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Robot-assisted surgery — inevitable evil or precious innovation in the field of urogynecology?

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Robot-assisted surgery (RAS) is becoming increasingly popular in the field of gynecological surgery since it was first approved by the US Food and Drug Administration (FDA) in 2000, initially designed for cardiovascular surgery, and in 2005 for gynecologic surgery [1, 2]. Among these is pelvic floor surgery for pelvic floor disorders such as pelvic organ prolapse, urinary incontinence, and other pelvic floor conditions like mesh complication-related operations, and vesicovaginal fistula (VVF) repair.

Pelvic organ prolapse (POP) is a common disorder; one observational study found that more than 50% of women presenting for routine gynecologic care have stage II or greater prolapse as assessed by the POP-Quantification (POP-Q), with approximately 200 000 inpatient surgical procedures performed annually in the United States [3]. Treatment of POP is based on conservative and/or surgical management, including native tissue repair or mesh-augmented procedures using either a vaginal or abdominal approach. In October 2008, the FDA issued its first safety report on transvaginal mesh implants in response to an increasing number of reported complications, and in July 2011 a second one concluding that adverse effects were significantly higher than expected, following the use of transvaginal mesh implants. Finally, in April 2019, the FDA decided to disallow the sales of anterior transvaginal mesh implants [4]. Consequently, abdominal surgical procedures (open or laparoscopic) were being performed with an increasing frequency. The last two decades have seen a plethora of studies investigating the feasibility of minimally invasive techniques for the treatment of POP, especially apical compartment defects, *i.e.*, level I support according to DeLancey. Among these are sacrocolpopexy, sacrocervicopexy, laparoscopic uterosacral ligament hysteropexy, laparoscopic pectopexy, and laparoscopic lateral suspension [5–8].

Since 2012, and the paper published by Freeman et al., laparoscopic sacral colpopexy has been regarded as the gold standard for post-hysterectomy vault prolapse with as good anatomical and subjective outcomes as the same operation by laparotomy [9]. Minimally invasive sacrocolpopexy, such as laparoscopic sacrocolpopexy (LSC) is preferred in the management of POP because of shorter recovery time, less blood loss and shorter operating time as compared to open abdominal approach [10].

Among the most cited disadvantages of laparoscopic methods is the long learning curve. The learning curve issue is often not properly analyzed in scientific papers [11]. However, in the case of laparoscopic sacrocolpopexy the cumulative sum (CUSUM) analysis showed adequate learning after 60 cases, and operative time reached a steady performance level after 90 patients. With the introduction of robotic-assisted sacrocolpopexy (RASC), learning curve analysis revealed that proficiency was achieved after 78 cases, and operative time decreased after 24–29 cases. In another study of RASC, median operative time plateaued after the first 60 cases. In turn, a proficiency for laparoscopic pectopexy based on CUSUM analysis was observed after 38–40 procedures [12].

The advantages of RAS, which have made it more popular, are better wrist dexterity, a 3D view, and motion scaling up to 5:1 [10]. Next to the high costs, other disadvantages are the lack of tactile feedback and instrument crowding, especially in a narrow operating field, such as the pelvis [13].

A meta-analysis published in 2021 compared the efficacy and safety of robotic-assisted sacrocolpopexy (RASC) and laparoscopic sacrocolpopexy (LSC) with a total of 2115 participants who were included in the pooled analysis. It revealed that RASC was associated with a significantly longer operative time [weighted mean difference, 29.53 min;

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95% confidence interval (CI) 12.88–46.18 min; p < 0.0001], significantly less estimated blood loss (weighted mean difference, –86.52 mL; 95% CI –130.26 to –42.79 mL; p = 0.0001), fewer overall intraoperative complications [odds ratio (OR) 0.6; 95% CI 0.40–0.91; p = 0.01] and a lower conversion rate (OR 0.39; 95% CI 0.19–0.82; p = 0.01) compared with the LSC group. There was no significant difference in the length of hospital stay, overall postoperative complications, postoperative stress urinary incontinence, and mesh exposure between the two groups. Postoperative anatomical outcomes 6 months after surgery were analyzed using three POP-Q points (Ba, Bp and C), and no significant differences for the points were noted. Additionally, RASC was associated with less blood loss and a lower conversion rate, but the differences were not clinically significant [10]. Interestingly, the authors suggest that better 3D vision, wrist dexterity for suturing, better range of motion with instrument articulation, tremor filtration, and improved ergonomics may account for the lower intraoperative complication rate, blood loss, and fewer conversions to laparotomy observed in the RASC group.

Beyond doubt, surgical costs for RASC are higher than for LSC. However, in a recent study, Wang et al. evaluated the cost-effectiveness of surgical treatment pathways for prolapse, analyzing complications, apical relapse, and the need for repeated surgery. The model included vaginal apical suspension, laparoscopic sacrocolpopexy, and robotic sacrocolpopexy in 5-year and 10-year timelines. All the surgical approaches for apical prolapse repair are cost-effective when compared to expectant management. However, among surgical treatments, starting with a vaginal approach would be more cost-effective for older patients (5 years model). Over 10 years, starting with a laparoscopic (or robotic) approach, it becomes cost-effective for younger patients (longer time horizon) [14].

In addition, various robotic systems are being launched to drive market expansion (Medtronic's Hugo™ RAS, CMR Surgical's Versius), so the cost of robotic surgery will reduce over time. Accessible are studies comparing RASC executed using different robotic systems (HUGO™ RAS System vs Da Vinci® Xi surgical system), confirming similar perioperative outcomes for both robotic platforms [15]. Feasibility studies are performed for single-incision robotic-assisted laparoscopic sacrocolpopexy (single port and single-site) [16].

The robotic-assisted approach may help us gain advantages in challenging procedures due to its improved visualization, precision, ergonomic comfort, and steep learning curve [1]. The number of complex pelvic floor surgeries is increasing, such as mesh complication-related operations, exposed mesh removal, complex fistula repair, and artificial urinary sphincter implantation. Multi-compartmental surgeries are performed with robotic assistance (*i.e.*, robotic ventral mesh rectopexy and sacrocolpopexy).

We have taken another step forward in developing surgical techniques, and the unknown is what other possibilities modern technology will give us and where we will apply these technologies. All this is to ensure the safety and effectiveness of surgical treatment for our patients. It is essential to recognize the path we have taken, from open surgery to minimally invasive and now to RAS. We can already see that the entry of robotic technology into our arsenal of surgical activities is inevitable; the technologies are constantly evolving, as are our skills and ability to apply them.

Article information and declarations

Conflict of interest

All authors declare no conflict of interest.

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