite the exit site of the last bite.

To bury the last knot, place a deep stitch and, after tying it, bring the end out through the skin 1 cm from the wound (see Fig. 2.2B). Cut the excess suture, and let the end retract. *Alternatively*, lock the suture at the start by passing back and forth at one end of the wound, having the needle enter exactly at the site of

TABLE 2.2 SUGGESTED TYPE AND SIZE OF SUTURE FOR VARIOUS TISSUES

Tissue	ADULT		PEDIATRIC	
	Type	*Size*	*Type*	*Size*
Skin				
Cosmetic closure	Absorbable	4-0	Absorbable	5-0
Noncosmetic closure	Staples Nonabsorbable	 4-0 3-0	Nonabsorbable	5-0 4-0
Fascia	PDS Maxon silk	Zero 1-0	PDS Maxon silk	3-0 2-0
Muscle	Absorbable	1-0 2-0	Absorbable	3-0 3-0
Bladder	Absorbable	3-0 2-0	Absorbable	4-0 3-0
Ureter-pelvis	Absorbable	5-0 4-0	Absorbable	5-0 6-0
Urethra (vascular)	Absorbable (Maxon, PDS)	4-0 5-0	Absorbable	5-0 6-0
Bowel	Staples Absorbable (inner layer) Nonabsorbable (outer layer)	 3-0 4-0 3-0	Staples Absorbable (inner layer) Nonabsorbable (outer layer)	 5-0 4-0 4-0
Vascular	Nonabsorbable	4-0 5-0	Nonabsorbable	4-0 5-0

Adapted from Foster LS, McAninch JW: Suture material and wound healing: An overview. AUA Update 11:86, 1992.

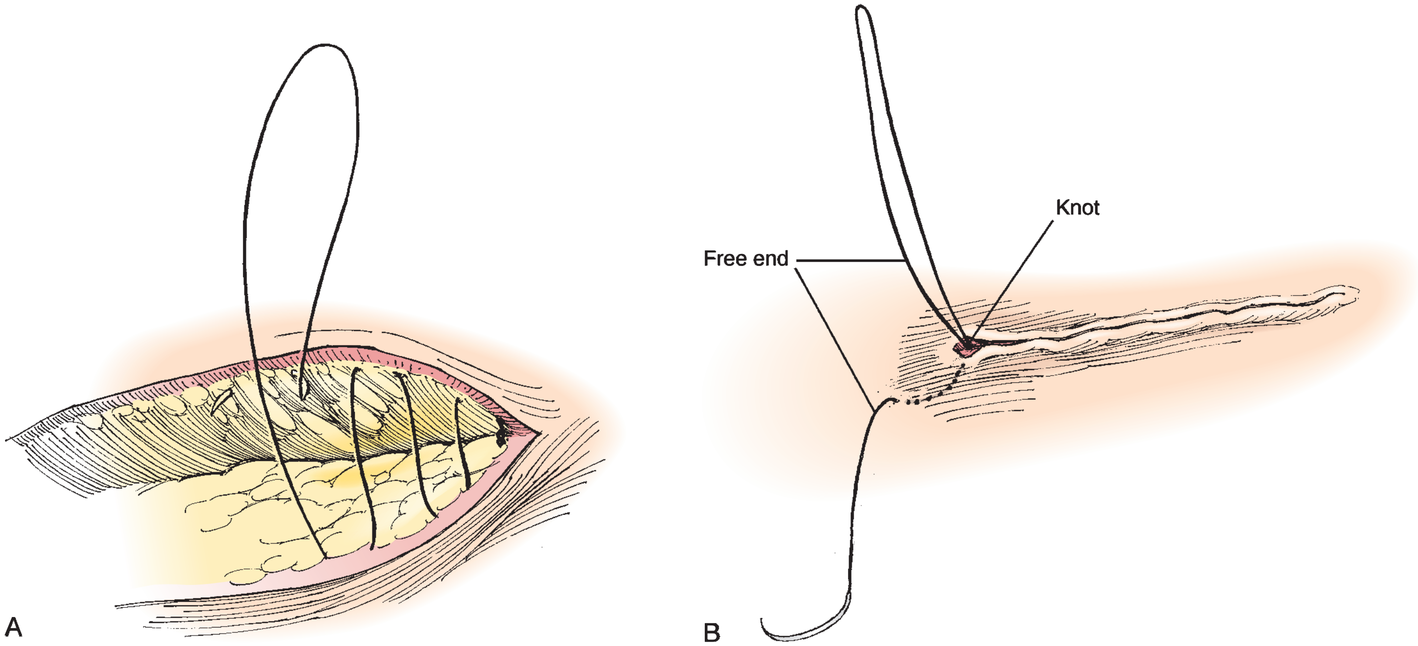

FIGURE 2.2 (**A**, **B**) Subcuticular closure.

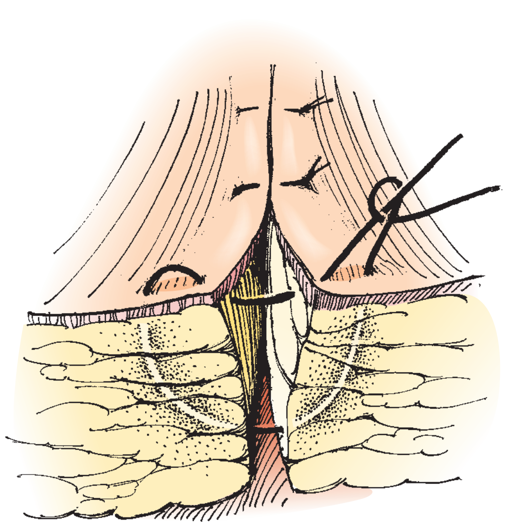

FIGURE 2.3 Vertical mattress suture.

exit of the suture (Giddins). Do the same lock after the subcuticular suture line is completed. Another alternative is to apply inverted absorbable interrupted subcuticular sutures, thus burying each knot.

Vertical mattress suture (Fig. 2.3)*:* This suture is a double stitch that forms a loop around the tissue on both sides to produce eversion of the skin. Use monofilament NASs, and catch only the very edge of the skin in the second bite. Throw four or five knots.

Everting interrupted suture (Fig. 2.4A)*:* For plastic procedures, penetrate the skin close to the edge of the incision, then encircle a larger amount of tissue beneath.

Halsted mattress suture (see Fig. 2.4B)*:* This suture inverts the edge. Pass the suture into the skin, and have it pass out again near the skin edge.

FASCIAL SUTURES

Interrupted Sutures

Place 2-0 synthetic absorbable or monofilament sutures 1 cm deep and 1 cm apart (the “one-by-one” rule) (Fig. 2.5A).

Tie suture only tight enough to bring the edges in contact. Throw at least three square knots (see Fig. 2.5B). Monofilament sutures consist of only one strand, so they “can be inadvertently and easily damaged by any instrument, needle or sharp-edged material that cuts or scratches its surface” (*The Wound Closure Manual*, Ethicon, Inc.). This risk is greater with running sutures that depend on a single knot at either end. If the terminal knot is tied with the so-called loop-to-strand knot, it may pull out. In thin patients and in children, bury the knots to prevent wound discomfort.

Far-and-Near Sutures

Place 2-0 SAS at 1-cm intervals, first deep on one side and shallow on the other, then shallow on one side and deep on the other (Fig. 2.6).

Skin Clips

Skin clips in an automatic dispenser are a rapid but relatively expensive way of closing the skin. Partially squeeze the handle to advance the staple into position. Hold the end of the stapler loosely against the skin with the arrow in line with the incision. Fire the staple. Clips require subsequent removal.

Other Types of Fascial Sutures

Near-and-far suture for mass closure of the abdomen (Fig. 2.7A): Use 2-0 NAS. Place the deep sutures first, then catch the edges with the shallower bites.

Smead-Jones fascial closure technique (see Fig. 2.7B): Place 2-0 NAS 2 cm apart as figure-eight stitches, taking bites near and far.

Vertical mattress suture (sometimes called a Gambee stitch) incorporates both fascial layers (see Fig. 2.7C): On the first side, pass the suture through the superficial and deep fascia and the