Introduction

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Approximately one in five women undergoes surgery for prolapse or incontinence in her lifetime [1]. Of these, up to 30% require a re-operation for recurrence of their prolapse or incontinence symptoms [2]. It has been estimated that one in nine women will undergo a hysterectomy in her lifetime, and up to 10% of these women will require surgery for symptomatic vaginal vault prolapse [2, 3]. The search for the ideal repair for vaginal vault prolapse has led to the invention of several approaches to this problem [4].

The transabdominal sacrocolpopexy is considered the gold standard in the surgical management of vaginal vault prolapse, with long-term success rates of up to 100% [5]. Randomized comparative effectiveness trials and systematic literature reviews have demonstrated the anatomic superiority of sacrocolpopexy to vaginal vault suspension [6–8]. The sacrocolpopexy involves an attachment of a Y-shaped surgical mesh to the vaginal apex and anterior and posterior vaginal walls. The tail end of the mesh is sutured to the anterior longitudinal ligament overlying the sacral promontory.

Although the most successful operation for vaginal vault prolapse, the open approach to sacrocolpopexy requires an abdominal incision. In an effort to develop minimally invasive alternatives to open sacrocolpopexy, vaginal approaches that utilize synthetic mesh were developed. The placement of mesh vaginally is theoretically advantageous. However, vaginal approaches to prolapse have a lower cure rate than sacrocolpopexy [6] and are associated with significant complications. The frequency and severity of such complications led to the publication by the U.S. Food and Drug Administration (FDA) of the following warning to healthcare providers on October 20, 2008 [9]: "This is to alert you to complications associated with transvaginal placement of surgical mesh to treat Pelvic Organ Prolapse (POP) and Stress Urinary Incontinence (SUI). Although rare, these complications can have serious consequences. Over the past 3 years, FDA has received over 1000 reports from nine surgical mesh manufacturers of complications that were associated with surgical mesh devices used to repair POP and SUI…. The most frequent complications included erosion through vaginal epithelium, infection, pain, urinary problems, and recurrence of prolapse and/or incontinence. There were also reports of

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bowel, bladder, and blood vessel perforation during insertion." As the number of vaginal mesh-related cases rose to over 3874, the FDA communicated a second safety notification to providers on July 13, 2011 [10]. Ultimately, the FDA gave an order to reclassify transvaginal mesh kits from class II (which generally includes moderate-risk devices) to class III (which generally includes high-risk devices). The FDA also issued a second order that requires manufacturers to submit a premarket approval (PMA) application to support the safety and effectiveness of transvaginal mesh [11].

The high complication rate of vaginally placed mesh led many pelvic surgeons to return to the gold standard technique for vaginal vault prolapse—the abdominal sacrocolpopexy. During the same time period that transvaginal mesh became controversial, robotic surgery gained rapid popularity in the world of urology. Specifically, the number of robot-assisted radical prostatectomies performed worldwide nearly tripled between 2007 and 2010, from 80,000 to 205,000 [12]. Between 2007 and 2009, the number of da Vinci systems installed in U.S. hospitals grew by approximately 75%, from almost 800 to around 1400. Soon after radical prostatectomy, robotic surgery began to diffuse across many other surgical specialties. The rapid innovation of robotic surgery, combined with the negative media attention surrounding transvaginal mesh, contributed to the rapid adoption of robotic-assisted sacrocolpopexy. In fact, the rate of sacrocolpopexy procedures almost doubled yearly from 2008 to 2011 among Medicare beneficiaries [13].

For the skilled laparoscopic surgeon, laparoscopy offers a minimally invasive alternative to open sacrocolpopexy. However, suturing the mesh to the vagina laparoscopically is tedious, and access to the deep pelvis is often difficult. In operations where a pure laparoscopic approach is feasible, such as in appendectomy and cholecystectomy, the use of robotic assistance may not be justifiable financially. However, the sacrocolpopexy is an operation that benefits greatly from robotic assistance. The use of robotic technology has made laparoscopic sacrocolpopexy a more feasible procedure for many pelvic surgeons, not just expert laparoscopists. The improved dexterity of the robot and precision of instruments allow suturing of mesh to the vagina to be accomplished with ease. Further, the three-dimensional imaging of the robotic camera provides close visualization of the vessels overlying the sacral promontory and may allow for better preservation of these vessels and less blood loss.

Like many techniques in pelvic surgery, trends in the management of vaginal vault prolapse have continued to evolve. Unfortunately, such trends are not supported by level I data, specifically that provided by randomized clinical trials. Although robotic technology is new and rapidly spreading throughout the urologic and gynecologic communities, there have been no randomized trials comparing outcomes of robotic versus open sacrocolpopexy. Retrospective series indicate comparable efficacy with respect to cure of prolapse. However, to date, it is unknown how robotic surgery compares to open techniques with respect to patient safety, pain, and ability to return to normal activities.

The use of the robot in laparoscopic surgery is costly. The costs of purchasing a robot have been estimated at $1.5 million dollars with annual maintenance costs of $112,000 [14]. In addition, additional costs exist for the robotic equipment utilized with each case. It is arguable that the maintenance and operative equipment costs may overshadow any potential savings in length of hospital stay and patient convalescence [15]. However, we have shown in a randomized trial that, when costs of robot purchase and maintenance were excluded, there was no statistical difference in initial day of surgery costs of robotic compared with laparoscopic sacrocolpopexy [16, 17]. If robotic sacrocolpopexy can provide better immediate quality of life, less pain, and faster recovery compared to open techniques and can allow good laparoscopy to be performed by many pelvic surgeons (not just expert laparoscopists), the investment in robotic techniques may very well be cost-effective when a societal perspective is taken.

In this textbook, we seek to present concepts important to the pelvic surgeon with interest in

robotic-assisted sacrocolpopexy (RASC). We will review patient candidacy and alternatives, choice of concomitant vaginal procedures, and management of concomitant stress urinary incontinence (symptomatic and occult). We will also provide detailed descriptions of the set up and steps of RASC. Several chapters will address uterine prolapse and management of the ovaries and fallopian tubes, as well as controversies surrounding uterine morcellation. We will also address robotic management of enterocele and rectal prolapse, which often occur simultaneously with vaginal prolapse. Other pelvic procedures that can successfully be performed robotically, including vesicovaginal fistula repair and robotic-assisted ureteral reimplantation, will be reviewed in detail. Lastly, we will review complications unique to robotic surgery and their management.

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