

# Robotic vs Laparoscopic Hysterectomy: Is Robot Superior?

Mokoena Martins Mohosho

## ABSTRACT

The objective of this article is to reflect the current stand on robotic vs laparoscopic hysterectomy. There are only few recent studies comparing robotic with laparoscopic hysterectomy and most are retrospective. Early studies found prolonged operating times (e.g. 150.8 vs 114.4 minutes,  $p = 0.001$ ) for robotic assisted than laparoscopic hysterectomy,<sup>1,2</sup> but this appears to have been the result of a lack of experience with this new technology; the learning curve to reduce the robotic surgical time had median of 29 cases per surgeon.<sup>10</sup> Subsequent studies reported operative durations which are comparable to conventional total laparoscopic hysterectomy, approximately 2 hours.<sup>13,14</sup> A minority of studies have reported that robotic-assisted is superior to conventional laparoscopic hysterectomy, with reports of shorter operative duration, decreased blood loss, decreased rate of conversion to laparotomy, decreased use of postoperative narcotic analgesia, and shorter hospital stay.<sup>1,2,12</sup>

**Materials and methods:** This involved the review of related articles to robotic vs laparoscopic hysterectomy. The scope of this review covered Medline, UpToDate, PubMed, Highwire press, Da Vinci community, Google search engine.<sup>12,13</sup>

**Summary:** Recent comparative studies have found that robotic and conventional laparoscopic hysterectomy are essentially equivalent regarding surgical and clinical outcome. Operating times are slightly higher and costs are significantly higher for the robotic hysterectomy.

**Keywords:** Robotic hysterectomy, Laparoscopic hysterectomy, Hysterectomy, Minimal access surgery, Cost of robotic surgery, Robotic vs laparoscopic hysterectomy.

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## INTRODUCTION

Despite the presence of multiple nonsurgical alternatives for treating uterine disease, hysterectomy continues to be one of the most commonly performed gynecologic procedures. A minimal access approach to hysterectomy, which has several benefits over the traditional abdominal technique, has already established a modest attraction in gynecologic surgery. However, its practice and adoption is currently still limited. Factors that might explain this slow adoption include the learning curve associated with minimal access surgery, lack of sufficient resident and fellow training, uneven availability of proper equipment, as well as a low level of physician reimbursement.<sup>3,10,15</sup>

Laparoscopic measures in gynecologic surgery have been performed successfully in excess of 20 years now. The

1st total laparoscopic hysterectomy was performed by Reich et al in 1988.<sup>14</sup> Since then, substantial improvements in optic systems and instrumentation have made laparoscopic surgery a lot more accurate, safer and probably easier to learn. As a result of these technical advances during the past two decades, complicated procedures like gynecologic cancer surgery, surgery of deep infiltrating endometriosis or prolapse surgery today can be performed safely by laparoscopy.<sup>7,11,13</sup>

A surgical robot is a computer-controlled device that can be programmed to aid the positioning and manipulation of surgical instruments. Surgical robotics is typically used in laparoscopy rather than open surgical approaches. Since 1980s, surgical robots have been developed to address the limitations of laparoscopy, including two-dimensional visualization, incomplete articulation of instruments and ergonomic limitations.<sup>15</sup>

## Features of Robotic Surgery

The most important benefits of robot-assisted over conventional laparoscopy are:<sup>12,13</sup>

- *Superior visualization:* Three-dimensional (3D) vs two-dimensional (2D) imaging from the operative field.
- *Mechanical improvements:* A fulcrum effect is created when rigid conventional instruments pass through the incision, thereby ultimately causing inversion of movement from the surgeon's hand for the working end of the instrument. When an instrument is introduced in a trocar, the abdominal wall is the fulcrum. Each time a surgeon's hand moves in one direction, the instrument moves in the opposite direction. If a patient is obese, there is more torque placed on the instrument and the rigid smaller caliber instruments as of laparoscope, may fracture. Robotic instruments are less likely to break, thus, many surgeons prefer robot-assisted laparoscopy in obese patients. This is because all robotic instruments are 8 mm wide and attached to the robotic arms, which often attach to the robotic cannulas (trocars). The force that the abdominal wall places on each instrument is sustained by the trocar and mechanical robotic arm. The robotic laparoscope is 11 mm in diameter and is also introduced through a trocar, which is docked on the robotic scope arm. In contrast, conventional laparoscopy is performed with 3 or 5 mm instruments which are introduced through smaller trocars.

Also, robotic instruments have 7° of freedom, similar to the human arm and hand, while rigid conventional instruments have 4° of freedom. While there are newer flexible laparoscopic needle holders which move around in 7° (e.g. Autonomy Laparo-Angle™), movements with these are not intuitive and their use requires additional training.

- *Stabilization of instruments within surgical field:* In conventional laparoscopy, small movements from the surgeon are amplified (including errors or hand tremor). Robot-assisted surgery minimizes surgeon tremor.
- *Improved ergonomics for the operating surgeon:* The surgeon can be seated with telerobotic systems. This avoidance of long-term standing during surgery could possibly be particularly beneficial to surgeons who are pregnant and have orthopedic limitations.

### Limitations of Robotic Surgery

Limitations of robotic technology include:<sup>15</sup>

- Additional surgical training
- Increased costs and operating room time
- Bulkiness of the devices
- Instrumentation limitations (e.g. lack of a robotic suction and irrigation device, size, cost)
- Lack of haptics (tactile feedback)
- Risk of mechanical failure
- Limited number of energy sources (i.e. less than conventional laparoscopy)
- Not designed for abdominal surgery involving more than two quadrants (the device has to be redocked and repositioned to operate in the quadrants it is not facing).

In this article the comparison of robot-assisted hysterectomy to conventional laparoscopic hysterectomy for benign and malignant indications is reviewed with the recent data available.

### RESULTS

The main focus of this comparison between these two minimally invasive procedures is on the clinical outcome and the costs.

In earlier studies the robotic hysterectomy was superior to laparoscopic hysterectomy in less conversion rate, less blood loss, shortened hospital stay. However, it was found that operative time was longer and the costs were higher with robotic than laparoscopic hysterectomy.<sup>1-3</sup> The incidence of complication was the same in both procedures. Only in one study the less cost and shorter operative time was found in robotic than laparoscopic hysterectomy.<sup>6</sup> In the study by Thomas et al<sup>3</sup> the robotic hysterectomy was superior with blood loss of 113 vs 60.9 ml ( $p < 0.0001$ ); hospital stay of 1.6 vs 1.1 days ( $p < 0.007$ ); conversion rate of 9 vs 4%, but inferior to conversional hysterectomy with operative time of 92.2 vs 78.7 minutes. Both earlier and

recent studies show significantly higher cost with robotic than laparoscopic hysterectomy. The study by Frey et al<sup>6</sup> showed higher cost with robotic than laparoscopic hysterectomy with \$2995 vs with \$3735 ( $p = 0.003$ ).

### DISCUSSION

This comparison between robotic and laparoscopic hysterectomy is apparently important, as worldwide robotic procedures are gaining more and more interest in gynecological surgery. But there are only few comparative studies on this subject and most are retrospective with a low case load.

Both of them are minimally invasive procedures with the only difference being the use of the robot. Costs are significantly higher for robotic hysterectomy and the difference per case adds up to approximately 2500 USD excluding the cost for investment and amortization.<sup>15</sup> Robotic hysterectomy is easy to learn for the experienced laparoscopic surgeon, but to reach operating times of the conventional laparoscopic hysterectomy, a learning curve of at least 50 cases seems to be needed.<sup>13</sup> Robotic hysterectomy may not offer a benefit for expert laparoscopic surgeons as well as the clinical outcome is most likely not better, but it might be a tool which offers an opportunity to perform a minimally invasive hysterectomy to more surgeons and also to give more patients the advantages of this minimally invasive surgery.

Recent studies show that the clinical outcome seems to be the same for robotic and conventional laparoscopic hysterectomy. Operating times are slightly higher and costs are significantly higher for that robotic procedure.<sup>7,8,10,12,13</sup> A few studies indicated that the robotic hysterectomy carries less risks and can be performed easier in patients with increased BMI than laparoscopic hysterectomy.<sup>5,7</sup> It was also demonstrated in a single study<sup>9</sup> that there are less musculoskeletal strain injuries among surgeons performing robotic procedures than conversional laparoscopic procedures.

It is clear from recent reports that this prolonged operative times and higher cost are the two main drawbacks of robotic hysterectomy against laparoscopic hysterectomy.<sup>4,13,14</sup> The robotic operative time can be improved with training of gynecologic surgeons. Despite these promising results, the proportion of robotic hysterectomies is disappointingly low weighed against laparoscopic hysterectomies worldwide; consequently laparoscopic hysterectomy continues to be the most common minimal access surgical approach in nearly all countries worldwide. This is because of most likely the limited exposure to robotic surgery in several hospitals in which gynecologic surgeons are educated and trained. To overcome this drawback of robotic hysterectomy, intensive training of surgeons is required. To attain training and

competence, a surgeon can create three robotic cases prior to scheduled training in an animal lab at various robotic-training centers so that he or she immediately implements the training and reinforces what he/she learns inside the animate or cadaver lab. The volume of mentored patient procedures resulting in independent practice varies from institution to institution and will be likely individualized based on surgical experience and technical ability. Additionally, many institutions are imposing a certain volume of cases to ensure that they maintain a competent level of skill, although individual differences in acquiring skills make an arbitrary number of completed cases illogical. Further, performance of one type of pelvic surgery does not mean another type of pelvic procedure can be performed safely. Credentialing requirements vary among institutions and many institutions are in the process or have recently established criteria for credentialing surgeons to perform procedures on robotic platforms.

Surgical learning curves depend on two elements of surgical volume: total number of procedures performed and the time interval between procedures. Proficiency in a new procedure includes the procedure itself and also the ability to manage complications. Furthermore, safe surgical practice also is dependent upon continued surgical volume after training, equally as for laparoscopic hysterectomy. Additionally, most experts agree that the surgeon must be competent in performing a procedure via laparoscopy before learning a robotic approach. However, there may come a time in the future that many open surgeries are converted to robotic surgery and therefore, trainees will perform a certain procedure solely with robot-assisted.

Robotic surgical procedures are expensive. The da Vinci® system currently costs over \$1.75 million, each instrument attached to the robotic arm costs between \$2200 and \$3200 and requires replacement after 10 uses. Costs incurred by robotic surgery include capital acquisition, limited use instruments, team training expenses, equipment maintenance, equipment repair, and operating room set-up time. As noted above, robot-assisted cases cost approximately \$2000 more per case as opposed to same procedure accomplished by conventional laparoscopic procedure. Inside the era of healthcare reform, this elevated cost will be the greatest detriment to continued implementation of robotic surgery. More prospective research is required to analyze overall costs (direct and indirect) of robot-assisted procedures to medical care systems.<sup>15</sup>

The rapid uptake of robotic hysterectomy is likely to be as result of a variety of factors. First, robotic surgery could be easier to learn than laparoscopy because it is more analogous to traditional open surgery. Second, robotic assistance may

accommodate the culmination of extra-technically demanding cases that would otherwise have required laparotomy. Third, robotic surgery has become the topic of extensive marketing not just in surgeons and hospitals, but also to medical consumers.<sup>15</sup> The potential effect on this marketing may be the topic of numerous reports.<sup>16</sup> The improved use of laparoscopic hysterectomy is noted almost solely at hospitals where robotic surgical procedures are not performed<sup>16</sup> and also this may be due to competitive pressures or even an increased awareness and appreciation of minimally invasive surgical options for hysterectomy.

Robotic surgery is of enormous interest for future years and in my opinion will significantly influence minimal access surgical procedures. Robotic surgery is still in its infancy and I believe that further improvements in technology and costs are needed. Furthermore, technical advances such as reducing bulkiness, better suturing techniques and implementation of learning software/simulators and teaching consoles, robotic surgery may help in its endemic use. Multiple issues concerning the use of robotics in gynecology remain. Short-and long-term patient outcomes must be further evaluated with randomized prospective trials. Surgical costs, considering postoperative variables, need critical review.

## CONCLUSION

Clinical outcomes for both the robotic and conventional laparoscopic hysterectomy are equivalent. Cost and operative time for the robotic-assisted hysterectomy is higher than that of conventional laparoscopic hysterectomy. As technical evolution has always influenced surgery during the past, I do believe that robotic surgery has enormous technical potential to play a crucial role in the next decade.

However, until randomized controlled studies of comparative effectiveness are conducted to further decisions regarding the diffusion of robotic in conventional laparoscopic hysterectomy, I cannot definitively state the superiority of robotic over conventional hysterectomy.

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## ABOUT THE AUTHOR

### Mokoena Martins Mohosho

Senior Lecturer, Consultant and Gynecologic Surgeon, Department of Obstetrics and Gynecology, University of Free State and Pelonomi Regional Hospital, Bloemfontein-9301, South Africa  
Phone: +27731934098, e-mail: mohoshomartins@webmail.co.za