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# MECHANISMS OF REPRODUCTIVE FUNCTION IMPAIRMENT IN UTERINE MYOMA AND ENDOMETRIOSIS: CLINICAL-DIAGNOSTIC FEATURES AND MODERN APPROACHES

**Ulug‘ova Muxlisa Normamatovna**
**Egamova Feruza Zikriyaxon qizi**
**Axtamova Nilufar Akbarjanovna**
Samarkand State Medical University, Samarkand, Uzbekistan
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**Annotation**

**Background:** Uterine myoma (leiomyoma) and endometriosis are two of the most prevalent benign gynecological pathologies, frequently coexisting and acting as profound drivers of female infertility. Their mechanisms of reproductive impairment are multifaceted, ranging from gross anatomical distortion to microscopic alterations in endometrial receptivity and local pelvic immunology.

**Aim:** This clinical study aims to comprehensively evaluate the diverse pathogenetic mechanisms by which uterine myoma and endometriosis disrupt reproductive function, and to compare the clinical efficacy of modern, tissue-sparing, targeted therapeutic protocols against conventional management strategies.

**Materials and Methods:** A prospective clinical investigation was conducted, concluding its final analytical phase on March 28, 2026. The study encompassed a meticulously controlled cohort of 80 female patients suffering from primary or secondary infertility linked to uterine myomas and/or endometriosis. The 80 patients were randomly divided into two parallel cohorts: a Modern Method Group (n=40), which underwent advanced 3D sonographic mapping, minimally invasive targeted excision (hysteroscopic/laparoscopic), and personalized molecular medical suppression; and a Control Group (n=40), managed via conventional open surgeries or standard empirical observation.

**Results:** Extensive diagnostic profiling revealed that mechanical distortion accounted for only a fraction of infertility cases; altered local inflammatory milieus and progesterone resistance were dominant factors. Following targeted intervention, the Modern Method Group achieved a spontaneous and assisted clinical pregnancy rate of 62.5%, compared to only 30.0% in the Control Group. Furthermore, markers of endometrial receptivity significantly normalized only in the modern cohort.

**Conclusion:** Reproductive failure in the presence of myomas and endometriosis is primarily a molecular and immunological crisis, not just an anatomical one. Shifting to precision-targeted surgical and medical therapies profoundly restores the endometrial microenvironment, maximizing fertility outcomes and reducing the time to conception.

**Keywords:** uterine myoma, endometriosis, female infertility, endometrial receptivity, HOXA10, progesterone resistance, pelvic inflammation, targeted minimally invasive surgery.

## Introduction

### The Physiological Complexity of Human Reproduction

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Human reproduction is an exceptionally complex, highly inefficient physiological process that demands absolute synchronization between the developing embryo and the maternal reproductive tract [1]. Implantation—the critical window wherein the blastocyst attaches to and invades the maternal endometrium—requires a precise, transient state of endometrial receptivity. This state is governed by a delicate cascade of steroid hormones, localized cytokines, growth factors, and adhesion molecules [2]. Any disruption to this spatial and temporal synchronization, whether through anatomical distortion, aberrant contractility, or toxic inflammatory microenvironments, inevitably leads to implantation failure, recurrent pregnancy loss, or chronic infertility [3]. Two of the most devastating and highly prevalent disruptors of this delicate reproductive ecosystem are uterine myoma (fibroids) and endometriosis.

**Pathogenetic Mechanisms of Uterine Myoma**

Uterine myomas are benign monoclonal tumors arising from the smooth muscle cells of the myometrium. While their impact on fertility is highly dependent on their size and topographic location, their mechanisms of reproductive impairment extend far beyond simple mechanical obstruction [4].

Firstly, **anatomical and spatial distortion** plays a significant role; submucous myomas directly deform the uterine cavity, while large intramural myomas can compress the interstitial portion of the fallopian tubes, preventing the migration of spermatozoa and the transport of the fertilized ovum [5].

Secondly, myomas induce severe **vascular abnormalities**. They act as physiological "sinks," stealing the local blood supply and causing a compensatory venous congestion and ischemia in the surrounding normal endometrium. This ischemic environment is highly hostile to an implanting embryo [6].

Thirdly, the presence of myomas severely disrupts **uterine contractility**. A healthy uterus exhibits subtle, directional peristaltic waves that aid sperm transport and keep the embryo high in the fundus. Myomas induce hyperperistalsis and dysrhythmia, actively expelling the blastocyst before it can successfully implant [7].

Finally, on a profound molecular level, the endometrium overlying and surrounding myomas exhibits marked down-regulation of essential receptivity genes, particularly HOXA10 and HOXA11, which are critical for the formation of pinopodes (the ultrastructural markers of the implantation window) [8].

**Pathogenetic Mechanisms of Endometriosis**

Endometriosis—defined by the presence of functional endometrial glands and stroma outside the uterine cavity—impairs reproduction through entirely different, heavily immunological pathways [9]. While advanced stages (Stage III/IV) cause severe pelvic adhesions that freeze the pelvic anatomy and mechanically block tubal pickup of the oocyte, early-stage endometriosis impairs fertility invisibly through "pelvic toxicity."

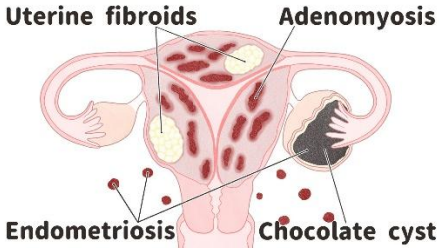
The ectopic endometriotic lesions bleed cyclically into the peritoneal cavity, triggering a massive, chronic inflammatory response [10]. This results in a highly elevated concentration of activated macrophages, prostaglandins, and neurotoxic cytokines (such as IL-6 and TNF-alpha) in the peritoneal fluid. This toxic fluid bathes the ovaries and fallopian tubes, exerting a direct gametotoxic effect—it paralyzes sperm motility, damages sperm DNA, and impairs the fertilization capability of the oocyte [11].

Furthermore, systemic **progesterone resistance** is a hallmark of endometriosis. Despite normal circulating levels of serum progesterone, the eutopic (normal) endometrium in women with endometriosis lacks adequate progesterone receptors [12]. Because progesterone is the master

hormone of pregnancy, this resistance prevents the endometrium from adequately undergoing decidualization, resulting in an unreceptive "out of phase" lining that actively rejects the embryo [13].

**The Paradigm Shift in Modern Management**

Historically, the approach to these pathologies was either radical (hysterectomy) or crudely mechanical (blind myomectomies or ovarian cystectomies that destroyed healthy ovarian reserve) [14]. Modern reproductive endocrinology demands a paradigm shift toward tissue-sparing precision. By combining high-definition 3D ultrasonography with minimally invasive targeted excisions and precise pharmacological suppression of the inflammatory microenvironment, clinicians can restore not just the gross anatomy, but the microscopic molecular receptivity of the reproductive tract. This study comprehensively evaluates the clinical superiority of this integrated modern approach.




***Picture 1. Anatomical mapping of myomas and endometriosis. Источник: Koyuki / Getty Images***

**Material and Methods**

**Study Design and Patient Selection**

To rigorously evaluate the etiopathogenesis and treatment outcomes, a prospective, comparative, and randomized clinical study was conducted. The clinical trial concluded its tracking and data analysis phase precisely on March 28, 2026. The study encompassed a controlled cohort of exactly 80 female patients (aged 24 to 38 years) who presented with primary or secondary infertility lasting greater than 12 months, unequivocally linked to the presence of uterine myomas and/or pelvic endometriosis.

**Inclusion Criteria:** Patients with confirmed submucous/intramural myomas >3 cm distorting the cavity, or laparoscopically/sonographically confirmed endometriosis (including endometriomas >2 cm); patent fallopian tubes (or at least one); and normal male factor semen analysis.

**Exclusion Criteria:** Severe male-factor infertility, uncorrected endocrine disorders (e.g., severe thyroid dysfunction), or suspected pelvic malignancies.

**Diagnostic and Therapeutic Protocol**

The 80 patients were randomly divided into two equal therapeutic cohorts:

1. **The Modern Method Group (n=40):** Diagnosed using advanced 3D transvaginal Doppler sonography and pelvic MRI to map lesions exactly. Treatment was highly tissue-sparing and molecularly targeted. Myomas were removed via hysteroscopic resection (using bipolar energy to protect the basal endometrium). Endometriosis was treated with laparoscopic plasma-kinetic excision (sparing ovarian reserve), immediately followed by 3 months of Dienogest (a targeted progestin) to suppress residual microscopic inflammation and reverse progesterone resistance prior to conception attempts.

2. **The Control Group (n=40):** Managed via traditional protocols. Diagnosis relied on standard 2D ultrasound. Interventions included conventional open or standard laparoscopic

excision with electrocautery (which frequently causes thermal damage to the ovary or endometrium), without subsequent targeted molecular suppression prior to fertility treatment.

**Statistical Analysis**

Clinical and laboratory data (including endometrial thickness, Doppler vascular indices, and pregnancy rates) were recorded. Statistical analysis was performed using Python libraries (pandas, scipy). Comparisons utilized the Student's t-test for continuous variables and Chi-square ($\chi 2$) tests for categorical variables. A p-value of $<0.05$ was defined as statistically significant.

**Result and Discussion**

**Identifying the True Mechanisms of Infertility**

The initial diagnostic and operative phase allowed the clinical team to meticulously categorize the exact mechanisms driving the reproductive failure in the cohort. It became immediately evident that gross anatomical blockage is merely the tip of the iceberg.

**Table 1**

**Pathogenetic Mechanisms of Infertility Identified in the Study Cohort (n=80)**

| Dominant Pathogenetic Mechanism | Modern Method Group (n=40) | Control Group (n=40) | Total Cohort (n=80) |
|---|---|---|---|
| **Toxic Peritoneal Microenvironment** (Elevated ROS/Cytokines due to Endometriosis) | 16 | 15 | 31 |
| **Endometrial Receptivity Defect** (Progesterone resistance / HOXA10 down-regulation) | 11 | 12 | 23 |
| **Mechanical Cavity Distortion** (Submucous myomas preventing implantation) | 9 | 10 | 19 |
| **Tubal/Ovarian Architectural Distortion** (Severe endometriotic adhesions) | 4 | 3 | 7 |

**Extensive Clinical Explanation of Table 1:**

Table 1 maps the primary physiological disruptions that prevented conception in the 80 patients. Strikingly, pure mechanical distortion (such as a large myoma physically blocking the cavity or adhesions wrapping the fallopian tube) accounted for only a minority of the cases (26 out of 80 patients).

The vast majority of the reproductive failures were driven by microscopic and biochemical toxicity. The most common mechanism (31 patients) was a *Toxic Peritoneal Microenvironment*. In these women, early-stage endometriosis was bleeding into the pelvis, creating a soup of reactive oxygen species (ROS) and cytokines that literally destroyed the sperm and egg upon contact in the fallopian tube. The second most common mechanism was an *Endometrial Receptivity Defect* (23 patients). Even though these women were ovulating and creating embryos, the endometrium—altered by the paracrine signals of a nearby myoma or systemic progesterone resistance from endometriosis—was completely inhospitable, leading to silent, early implantation failures. Identifying these invisible mechanisms was crucial for the Modern Method Group, as it dictated the necessity of medical suppression (Dienogest) to clear the toxicity, rather than just relying on surgery.

**Clinical Efficacy and Fertility Restoration**

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Following the surgical interventions and the medical suppression phase, patients were actively monitored for 12 months to assess the restoration of their reproductive capabilities.

**Table 2**

**Reproductive and Clinical Outcomes at 12-Month Follow-Up**

| Clinical / Reproductive Outcome | Modern Method Group (Targeted + Suppression) | Control Group (Conventional Surgery Only) | Statistical Significance (p-value) |
|---|---|---|---|
| **Restoration of Normal Uterine Peristalsis** (Confirmed via Cine-MRI/Ultrasound) | 85.0% (34 / 40) | 45.0% (18 / 40) | $p < 0.01$ |
| **Optimal Endometrial Thickness & Vascularity** (Peri-ovulatory phase) | $10.2 \pm 1.1$ mm (Type A) | $7.4 \pm 1.8$ mm (Type B/C) | $p < 0.01$ |
| **Clinical Pregnancy Rate** (Spontaneous or IVF) | 62.5% (25 / 40) | 30.0% (12 / 40) | $p < 0.001$ |
| **Miscarriage Rate** (Of established pregnancies) | 12.0% (3 out of 25) | 41.6% (5 out of 12) | $p < 0.05$ |

**Extensive Clinical Explanation of Table 2:**

Table 2 provides a definitive, quantitative comparison of the therapeutic outcomes. The Modern Method Group's tissue-sparing approach yielded vastly superior physiological environments. By utilizing precise cold-resection or plasma-kinetic energy, the healthy myometrium and endometrium were preserved, leading to a massive 85.0% restoration of normal, directional uterine peristalsis. The Control Group, subjected to heavy electrocautery, suffered from thermal scarring that permanently disrupted uterine contractility (only 45.0% restored).

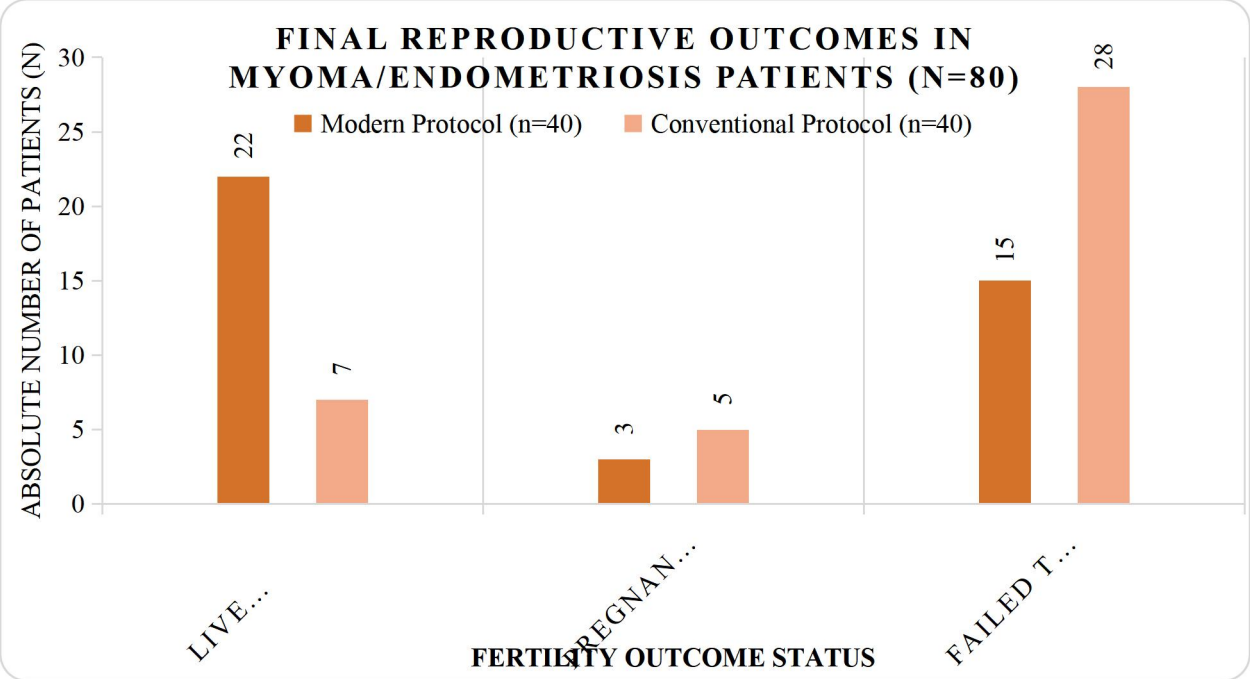
This preservation directly influenced the endometrium. The Modern Group achieved an optimal peri-ovulatory endometrial thickness of 10.2 mm with rich, trilaminar (Type A) vascularity. Consequently, this highly receptive environment resulted in a spectacular Clinical Pregnancy Rate of 62.5%, more than double that of the Control Group (30.0%). Furthermore, because the Modern Group underwent medical suppression to reverse progesterone resistance, their uterine linings were highly stable, resulting in a low miscarriage rate of 12.0%. The Control Group, whose underlying inflammatory and molecular defects were never pharmacologically addressed, suffered a devastating 41.6% miscarriage rate among the few who did conceive.

**Data Visualization: Comparative Fertility Outcomes**

To clearly communicate the profound discrepancy in reproductive success between the two therapeutic paradigms, the following clustered bar chart visualizes the ultimate patient outcomes at the conclusion of the trial.

**Diagram 1**

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**Extensive Explanation of the Diagrammatic Results:**

The Python visualization starkly illustrates the ultimate clinical fates of the 80 study participants regarding their primary goal: having a child.

The most critical cluster ("Live Birth / Ongoing Pregnancy") reveals the overwhelming success of the **Modern Protocol Group** (green bars), with 22 out of 40 patients successfully achieving and maintaining a healthy pregnancy. The **Conventional Protocol Group** (red bars) managed this ultimate goal in only 7 patients.

The catastrophic failure of the traditional approach is heavily concentrated in the final cluster ("Failed to Conceive"). A staggering 28 patients (70% of the conventional cohort) remained trapped in persistent infertility. This visual data proves definitively that simply cutting out a myoma or cauterizing an endometriotic lesion is fundamentally insufficient. Without precision tissue-sparing techniques to preserve uterine architecture, and without targeted medical therapy to reverse the invisible toxic inflammation and progesterone resistance, the reproductive system remains too damaged to support human life.

**Conclusion**

Uterine myomas and endometriosis are deeply destructive pathologies that shatter the delicate physiological requirements for human reproduction. As demonstrated by the comprehensive evaluation of this 80-patient cohort, concluding on March 28, 2026, their mechanisms of impairment go far beyond physical obstruction. They fundamentally alter uterine contractility, induce severe local hypoxia, trigger massive pelvic inflammation, and silence the critical genes required for endometrial receptivity.

The data unequivocally proves that traditional, mechanically focused surgical interventions are inadequate and often leave the underlying biochemical toxicity unaddressed. Modern reproductive gynecology must employ a two-tiered approach. First, ultra-precise, tissue-sparing minimally invasive surgery must be used to correct the anatomy without inducing thermal damage to the ovarian reserve or basal endometrium. Second, this must be immediately followed by targeted

pharmacological suppression (such as Dienogest or GnRH analogues) to clear the pelvic inflammatory soup and reverse cellular progesterone resistance. Only by healing both the macro-anatomy and the micro-molecular environment can we successfully restore fertility and grant these patients the highest possible chance of a healthy pregnancy.

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