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Review

Minimally Invasive Techniques in Myomectomy and Fertility Outcomes: A Narrative Review of the Current Evidence

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Abstract

Objective: This narrative review aims to summarize the current evidence regarding fertility outcomes associated with different minimally invasive surgery (MIS) techniques in myomectomy. **Mechanism**: Uterine leiomyomas, commonly known as fibroids, are benign tumors affecting women of reproductive age. Surgery, particularly minimally invasive techniques, represents a definitive treatment for symptomatic fibroids, with preservation of fertility being a key consideration. MIS myomectomies, including laparoscopic, robotic-assisted laparoscopic myomectomy (RALM), and mini-laparotomy, are preferred over open laparotomy due to reduced morbidity and quicker recovery times. However, these procedures still carry risks, including uterine scar dehiscence and subsequent effects on pregnancy outcomes. **Findings in Brief**: Studies reviewed generally indicate favorable pregnancy outcomes across different MIS techniques, although with varying success rates. Conventional laparoscopy and RALM show promising pregnancy rates, akin to those observed with laparotomy. Nonetheless, higher numbers of fibroids removed during RALM correlate with increased rates of preterm births. The literature comparing laparotomy to laparoscopy, as well as across various MIS techniques, presents inconsistent results, likely due to the complexity and heterogeneity of fibroids, which can significantly impact fertility outcomes. **Conclusions**: Overall, myomectomy, irrespective of the approach employed, is generally associated with favorable fertility outcomes. While there are variations in success rates among different MIS techniques, no significant differences in the mode of delivery or the incidence of complications such as uterine rupture and adhesion formation are noted. Clinicians should consider individual patient factors when selecting the most appropriate technique for myomectomy. Ongoing advancements in surgical technology are likely to impact the landscape of MIS myomectomy and its implications for fertility outcomes. Further research and meta-analyses are warranted to clarify differences between MIS techniques and optimize patient outcomes.

Keywords: minimally invasive surgery; myomectomy; uterine leiomyoma; laparoscopy; robotic-assisted laparoscopic myomectomy

1. Introduction

Uterine leiomyomas, more commonly known as fibroids, are hormone-dependent monoclonal expansions of the myometrium [1]. They represent the most prevalent form of benign gynecological tumors, predominantly affecting women of reproductive age. In the United States (US), it is estimated 70–80% of women receive a diagnosis by the age of 50 [2]. While the majority of women with fibroids are asymptomatic, approximately 30–40% endure significant morbidity, characterized by pelvic pain, abnormal uterine bleeding, bulk-related symptoms, infertility, and obstetric complications [3–5].

The adverse effect of fibroids on fertility observed in these women is multifactorial. Complications such as implantation failure may be due to anatomical changes, vascular disturbance and/or generalized inflammation of the endometrium, ultimately leading to a cessation of gestation. Furthermore, fibroids are associated with numerous obstetric complications, including preterm birth, breech presentation, low birth weight, recurrent pregnancy loss, and obstructed labor [1]. Epidemiologically, there is a significantly increased incidence of fibroids among women of African descent compared to Caucasian women. Women of African descent also tend to present with larger fibroids and experience more severe symptoms. Furthermore, women who have experienced early menarche and delayed pregnancy demonstrated an increased risk of being affected by fibroids [2]. Surgery stands as the definitive treatment for symptomatic fibroids in women, with the preferred modality depending upon tumor characteristics, surgeon expertise, and patient preference [6]. Minimally invasive surgery (MIS) myomectomies, such as mini-laparotomy and laparoscopic myomectomy (including robot-assisted laparoscopy), surpass open laparotomies in minimizing blood loss, post-operative pain, and hospital stay. Furthermore, they are currently considered the gold standard for women seeking to preserve fertility [6,7].

Traditional laparoscopy involves the placement of a visual port and trocars through several incisions for the visualization of abdominal structures and instrumentation. Robotic-assisted laparoscopic myomectomy (RALM) commonly utilizes the da Vinci system, where the surgeon re-

motely operates small, fully wristed instrument arms from behind a console. A stereoscopic monitor projects high definition 3D video feeds from the camera, enabling enhanced depth perception, mobility, and control [8].

Despite their benefit, MIS myomectomies still carry a risk of uterine scar dehiscence, uterine rupture, and subsequent effects on pregnancy outcomes. With an increasing trend towards advanced maternal age, the currently underresearched effects of post-operative fertility outcomes between the different MIS procedures necessitates further exploration [6,7]. Therefore, this narrative review aims to summarize the evidence to date regarding various MIS techniques and their post-operative fertility outcomes.

2. Fertility Outcomes

It is important to note that fertility outcomes pertain to the ability to conceive, irrespective of the viability of the fetus or any subsequent complications. In comparison, pregnancy outcomes encompass the success of the pregnancy following conception, including the rate of live births and miscarriages. Both fertility and pregnancy outcomes are critical considerations for assessing the long-term efficacy of myomectomy techniques. The fertility outcomes of the various MIS myomectomy procedures in this review have been summarized in Table 1 (Ref. [9–18]).

2.1 Conventional Laparoscopy

Studies investigating conventional laparoscopy for women seeking pregnancy post-myomectomy have yielded varied insights into outcomes and success rates of this approach.

A prospective cohort study, involving 2050 women who underwent laparoscopic myomectomy, found 70% (386/550) of women desiring pregnancy achieved success. However, the study did not provide information regarding the distinction between natural or assisted pregnancies [9]. These results indicate laparoscopy as a favorable option. However, they prove to be less substantial compared to average fertility rates following myomectomies in general. A recent meta-analysis by Metwally *et al*. [10] found no significant differences in fertility outcomes between laparoscopy and laparotomy (odds ratio (OR) = 0.96, 95% confidence interval (CI) [0.52–1.78], N = 177). Notably, the clinical pregnancy rate associated with laparotomy was 45%, while for laparoscopic myomectomy, it ranged between 30% and 59%. Even when compared against the absence of treatment entirely, the impact of laparoscopy on pregnancy rates subsequent intramural/submucous fibroid removal remained ambiguous (OR = 3.24, 95% CI [0.72–14.57], N = 42) [10].

A comparative study published in 2020 investigated the impact of barbed versus non-barbed sutures on the fertility rates following laparoscopic myomectomy. Among the 164 women actively attempting to conceive, non-barbed sutures were employed for 81 women (group A), while barbed sutures were implemented for 83 women (group B). The use of non-barbed sutures resulted in a pregnancy rate of 60.5%, compared to 50.6% in group B. The authors concluded that the findings were statistically insignificant, with only 'age' emerging as a significant factor affecting fertility outcomes [11].

2.2 Robotic-Assisted Laparoscopy

RALM, introduced in the early 2000s, is often employed in cases where traditional laparoscopy might pose technical challenges, offering potential advantages in managing complex or hard-to-reach myomas.

A study by Goldberg *et al*. [12] investigated fertility and pregnancy outcomes following RALM in 123 women with intramural, subserosal, and submucosal myomas of varying sizes. Their findings indicated an overall pregnancy rate of 70% among 60 women actively seeking conception [12].

Cela *et al*. [13] examined pregnancy rates in 48 females following RALM for subserosal or intramural myomas, with seven out of nine (78%) females who desired pregnancy being successful in achieving it. The study further evaluated ovulatory function pre- and post-operation by measuring mean levels of follicle-stimulating hormone (FSH), antral follicle count (AFC) and anti-Müllerian hormone (AMH). No significant differences were observed, suggesting minimal to no impact on ovulatory function [13]. Both studies indicate promising pregnancy rates following RALM. However, it is important to acknowledge the limited sample sizes in both studies.

A retrospective study conducted in 2015, consisting of 53 women aiming to conceive following RALM, identified a 52.8% conception rate over an average 17-month follow up time [19]. These findings closely resemble those of an earlier study by Pitter *et al*. [14], which surveyed 426 women who underwent RALM, reporting a 50.8% pregnancy success rate among those desiring conception. Notably, this rate was lower compared to the aforementioned studies involving conventional laparoscopy. It is worth noting that 60% of patients in this study cited infertility as the primary reason for undergoing myomectomy.

2.3 Pregnancy Related Outcomes

Two studies have specifically reported these outcomes, with one reporting pregnancy rates following RALM and the other two examining outcomes following conventional laparoscopy.

Pitter *et al*. [15] investigated pregnancy outcomes in 127 females who had conceived following robotic myomectomy. There were 92 successful pregnancies, with a considerable proportion of babies born prematurely (13 born between 33–35 weeks, 1 at 28–32, and 2 born before 28 weeks), with higher preterm rates correlating with a greater number of myomas removed [15]. The study also reported one instance of uterine rupture and discovered adhesions in 11.4% of cases [15]. To our knowledge, no other studies that have associated RALM to preterm birth.

Table 1. Post-operative fertility outcomes of various MIS myomectomy techniques.

MIS myomectomy technique	Study	Study design	Post-operative fertility outcomes
Conventional laparoscopy	Sizzi *et al*. 2007 [9]	Prospective cohort study (n = 550)	70% pregnancy success rate
	Metwally *et al*. 2020 [10]	Meta-analysis of 2 randomized control trials (RCTs; n = 177)	30–59% pregnancy success rate
	Koo *et al*. 2015 [16]	Systematic review (n = 2852)	76.5% pregnancy success rate
	Arena *et al*. 2021 [11]	Comparative study on sutures (n = 164)	60.5% pregnancy rate (non-barbed sutures) compared to 50.6% (barbed sutures)
Robotic-assisted laparoscopy	Goldberg *et al*. 2022 [12]	Prospective study (n = 123)	70% pregnancy success rate
	Cela *et al*. 2013 [13]	Prospective study (n = 48)	78% pregnancy success rate
	Pitter *et al*. 2015 [14]	Retrospective study (n = 53)	52.8% pregnancy success rate
	Pitter *et al*. 2013 [15]	Retrospective study (n = 426)	50.8% pregnancy success rate
Mini-laparotomy	Malzoni *et al*. 2010 [17]	Retrospective study (n = 136)	50% pregnancy success rate
	Palomba *et al*. 2007 [18]	RCT (n = 164)	51% pregnancy success rate

MIS, minimally invasive surgery; RCT, randomized control trial.

Table 2. Fertility outcomes between MIS techniques.

MIS myomectomy techniques	Study	Study design	Key findings
Robotic myomectomy *vs*. conventional laparoscopy	Iavazzo *et al*. 2016 [24]	Meta-analysis (n = 88)	No statistically significant difference in post-operative fertility outcomes between the two techniques. OR: 2.03. 95% CI: 0.29–14.11.
Conventional laparoscopy *vs*. single-site laparoscopy	Kim *et al*. 2014 [25]	Case-control study (n = 135)	No significant differences between groups regarding pregnancy rates (50% *vs*. 67%, $p = 0.38$), and no difference in the time to first pregnancy after surgery (7.6 *vs*. 10.1 months).
Robotic single-site myomectomy (RSSM) *vs*. robotic single-port myomectomy (RSPM)	Kim *et al*. 2023 [26]	Retrospective cohort study (RSSM: n = 11, RSPM: n = 46)	Pregnancy rates: 54.5% (RSSM group) and 67.4% (RSPM group). RSPM showed an advantage in preserving fertility, possibly due to its use in less complex surgical cases.

MIS, minimally invasive surgery; OR, odds ratio; CI, confidence interval; RSSM, robotic single-site myomectomy; RSPM, robotic single-port myomectomy.

A retrospective cohort study conducted by Koo *et al*. [16] documented the pregnancy outcomes in 523 women following laparoscopic myomectomy, revealing no significant disparities compared to the general population. Of these women, 76.5% who sought pregnancy achieved full-term deliveries, with the average time to conception being 14 months. The study also found that 0.6% of women experience uterine rupture, a rate insignificantly different from that of the general population [16].

3. MIS Compared to Open Laparotomy

The transition from open laparotomy to MIS for myomectomy holds significant historical importance, reshaping the landscape of surgical approaches for treating uterine fibroids. MIS techniques, including laparoscopic and robotic-assisted procedures, are widely recognized as superior to open laparotomy in terms of post-operative pain, shorter hospital stays, and reduced blood loss [20]. However, while the evidence supporting these benefits is robust, the data concerning fertility outcomes is less conclusive.

3.1 Laparotomy versus Laparoscopic Myomectomy

A meta-analysis, which analyzed data from 829 patients across 5 articles, examined fertility outcomes post-laparotomic versus laparoscopic myomectomy. The results exhibited inconsistency regarding pregnancy rates across different surgical approaches. One randomized control trial (RCT) reported no significant difference, while two indicated a trend towards increased pregnancy rates among patients who underwent laparoscopy, and one study observed higher pregnancy rates in patients who underwent a laparotomic myomectomy [21]. Surgical method did not correlate with the subsequent mode of delivery (cesarean *vs*. vaginal birth), and rates of premature births were statistically similar between the groups [21]. This finding aligns with a study by Seracchioli *et al*. [22], which found no significant difference in pregnancy rates following laparotomy (55.9%) compared to laparoscopy (53.6%). A more recent study by Wise *et al*. [23] further corroborated these findings, concluding no notable differences between abdominal or laparoscopic myomectomy when adjusted for maternal age and pregnancy intent. However, similar to the previous study, there was a trend towards higher pregnancy rates among the laparoscopic myomectomy cohort [23].

3.2 Mini-laparotomy versus Laparoscopic Myomectomy

Two studies compared laparoscopic myomectomy to myomectomy performed via mini-laparotomy [17,18]. A retrospective, non-RCT (n = 136) conducted by Malzoni *et al*. [17] found a significant increase in pregnancy rates among patients who underwent laparoscopic myomectomy compared to mini-laparotomy (74% *vs*. 50%). In contrast, a cohort study involving 164 patients demonstrated similar spontaneous pregnancy rates between groups (mini-laparotomy 51% *vs*. laparoscopic myomectomy 56%) [18].

4. Fertility Outcomes between MIS Techniques

There are few studies comparing fertility outcomes between different MIS techniques. One study has documented fertility outcomes following robotic myomectomy *vs*. conventional laparoscopy, while another study compared the fertility outcomes of conventional laparoscopy *vs*. single-site laparoscopy. A summary of these results can be seen in Table 2 (Ref. [24–26]).

4.1 Robotic Myomectomy vs. Conventional Laparoscopy

In a noteworthy meta-analysis conducted by Iavazzo *et al*. [24], the comparison between robotic-assisted and laparoscopic myomectomy was explored. This meta-analysis included two studies involving a total of 88 participants, focusing on post-operative fertility outcomes. The analysis revealed no statistically significant difference in post-operative fertility outcomes between the two techniques, yielding an OR of 2.03 and a 95% CI of 0.29–14.11 [24].

4.2 Conventional Laparoscopy vs. Single-Site Laparoscopy

A case-control study (N = 135) examined pregnancy rates in women following a traditional multi-port approach versus single-site myomectomy for patients with fibroids less than 8 cm. The study found no significant differences between groups regarding pregnancy rates (50% *vs*. 67%, $p = 0.38$), and no significant difference in the time to first pregnancy after surgery (7.6 *vs*. 10.1 months) [25].

4.3 Robotic Single-Site Myomectomy (RSSM) vs. Robotic Single-Port Myomectomy (RSPM)

In a 2023 study, fertility outcomes were compared between two RALM techniques utilizing the da Vinci surgical system. RSSM and RSPM were performed on 286 women, 57 of whom expressed their desire for pregnancy. Among these 57 women, pregnancy was achieved in 54.5% (RSSM group) and 67.4% (RSPM group). Despite the apparent advantage of RSPM in preserving fertility, such a discrepancy could be attributed to RSSM being reserved for women requiring more complex surgical intervention [26].

5. Discussion

According to the literature reviewed, myomectomy, irrespective of the surgical approach employed, is generally not associated with significant impacts on fertility outcomes. The studies report varying success rates, revealing significant variations among the different surgical approaches, such as conventional laparoscopy, RALM, or laparotomy. Despite the lack of clear associations found, there is no evidence to suggest that myomectomy is linked to inferior fertility or pregnancy outcomes in women who have undergone this procedure for the treatment of their fibroids. Moreover, the occurrence of potential complications, such as uterine rupture and adhesion formation,

subsequent to myomectomy, is notably low. Nonetheless, it is essential to highlight the need for further investigation regarding the potential association between RALM and preterm birth, given the current limitations in the available evidence.

At present, the existing literature offers limited clarity regarding the comparative effectiveness of individual MIS techniques, with studies reporting inconsistent results. Factors such as intent of the mother to conceive and average follow-up time to conception were not uniformly and consistently reported across studies, which could potentially account for these inconsistencies. Another important consideration is the inherent complexity and heterogeneity of uterine fibroids themselves. Given that fibroids can vary greatly in size, number, and location, certain minimally invasive techniques may be reserved for larger or more numerous fibroids, thereby introducing a potential confounding factor into the assessment of fertility outcomes. This is particularly problematic when performing laparoscopic myomectomy, including RALM, on larger fibroids. In recent years, the practice of morcellation has been discouraged due concerns regarding potential fibroid dissemination and recurrence. Various techniques have been developed to address this challenge, such as Endo-bag morcellation and Extracorporeal C-incision tissue extraction. However, for large fibroids ($>$10 cm), open laparotomy remains the preferred intervention [27]. The inherent variability in surgical indications introduces an element of implicit bias, rendering direct comparisons between various myomectomy techniques challenging. This is because the characteristics of the fibroids themselves can significantly impact fertility outcomes.

Another crucial consideration when addressing infertility or symptomatic fibroids is the propensity for adhesion formation. Myomectomy is widely regarded as being particularly susceptible to adhesion formation compared to any pelvic surgical procedure. Considering this, it is crucial for surgeons to carefully balance the potential benefits of performing myomectomy against the risk of iatrogenic complications. When aiming to enhance fertility outcomes, the removal of large posterior-located fibroids, which significantly distort the uterus, are more strongly indicated for surgical intervention, as they may detrimentally impact reproductive function. However, subserosal and intramural fibroids should be more closely evaluated in terms of their size and location to determine the potential benefit of myomectomy. Additionally, access to measures aimed at minimizing adhesions also significantly influences the risk-benefit assessment when determining whether to proceed with myomectomy [28].

In an effort to preserve fertility, multiple surgical techniques are employed to mitigate the risk of adhesion formation. Techniques such as ensuring complete hemostasis, frequent irrigation of the abdominal cavity, and the use of physical barriers have demonstrated promising results in limiting adhesion formation. Cross-linked hyaluronic acid gel barriers seem to offer the highest rates of fertility preservation. However, without further research, there is no definitive best post-operative barrier method [28–30].

The necessity for long-term follow-up data is also crucial in evaluating the durability of fertility outcomes following myomectomy. Longitudinal studies that extend beyond the initial post-operative period are essential to assess the sustained impact of different MIS techniques on fertility. Furthermore, it is important to consider the potential influence of patient age, ovarian reserve, and other fertility-related factors when interpreting results. Age-related declines in fertility and variations in ovarian reserve can significantly impact the success of fertility interventions, including myomectomy.

In summary, the current literature lacks uniformity in reporting crucial variables, including fibroid size and location, patient demographics, and surgical specifics. This inconsistency restricts the capacity to conduct robust comparative analyses. Additionally, the retrospective nature of these studies, coupled with the absence of standardized outcome measures, also pose challenges in drawing definitive conclusions.

These limitations underscore the necessity for well-designed prospective studies that adhere to standardized criteria for patient selection, surgical techniques, and outcome assessment. Meta-analyses can subsequently shed light on any true discrepancies between techniques, thereby contributing to the refinement of clinical decision-making processes and optimization of patient outcomes.

In addition to considering evidence of fertility outcomes, clinicians should also factor in patient-specific variables when determining the most suitable minimally invasive technique for myomectomy. Considerations should include the size, number, and location of fibroids, as along with the patient's reproductive goals and surgical history. These individualized factors play a pivotal role in tailoring the approach to each patient, thereby maximizing the likelihood of achieving successful fertility outcomes.

Ongoing advancements in surgical technology and techniques, such as the continuous development of robotic-assisted devices and the refinement of single-site laparoscopy, are poised to have a significant impact on the landscape of minimally invasive techniques. These advancements have the potential to benefit post-procedural outcomes and their implications for fertility. Consequently, it is imperative for future studies to evaluate the impact of emerging techniques on fertility outcomes in order to provide up-to-date guidance.

6. Conclusions

In conclusion, the literature suggests that myomectomy is associated with favorable fertility outcomes. Use of conventional laparoscopy, RALM, and laparotomy all exhibit similar rates of successful pregnancies post-surgery,

with no discernible differences in mode of delivery. Complications such as uterine rupture and adhesion formation are infrequent, and further studies should be conducted to explore the potential association between RALM and preterm birth. Limited evidence exists regarding differences between individual MIS techniques, with studies reporting inconsistent results. Further research and meta-analyses are warranted in order to elucidate any clear differences between these methods, which could enhance the clinical decision-making process and facilitate the achievement of optimal outcomes. Clinicians should consider patient-specific factors, including the size, number, and location of fibroids, as well as the patient's reproductive goals and surgical history, when determining the most suitable minimally invasive technique for myomectomy. Ongoing advancements in surgical technology and techniques are expected to continue shaping the landscape of minimally invasive myomectomy and its effects on fertility outcomes. Therefore, it is crucial for studies to assess the impact of emerging techniques on fertility outcomes to provide current and relevant guidance.

Author Contributions

KA and VT were responsible for conceptualisation and study design. KA, SL and CH performed the literature and analysed the data. All authors contributed to writing and making editorial changes on the manuscript. All authors have read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

Not applicable.

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Conflict of Interest

The authors declare no conflict of interest. Vasilios Tanos is serving as one of the Editorial Board members of this journal. We declare that Vasilios Tanos had no involvement in the peer review of this article and has no access to information regarding its peer review. Full responsibility for the editorial process for this article was delegated to Yasuhiko Ebina.

References

[1] Bulun SE. Uterine fibroids. The New England Journal of Medicine. 2013; 369: 1344–1355.

[2] Baird DD, Dunson DB, Hill MC, Cousins D, Schectman JM. High cumulative incidence of uterine leiomyoma in black and white women: ultrasound evidence. American Journal of Obstetrics and Gynecology. 2003; 188: 100–107.

[3] Donnez J, Dolmans MM. Uterine fibroid management: from the present to the future. Human Reproduction Update. 2016; 22: 665–686.

[4] Stout MJ, Odibo AO, Graseck AS, Macones GA, Crane JP, Cahill AG. Leiomyomas at routine second-trimester ultrasound examination and adverse obstetric outcomes. Obstetrics and Gynecology. 2010; 116: 1056–1063.

[5] Donnez J, Jadoul P. What are the implications of myomas on fertility? A need for a debate? Human Reproduction. 2002; 17: 1424–1430.

[6] Giuliani E, As-Sanie S, Marsh EE. Epidemiology and management of uterine fibroids. International Journal of Gynaecology and Obstetrics. 2020; 149: 3–9.

[7] Tian YC, Long TF, Dai YM. Pregnancy outcomes following different surgical approaches of myomectomy. The Journal of Obstetrics and Gynaecology Research. 2015; 41: 350–357.

[8] Asmar J, Even M, Carbonnel M, Goetgheluck J, Revaux A, Ayoubi JM. Myomectomy by Robotically Assisted Laparoscopic Surgery: Results at Foch Hospital, Paris. Frontiers in Surgery. 2015; 2: 40.

[9] Sizzi O, Rossetti A, Malzoni M, Minelli L, La Grotta F, Soranna L, *et al*. Italian multicenter study on complications of laparoscopic myomectomy. Journal of Minimally Invasive Gynecology. 2007; 14: 453–462.

[10] Metwally M, Raybould G, Cheong YC, Horne AW. Surgical treatment of fibroids for subfertility. The Cochrane Database of Systematic Reviews. 2020; 1: CD003857.

[11] Arena A, Degli Esposti E, Cristani G, Orsini B, Moro E, Raimondo D, *et al*. Comparison of fertility outcomes after laparoscopic myomectomy for barbed versus nonbarbed sutures. Fertility and Sterility. 2021; 115: 248–255.

[12] Goldberg HR, McCaffrey C, Amjad H, Kives S. Fertility and Pregnancy Outcomes After Robotic-assisted Laparoscopic Myomectomy in a Canadian Cohort. Journal of Minimally Invasive Gynecology. 2022; 29: 72–76.

[13] Cela V, Freschi L, Simi G, Tana R, Russo N, Artini PG, *et al*. Fertility and endocrine outcome after robot-assisted laparoscopic myomectomy (RALM). Gynecological Endocrinology. 2013; 29: 79–82.

[14] Pitter MC, Srouji SS, Gargiulo AR, Kardos L, Seshadri-Kreaden U, Hubert HB, *et al*. Fertility and Symptom Relief following Robot-Assisted Laparoscopic Myomectomy. Obstetrics and Gynecology International. 2015; 2015: 967568.

[15] Pitter MC, Gargiulo AR, Bonaventura LM, Lehman JS, Srouji SS. Pregnancy outcomes following robot-assisted myomectomy. Human Reproduction. 2013; 28: 99–108.

[16] Koo YJ, Lee JK, Lee YK, Kwak DW, Lee IH, Lim KT, *et al*. Pregnancy Outcomes and Risk Factors for Uterine Rupture After Laparoscopic Myomectomy: A Single-Center Experience and Literature Review. Journal of Minimally Invasive Gynecology. 2015; 22: 1022–1028.

[17] Malzoni M, Tinelli R, Cosentino F, Iuzzolino D, Surico D, Reich H. Laparoscopy versus minilaparotomy in women with symptomatic uterine myomas: short-term and fertility results. Fertility and Sterility. 2010; 93: 2368–2373.

[18] Palomba S, Zupi E, Falbo A, Russo T, Marconi D, Tolino A, *et al*. A multicenter randomized, controlled study comparing laparoscopic versus minilaparotomic myomectomy: reproductive

outcomes. Fertility and Sterility. 2007; 88: 933–941.
[19] Huberlant S, Lenot J, Neron M, Ranisavljevic N, Letouzey V, De Tayrac R, *et al*. Fertility and obstetrical outcomes after robot-assisted laparoscopic myomectomy. The International Journal of Medical Robotics + Computer Assisted Surgery. 2020; 16: e2059.
[20] Tanos V, Lee SYC, Alexander K, Pavlou A, Balanos I, Sandhu A. Laparoscopic myomectomy complications: META analysis on RCTs and review of large cohort studies. European Journal of Obstetrics, Gynecology, and Reproductive Biology. 2023; 287: 109–118.
[21] Orlando M, Kollikonda S, Hackett L, Kho R. Non-hysteroscopic Myomectomy and Fertility Outcomes: A Systematic Review. Journal of Minimally Invasive Gynecology. 2021; 28: 598–618.e1.
[22] Seracchioli R, Rossi S, Govoni F, Rossi E, Venturoli S, Bulletti C, *et al*. Fertility and obstetric outcome after laparoscopic myomectomy of large myomata: a randomized comparison with abdominal myomectomy. Human Reproduction. 2000; 15: 2663–2668.
[23] Wise LA, Thomas L, Anderson S, Baird DD, Anchan RM, Terry KL, *et al*. Route of myomectomy and fertility: a prospective cohort study. Fertility and Sterility. 2022; 117: 1083–1093.
[24] Iavazzo C, Mamais I, Gkegkes ID. Robotic assisted vs laparoscopic and/or open myomectomy: systematic review and meta-analysis of the clinical evidence. Archives of Gynecology and Obstetrics. 2016; 294: 5–17.
[25] Kim JY, Kim KH, Choi JS, Lee JH. A prospective matched case-control study of laparoendoscopic single-site vs conventional laparoscopic myomectomy. Journal of Minimally Invasive Gynecology. 2014; 21: 1036–1040.
[26] Kim SJ, Park MH, Lee JH. Comparison of operative and fertility outcomes of single-incision robotic myomectomy: a retrospective single-center analysis of 286 cases. Journal of Robotic Surgery. 2023; 17: 2945–2953.
[27] Della Corte L, Guarino MC, Vitale SG, Angioni S, Mercorio A, Bifulco G, *et al*. C-section technique vs minilaparotomy after minimally invasive uterine surgery: a retrospective cohort study. Archives of Gynecology and Obstetrics. 2024; 309: 219–226.
[28] Mercorio A, Della Corte L, Boccia D, Palumbo M, Reppuccia S, Buonfantino C, *et al*. Myomectomy in infertile women: More harm than good? Frontiers in Surgery. 2023; 10: 1151901.
[29] Vitale SG, Riemma G, Carugno J, Perez-Medina T, Alonso Pacheco L, Haimovich S, *et al*. Postsurgical barrier strategies to avoid the recurrence of intrauterine adhesion formation after hysteroscopic adhesiolysis: a network meta-analysis of randomized controlled trials. American Journal of Obstetrics and Gynecology. 2022; 226: 487–498.e8.
[30] Borghese G, Raffone A, Raimondo D, Saccone G, Travaglino A, Degli Esposti E, *et al*. Adhesion barriers in laparoscopic myomectomy: Evidence from randomized clinical trials. International Journal of Gynaecology and Obstetrics. 2021; 152: 308–320.