Signatory of DORA
https://doi.org/10.56183/iberojhr.v4i2.658
Ibero-American Journal of Health Science Research
OPEN ACCESS
BY-NC-ND
**Received**: 19/06/2024
**Accepted**: 29/07/2024
**Published**: 04/09/2024

# Efficacy and safety of robotic-assisted laparoscopic myomectomy for the treatment of uterine fibroids: an updated literature review

Eficacia y seguridad de la miomectomía laparoscópica asistida por robot para el tratamiento de los fibromas uterinos: una revisión de la literatura actualizada

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## ABSTRACT

During reproductive years, uterine fibroids are often benign tumors that may have a serious impact on a woman's health. In place of conventional laparoscopic (LM) and abdominal myomectomy (AM) techniques for the treatment of these fibroids, robotic-assisted laparoscopic myomectomy (RALM) is showing promise. This narrative evaluation assesses RALM's safety and effectiveness in comparison to LM and AM. A thorough literature search was carried out with an emphasis on research published between 2018 and 2024 in PubMed, Google Scholar, and Scopus. Hospital stay, surgical complications, operational time, and intraoperative blood loss are among the key outcomes evaluated. In major findings, the review shows that robotic-assisted laparoscopic myomectomy (RALM) performs better than conventional laparoscopic (LM) and abdominal myomectomy (AM) procedures. Comparing RALM to LM and AM, fewer blood transfusions, shorter hospital stays, and less intraoperative blood loss are all related with this approach. Longer operating periods are associated with RALM, but the procedure has a reduced rate of postoperative problems and fewer conversions to open surgery. The lengthier treatment time and increased expenses associated with RALM are still noteworthy factors, despite the advantages it offers in terms of safety and recovery. Therefore, RALM is a safe and efficient surgical alternative for treating uterine fibroids that has a significant positive impact on patient outcomes. To increase accessibility and use of robotic technology, future research should concentrate on cost-effectiveness, long-term efficacy, and technological breakthroughs.

Keywords: robotic-assisted myomectomy. uterine fibroids. surgical outcomes. laparoscopic myomectomy. safety.

## RESUMEN

Durante los años reproductivos, los fibromas uterinos suelen ser tumores benignos que pueden tener un impacto grave en la salud de la mujer. En lugar de las técnicas convencionales laparoscópicas (LM) y miomectomía abdominal (AM) para el tratamiento de estos fibromas, la miomectomía laparoscópica asistida por robot (RALM) se muestra prometedora. Esta evaluación narrativa evalúa la seguridad y eficacia de RALM en comparación con LM y AM. Se realizó una búsqueda bibliográfica exhaustiva con énfasis en investigaciones publicadas entre 2018 y 2024 en PubMed, Google Scholar y Scopus. La estancia hospitalaria, las complicaciones quirúrgicas, el tiempo operatorio y la pérdida de sangre intraoperatoria se encuentran entre los resultados clave evaluados. Entre los principales hallazgos, la revisión muestra que la miomectomía laparoscópica asistida por robot (RALM) funciona mejor que los procedimientos laparoscópicos (LM) y miomectomía abdominal (AM) convencionales. Al comparar RALM con LM y AM, este enfoque está relacionado con menos transfusiones de sangre, estancias hospitalarias más cortas y menos pérdida de sangre intraoperatoria. Los períodos operatorios más prolongados se asocian con RALM, pero el procedimiento tiene una tasa reducida de problemas posoperatorios y menos conversiones a cirugía abierta. El mayor tiempo de tratamiento y el aumento de los gastos asociados a la RALM siguen siendo factores destacables, a pesar de las ventajas que ofrece en términos de seguridad y recuperación. Por lo tanto, RALM es una alternativa quirúrgica segura y eficiente para el tratamiento de los fibromas uterinos que tiene un impacto positivo significativo en los resultados de las pacientes. Para aumentar la accesibilidad y el uso de la tecnología robótica, las investigaciones futuras deberían concentrarse en la rentabilidad, la eficacia a largo plazo y los avances tecnológicos.

**Palabras clave**: miomectomía asistida por robot. fibromas uterinos. resultados quirúrgicos. miomectomía laparoscópica. seguridad.

## INTRODUCTION

The most frequent benign gynecologic tumor throughout the reproductive years is uterine leiomyoma, often referred to as uterine fibroid, with a frequency that may vary from 5.4% to 77% (Sparic et al., 2016). The condition is recognized as a benign proliferation of the myometrium, mostly composed of smooth muscle cells and fibrous tissue, contained in a collagen-rich pseudocapsule. Intramural, submucosal, subserosal, pedunculated, and intracavitary fibroids are among the several forms of uterine fibroids. Despite the possibility that uterine fibroids are asymptomatic, patients often have infertility, pelvic discomfort during or after menstruation, excessive menstrual blood loss, and pressure symptoms such as changes in bowel and urine habits. Because of this, uterine fibroids are the most frequent reason for a hysterectomy in the US and have a significant effect on both healthcare expenses and life quality (Drayer & Catherino, 2015).

On the other hand, uterine-sparing therapies have gained prominence and fibroids may now be treated surgically or medically. A myomectomy may be a viable treatment option for most premenopausal women who want to maintain their uterus or fertility. For this reason, during the last several decades, uterine-sparing procedures have become more commonplace globally (Geller & Wu, 2013). Gonadotropin-releasing hormone analogs, progesterone antagonists, and selective progesterone receptor modulators are among the medical therapies for fibroids. However, myomectomy continues to be the recommended course of action for the treatment of fibroids in premenopausal women because to the negative consequences of long-term use of these medications and the potential for fibroids to grow back after stopping medical therapy (Levy, 2008).

Traditionally, a laparotomy is used to conduct a myomectomy (LM). Myomectomy is quickly becoming a frequent operation that involves minimally invasive techniques such as laparoscopy, robot-assisted surgery, or hysteroscopy (Takmaz et al., 2018). It has been over a decade since LM was initially described. Several studies have shown that LM is better than open myomectomy in terms of the quantity of blood lost during surgery, the time it takes to mobilize after surgery, and the duration of hospital stay (Iavazzo et al., 2016) (Takmaz et al., 2018). Since 2005, when the US Food and Drug Administration (FDA) authorized its use, the usage of robotic platforms in gynecologic procedures has increased significantly (Yamasato et al., 2014). Robot-assisted surgery has various benefits over conventional laparoscopy, including good ergonomics, a fast learning curve, three-dimensional imaging, and enhanced EndoWrist tool articulation (Bedient et al., 2009).However, there is a cost premium for surgery performed using a robot (Flyckt et al., 2017). Advincula carried performed the first robotic myomectomy (RM).sixteen There is no discernible difference between LM and RM in terms of early surgical results, according to several published publications (Iavazzo et al., 2016).

## METHODOLOGY

This review aimed to evaluate the efficacy and safety of robotic-assisted laparoscopic myomectomy (RALM) in treating uterine fibroids. A comprehensive search was conducted across multiple databases, including PubMed, Google Scholar, and Scopus, focusing on studies published from 2018 to 2024. The search terms employed included "robotic-assisted laparoscopic myomectomy," "laparoscopic myomectomy," "abdominal myomectomy," "uterine fibroids," "surgical outcomes," and "postoperative recovery.

### Inclusion and Exclusion Criteria

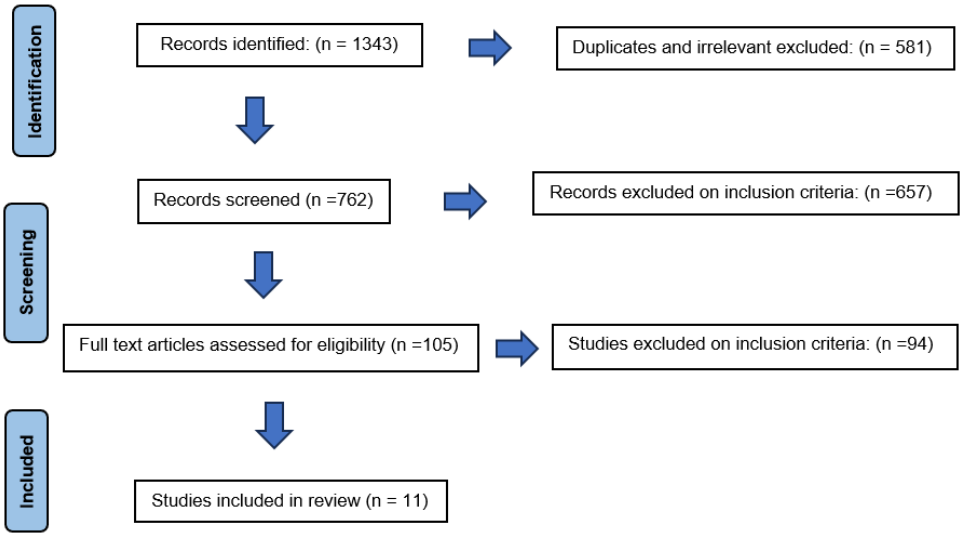
Studies were included if they provided comparative data on the outcomes of RALM, laparoscopic myomectomy (LM), and abdominal myomectomy (AM), specifically in human subjects, and were published in English during the specified period. The selected studies needed to address key outcomes such as intraoperative blood loss, operative time, complication rates, postoperative recovery, and fertility outcomes. Studies that did not meet these criteria, lacked methodological rigor, or did not contribute significantly to the understanding of RALM were excluded from the review. Each included study was rigorously evaluated for relevance, methodological quality, and alignment with the review's objectives.

### Categorization and Analysis

The included studies were categorized according to their reported outcomes, particularly focusing on intraoperative blood loss, operative time, complication rates, postoperative recovery, and fertility outcomes. A narrative synthesis was performed to summarize the findings, highlighting the comparative advantages and limitations of RALM versus LM and AM. This approach allowed for a comprehensive assessment of RALM's efficacy and safety across different clinical scenarios. The analysis aimed to provide a holistic understanding of RALM's role in the surgical management of uterine fibroids, with a focus

on optimizing patient outcomes and guiding clinical decision-making.

**Figure 1. PRISMA flow diagram**




Source: the authors.

## RESULTS

### Efficacy and safety

RALM is beneficial in treating symptomatic uterine fibroids in several investigations. When compared to standard abdominal myomectomy, patients having RALM frequently report effective fibroid removal, with low intraoperative blood loss and shorter operational times. RALM safety has a low rate of perioperative problems and is well-documented. Research continuously show that there is little blood loss during surgery, and blood transfusions are seldom necessary. Notably low is the chance of significant consequences, such as damage to neighboring organs or the need for open surgery. A retrospective analysis including 177 Indian patients was carried out by Sinha et al. to assess the results of robotic myomectomy (RM) (Sinha et al., 2023). The research comprised 177 patients in total, 116 in the RM group and 61 in the LM group. Though not statistically significant, the mean total operational time was somewhat longer in the RM group (127.37 ± 110.67 vs. 120.66 ± 44.27, p = 0.650). Compared to patients in the LM group, the RM group's patients experienced significantly less blood loss (115.43 ± 79.43 vs. 340.98 ± 453.9 ml, p = < 0.0001), hospital stay (1.28 ± 0.49 vs. 1.92 ± 1.05 days, p = < 0.0001), need for a blood transfusion (93.97 vs. 81.97%, p = 0.031), and requirement for intravenous (IV) analgesia (41.38 vs. 34.43%, p = 0.019). Compared to a laparoscopic myomectomy, a robotic myomectomy results in a considerable reduction in blood loss, length of hospital stays, need for blood transfusions, and IV analgesia.

A thorough meta-analysis including 15 retrospective clinical controlled trials covering 45,702 patients overall was carried out by Sheng et al (Sheng et al., 2023). The findings of the meta-analysis showed that while LM is more beneficial in terms of operative time, RALM was associated with less intraoperative bleeding, lower incidence of blood transfusions, shorter postoperative hospital stay, fewer transitions to open stomach, and lower incidence of postoperative complications. Regarding maximal myoma diameter, there was no statistically significant difference between the two surgical procedures. While LM has an advantage over RALM in terms of operational time, RALM has a distinct advantage over LM in terms of intraoperative bleeding, reduced frequency of blood transfusions, postoperative hospital stay, transit open stomach rate, and postoperative complications.

In order to assess the effectiveness and safety of RALM in comparison to AM and LM, Chen et al. carried out a systematic review and meta-analysis that comprised 32 trials totaling 6,357 participants (Chen et al., 2024). They discovered that the incidence of cesarean delivery after myomectomy was substantially lower in RLM than in LM (OR = 0.27, 95% CI: 0.10–0.78, P = 0.02), and that the operating duration was much longer (MD = 43.58, 95% confidence interval [CI]: 25.22–61.93, P < 0.001). The duration of hospital stay, overall cost, blood loss, blood transfusion rate, complication rate, pregnancy rate, and surgery time were all substantially different in RLM patients compared to AM patients.

Tsakos et al. compared the surgical results of RALM, CLM, and AM for the treatment of uterine fibroids by doing a

systematic review and meta-analysis of 53 relevant papers (Tsakos et al., 2023). Their results demonstrated that, except from operation length, RALM outperformed AM in every parameter that was evaluated. While CLM and RALM performed equally in most parameters, RALM was shown to be a safer overall strategy since it was linked to decreased rates of conversion to laparotomy and less intraoperative bleeding in patients with small fibroids. The robotic technique to surgically treating uterine fibroids is a feasible, safe, and continually improving method that may soon gain universal acceptance and outperform CLM in certain patient subgroups.

In order to assess the effectiveness of robotic surgery in myomectomies, Mourad et al. carried out a systematic review and meta-analysis, with a particular emphasis on how it contrasts with conventional laparoscopic and open surgical techniques (Mourad et al., 2024). Fibroid weights and the size of the biggest fibroid did not significantly change between robotic and laparoscopic myomectomies. Blood loss after robotic myomectomy was lower, but transfusion rates remained the same. While some robotic research indicated lengthier durations, both approaches had comparable complication rates and operating timeframes. Robotics was favored by conversion rates. Pregnancy rates did not significantly vary between the two procedures, however there were vast variations in hospital stays. In contrast to robotic myomectomies, open operations were used to treat bigger and heavier fibroids. Although they lost more blood overall, the robotic method needed fewer transfusions. Open procedures had a somewhat higher complication risk. In general, open surgeries took less time to complete, had comparable postoperative pain ratings, but required longer hospital stays. The rates of pregnancy using open and robotic procedures were similar.

Li Wang conducted research with the goal of contrasting the surgical results of robotic single-site myomectomy (RSSM) with robotic multi-site myomectomy (RMSM) (L. Wang et al., 2023). Regarding docking time, console time, estimated blood loss, postoperative hemoglobin (Hb) loss, transfusion rate, length of stay, conversion, postoperative fever, intraoperative complication, and postoperative complication, the statistical analysis did not find any significant differences between RMSM and RSSM. However, RSSM was reported to have fewer overall problems, a quicker morcellation time, a lower Hb change, and a shorter total operational time than RMSM. According to their results, RSSM is a secure and useful substitute for RMSM for the outcomes that have been researched the most.

A research comparing the perioperative outcomes of myomectomy done by robotic surgery (RM), laparoscopic surgery (LM), and open/abdominal surgery (OM) was carried out by Esra Özbaşlı and Mete Güngör (Özbaşlı & Güngör, 2021). Compared to the other groups, the RM group had a considerably bigger myoma, uterine size, and myoma weight, as well as a significantly lower body mass index. The OM group, however, exhibited the greatest quantity of myomas. In addition, compared to the OM and LM groups, the RM group had much lower maximum visual analog scale values but a longer operating duration and blood loss. The length of hospital stay varied substantially amongst the groups. In the OM, LM, and RM groups, the rates of one-day hospitalization were 56.2%, 64.8%, and 37.9%, respectively. Additionally, the OM group's blood transfusion demand was 12.3% greater than that of the LM and RM groups, which were 0.0% and 4.5%, respectively.

Wang et al, evaluated laparoscopic myomectomy (LM), abdominal myomectomy (AM), and robotic-assisted laparoscopic myomectomy (RALM) in their meta-analysis while treating uterine fibroids (T. Wang et al., 2018). They discovered that, in comparison to LM, RALM often leads to fewer problems, less blood loss, and less postoperative bleeding. Despite taking longer to complete than AM, RALM demonstrated advantages over AM in terms of fewer problems, shorter hospital stays, and less blood loss. When compared to both LM and AM, RALM was often linked to significant improvements in safety and recovery, which made it a useful treatment choice for uterine fibroids.

Morales et al compared the three methods of myomectomy-laparotomic, laparoscopic, and robotic. (Morales et al., 2022). 69 patients were split into three groups and given various forms of treatment. Regarding the number and weight of fibroids, the group differences supported laparotomic myomectomy. Additionally, robotic surgery took longer. When the number of fibroids was analyzed for its impact on the likelihood of pregnancy, the results showed that, following surgery, the minimally invasive routes were more successful in achieving pregnancy in both the group with < 6 fibroids and the group with > 6 fibroids, with no differences in the time between surgery and pregnancy. Reproductive diagnosis, surgical duration, and the quantity and size of resected fibroids should all be taken into account while choosing a surgical technique. Not to discount the advantages of laparotomy, but the less intrusive procedure has a greater chance of producing a child; this is especially true with the newly approved robotic-assisted method.

Comparing robotic-assisted laparoscopic myomectomy (RM) to traditional laparoscopic myomectomy (LM), Sheu et al. (2019) looked at uterine scarring after RM (Sheu et al., 2020). Myomas in both groups were comparable in weight (RM vs. LM, 322 vs. 274 g, p =.102) and size (RM vs. LM, 9.0 vs. 8.4 cm, p =.115). RM patients had a considerably higher mean myoma number compared to LM patients (3.3 vs. 1.8, p<.001). Compared to the RM group, the LM group had a significantly higher number of patients with hemorrhages (RM vs. LM, 0 vs. 6, p =.032): two patients had type 3, two had type 4, and two had type 8 myomas. Three tiny haematomas spontaneously resolved in the third month after surgery, while a major one resolved in the ninth month. During sonographic follow-up, one hemorrhage resulted in a pelvic infection and a 7-cm peritoneal

inclusion cyst. After symptomatic type 3, type 4, and type 8 myomas were excised, RM produced less postoperative hemorrhages and could lead to better uterine healing than LM. RM is advised for these individuals, particularly those who want to get pregnant in the future.

Huberlant et al investigated the effects of robot-assisted laparoscopic myomectomy (RALM) on obstetrical outcomes and fertility. There were fifty-three patients in al. With an average size of 69 ± 17.7 mm, there were an average of 2 ± 1.5 myomas. In 15.1% of the instances, a cavity breach was seen. During the post-operative office hysteroscopy, two incidences of intrauterine adhesions were identified and treated (5.7%). In patients who desired to get pregnant, the clinical pregnancy rate was 52.8% with a live birth rate of 41.5%. 17 instances (70.8%) resulted in a cesarean section. There were no reports of uterine ruptures. Following RALM, more than half of the patients got pregnant. The procedure shows promise for infertile individuals since there were no uterine ruptures and a low risk of obstetrical problems was observed.

**Comparison with Other Techniques**

Studies comparing RALM to other surgical methods have repeatedly shown its benefits, especially about recovery and safety. RM is a better alternative for individuals with uterine fibroids since Sinha et al. showed that it considerably outperformed LM in lowering blood loss, hospital stay, and postoperative discomfort (Sinha et al., 2023). Sheng et al. discovered that although while LM had a shorter operating duration, RALM was superior than LM in a number of areas, such as intraoperative bleeding, blood transfusion rates, and postoperative recovery (Sheng et al., 2023). When Chen et al. compared RALM to both LM and AM, they discovered that while RALM required more time during surgery, the results were superior in terms of fertility and postoperative recovery (Chen et al., 2024). On the other hand, although being faster to execute, AM was linked to higher problems and longer hospital stays. Tsakos et al, showed that RALM was similar to CLM and outperformed AM in most metrics, except surgical time. Its main benefits were in lowering intraoperative bleeding and conversion rates (Tsakos et al., 2023). Although open myomectomies were more rapid and could manage bigger fibroids, Mourad et al. discovered that RALM was superior in lowering blood loss, transfusion rates, and general problems (Mourad et al., 2024). Furthermore, compared to robotic multi-site myomectomy (RMSM), Li Wang et al. discovered that robotic single-site myomectomy (RSSM) had shorter operating times and fewer problems (L. Wang et al., 2023). These findings raise the possibility that RSSM is a safer and more effective option. In their final comparison, Esra Özbaşlı and Mete Güngör looked at RM, LM, and open myomectomy (OM) (Özbaşlı & Güngör, 2021). They found that RM was a competitive alternative when combined with other procedures since it was related with shorter hospital stays and less postoperative discomfort, even though it included longer operating periods and more blood loss.

## DISCUSSION

When treating uterine fibroids, robotic-assisted laparoscopic myomectomy (RALM) is very effective and safe. These advantages are further supported by the results of this updated literature review. Reducing intraoperative blood loss, avoiding postoperative problems, and promoting speedier recovery are just a few of the ways that RALM has consistently shown better results across various trials.

Relative to other surgical techniques, RALM has the important benefit of substantially reducing intraoperative blood loss. Research conducted by Sinha et al., Sheng et al., and Mourad et al. collectively suggest that patients undergoing RALM bleed less during surgery. This lowers the risk of perioperative complications and necessitates fewer blood transfusions (Sinha et al., 2023; Sheng et al., 2023; Mourad et al., 2024). Taking into account the possibility of severe blood loss is particularly important for individuals with bigger or more complicated fibroids.

RALM is less likely to cause blood loss than laparoscopic myomectomy (LM) and abdominal myomectomy (AM), and it also has a reduced likelihood of postoperative complications. According to research, RALM has a lower incidence of conversion to open surgery and fewer problems than LM and AM. These findings are consistent with the safety profile of RALM (Chen et al., 2024; Tsakos et al., 2023). These results imply that, especially in more complicated surgical situations, RALM provides a safer option.

In terms of postoperative recovery, the review also emphasizes the advantages of RALM. Chen et al., Wang et al., and Özbaşlı & Güngör's studies demonstrate that RALM is linked to shorter hospital stays and faster recovery times than both LM and AM, which improves patient outcomes overall and lowers medical expenses (Chen et al., 2024; Wang et al., 2018; Özbaşlı & Güngör, 2021). A beneficial choice in clinical practice, RALM may improve recovery while maintaining strict safety criteria.

Another important domain in which RALM may be advantageous is reproductive results. RALM is a particularly attractive alternative for patients who seek to retain fertility, as shown by the studies conducted by Sheu et al. and Huberlant

as al. (Sheu et al., 2019; Huberlant et al., 2023). It may result in improved uterine healing and greater pregnancy rates post-surgery against LM. More patients or those who want to get pregnant in the future would benefit from RALM's enhanced therapeutic utility due to its ability to preserve fertility.

RALM does have several drawbacks, however, especially in terms of operating time and expense. Research by Özbaşlı & Güngör and Wang et al. notes that RALM usually necessitates longer operational periods than LM and AM, which might be problematic in surgical settings when time is of the essence (Özbaşlı & Güngör, 2021; Wang et al., 2018). However, even with RALM's proven effectiveness and safety advantages, the expensive cost of robotic systems continues to be an obstacle to its wider use.

## CONCLUSION

In conclusion, robotic-assisted laparoscopic myomectomy (RALM) shows promise as a surgical option for treating uterine fibroids. Compared to traditional laparoscopic (LM) and abdominal myomectomy (AM), RALM offers clear benefits, including less intraoperative blood loss, shorter hospital stays, and shorter postoperative complications. When it comes to women who are looking for uterine-sparing operations with short recovery times, the data points to RALM as a safe and viable alternative. Although lengthier surgical durations may be necessary, RALM is becoming more and more popular in gynecologic surgery due to its advantages in improving patient outcomes, such as fertility preservation and general safety.

Several limitations apply to this review. First off, it is difficult to make direct comparisons across research because to the variety of the included studies, especially with regard to patient groups, fibroid features, and surgical methods. Conclusions about the durability of RALM results, especially with regard to fertility and recurrence rates, are further limited by the retrospective character of many studies and the absence of long-term follow-up data. It's also possible that the results cannot be applied to a larger range of clinical settings due to the more expensive and scarcer robotic devices.

To more accurately evaluate the long-term safety and effectiveness of RALM, especially when compared to LM and AM, future research should concentrate on well-planned prospective trials using standardized outcome tools. If RALM is to be widely used in clinical settings, it will also be essential to examine its cost-effectiveness and effect on patient quality of life. Furthermore, the prospect of RALM being the treatment of choice for myomectomy in certain patient groups may be further enhanced by developments in robotic technology, such as the creation of more accessible and affordable devices.

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