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Review Article

Evolving Health Frontiers in MRKH Syndrome: A Narrative Review

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ABSTRACT

Mayer-Rokitansky-Küster-Hauser (MRKH) syndrome, or Mullerian agenesis, affects approximately 1 in 4,500 women, characterized by congenital absence of the uterus and upper two-thirds of the vagina. While patients possess normal secondary sexual characteristics and functional ovaries, they face unique challenges related to sexual function and reproductive potential. This review explores two rapidly evolving aspects mullerian agenesis care: non-surgical vaginal creation methods and fertility preservation strategies. Progressive vaginal dilation remains the gold standard for neovagina creation, with emerging devices and digital health tools enhancing home-based therapy outcomes. On the fertility front, options such as oocyte cryopreservation, gestational surrogacy, and the experimental yet promising uterine transplantation are reshaping possibilities for biological motherhood. This review emphasizes the importance of patient-centred approaches, technological integration, and ethical considerations in advancing care for individuals with Mayer-Rokitansky-Küster-Hauser syndrome.

Keywords: Mayer-Rokitansky-Kuster-Hauser syndrome, Mullerian agenesis, Neovagina, Vaginal dilation, Fertility preservation, Surrogacy, Uterine transplant, Oocyte cryopreservation.

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INTRODUCTION

Mullerian agenesis, also known as Mayer-Rokitansky-Kuster-Hauser (MRKH) syndrome, is a congenital condition that results in the absence or underdevelopment of the uterus and upper vagina in individuals with a 46 XX karyotype. Despite the absence of menstruation, these individuals develop normal secondary sexual characteristics due to functional ovaries and normal hormone profiles. The diagnosis is often made during adolescence when primary amenorrhea prompts further evaluation.[1] The syndrome occurs in approximately 1 in 4,500-5,000 female births.[2] While not life-threatening, MRKH significantly impacts a person's sexual and reproductive life, creating challenges around intimacy, gender identity, and future parenthood. The implications of MRKH syndrome go far beyond anatomical anomalies. The inability to menstruate, engage in penetrative sexual activity without intervention, or conceive naturally can significantly affect a patient's emotional well-being, body image, and identity.[3]

The psychological burden is often compounded by the delay in diagnosis, societal taboos, and lack of awareness among healthcare providers. Sexual and reproductive autonomy is a fundamental aspect of human rights and quality of life. For individuals with MRKH, achieving autonomy in these domains involves overcoming not only biological challenges but also societal and systemic barriers. Access to informed counseling, compassionate care, and modern treatment options is essential in supporting these individuals to lead fulfilling lives. For decades, management has focused on anatomical correction and psychological counselling.[4] However, recent years have seen a paradigm shift toward more holistic care that emphasizes sexual function, reproductive autonomy, and psychosocial well-being. In recent years, advancements in both non-surgical neovagina creation and fertility preservation have revolutionized the clinical approach to MRKH.[5] These innovations offer renewed hope, allowing individuals to make empowered choices about their bodies and futures. This review focuses on these developments, highlighting their clinical implications and the importance of holistic, patient-centred care.

ADVANCES IN NON-SURGICAL NEOVAGINA CREATION

Traditional method: gradual vaginal dilation

The technique of progressive vaginal dilation has long been established as a cornerstone of non-surgical treatment for vaginal agenesis, with its roots tracing back to the work of Frank in the 1930s.[6] This conservative therapy relies on the regular use

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of cylindrical dilators of increasing diameters, applied to the vaginal dimple or perineal area. Over time, and with consistent application of mechanical pressure, the process encourages epithelial cell proliferation, collagen remodeling, and expansion of the fibrous tissues to form a functional vaginal canal, a process referred to as neo-vaginal epithelialization.[7,8]

While the physiological outcomes of this method are well-documented, its success is not solely biological. A patient's emotional readiness, mental resilience, motivation, and ability to commit to the often-time-consuming routine play a pivotal role in achieving optimal results[8]. Privacy and comfort during home-based use also significantly influence compliance. Unfortunately, the physical discomfort, emotional vulnerability, and psychological burden associated with dilation can lead some patients to abandon the method prematurely or to opt for surgical interventions, such as the Vecchietti or McIndoe procedures, which offer more immediate anatomical results.[9]

Modern innovations: devices and technology-enhanced techniques

Recognizing the limitations of traditional dilators, medical device innovation has focused on improving patient experience to increase adherence and outcomes. Recent advances have introduced ergonomically contoured dilators to reduce pressure points and enhance comfort during insertion and use. Some newer models incorporate self-heating elements or materials that adjust to body temperature, which helps relax pelvic floor muscles and ease discomfort during therapy.[10]

Patients with MRKH undergoing oocyte cryopreservation followed by IVF and surrogacy report live birth rates similar to the general IVF population-typically 40-50% per transfer cycle.

In addition, the personalization of dilator sets using 3D printing technology allows for better anatomical alignment and custom fitting, particularly beneficial for patients with unique pelvic structures or scarring from prior interventions. These custom-made devices reduce friction and enhance tolerability, making long-term compliance more feasible.[11]

Digital integration has also become a cornerstone of modern dilation therapy. Telemedicine platforms enable regular remote monitoring by clinicians, ensuring patients are progressing as expected. Mobile applications offer daily usage reminders, real-time tracking of dilation sessions, and educational content to guide users through the process. Some advanced platforms now include AI-driven features that provide adaptive feedback based on a user's progress and comfort levels, helping to modify dilation schedules and reduce dropout rates. These digital tools also create a private, supportive environment for users who may not have access to specialized care or who feel uncomfortable discussing such intimate issues in person.[11,12]

Persistent challenges and future perspectives

Despite the advances in device design and technological support, several systemic and individual-level barriers remain. Societal stigma, deeply rooted cultural taboos surrounding genital health and sexual development, and a general lack of awareness continue to limit the reach of dilation therapy. In many communities, discussions around female sexual anatomy and health are still considered inappropriate or are avoided altogether, creating barriers to timely diagnosis and intervention.[13] Moreover, patients with vaginal agenesis often experience significant psychological distress, including feelings of shame, confusion about their identity, fear of rejection, and body dysmorphia. For individuals with histories of sexual trauma, the process of dilation may trigger emotional distress, leading to avoidance behaviors.[14]

The absence of trained counselors or healthcare professionals familiar with the condition further compounds these issues.

Looking ahead, several strategies could significantly enhance the accessibility and success of dilation therapy:

- **Multidisciplinary Care Teams:** A collaborative approach involving gynecologists, clinical psychologists, pelvic floor physical therapists, and sex therapists can provide holistic care that addresses both the physical and emotional dimensions of treatment.[15]
- **Educational Outreach:** Integrating reproductive anatomy and congenital anomalies into school-based health education programs can foster early recognition and destigmatize discussions about conditions like vaginal agenesis.[13]
- **Access in Low-Resource Settings:** To expand reach, especially in underserved or rural areas, there is a need to develop cost-effective, reusable dilation kits, along with training community health workers who can offer guidance. Translation of educational materials into regional languages and the use of telehealth kiosks or mobile clinics may bridge the gap in remote regions.[16] The future of non-surgical vaginal agenesis treatment lies in combining medical innovation with compassionate, culturally competent care, ensuring that every patient, regardless of background, can access dignified, effective, and empowering treatment.

FERTILITY PRESERVATION AND SURROGACY IN MRKH PATIENTS

Oocyte cryopreservation: fertility preservation in MRKH syndrome

Although individuals with Mayer-Rokitansky-Küster-Hauser (MRKH) syndrome are born without a functional uterus, their ovarian function typically remains intact. This means they are capable of producing mature, fertilizable oocytes, making fertility

preservation through oocyte cryopreservation a viable and proactive option. This method is particularly beneficial when initiated early, ideally during adolescence or early adulthood, when ovarian reserve and response to stimulation are optimal.[17]

Clinical Indications for cryopreservation in MRKH patients include:

- Early diagnosis during adolescence or young adulthood.
- Plans to delay parenthood due to educational, professional, or personal reasons.
- Anticipation of future reproductive strategies such as uterine transplantation or surrogacy.[18]

The procedure involves:

- Controlled ovarian hyperstimulation using exogenous hormones.
- Monitoring follicular development through transvaginal ultrasound and hormonal assays.
- Retrieval of mature oocytes via transvaginal aspiration under ultrasound guidance.
- Cryopreservation of the harvested oocytes using vitrification-a rapid freezing method that minimizes ice crystal formation and preserves oocyte viability.

Comprehensive counseling is essential at all stages. Patients must understand that while cryopreservation preserves their biological potential for parenthood, successful pregnancy will ultimately require a gestational carrier. Informed consent should include discussions about success rates, costs, potential complications from ovarian stimulation, and long-term storage considerations. For patients with MRKH, fertility preservation is a unique and empowering tool that offers hope for future parenthood despite the absence of a uterus.[18,19]

Surrogacy and Assisted Reproductive Technology (ART): enabling biological parenthood

Assisted reproductive technologies, particularly *in vitro* Fertilization (IVF) combined with gestational surrogacy, provide a well-established path to biological parenthood for individuals with MRKH syndrome. In this approach, oocytes from the MRKH patient are fertilized with sperm from a partner or donor, and the resulting embryos are transferred to a gestational carrier who carries the pregnancy to term.[20]

Key components of this process include:

- Ovarian stimulation and oocyte retrieval from the MRKH patient.
- IVF to create embryos in the laboratory.
- Synchronization of menstrual cycles between the intended parent(s) and the surrogate.
- Embryo freezing and subsequent transfer to the gestational carrier.
- Legal and psychological screening to ensure the surrogate's eligibility and informed consent.

Success rates for IVF with surrogacy are generally comparable between MRKH patients and the general population, particularly when good-quality oocytes are used and the surrogate has an optimal uterine environment. However, several ethical, legal, and logistical considerations can affect the feasibility of surrogacy:

- **Legal landscape:** The legality of commercial or altruistic surrogacy varies greatly between countries. For instance, in India, recent legal reforms have introduced more stringent regulations, limiting eligibility to married heterosexual couples and requiring ethical approval from designated authorities.
- **Affordability:** The high financial costs associated with IVF and surrogacy, including medical procedures, legal contracts, surrogate compensation, and follow-up care, can be a barrier for many individuals.

Despite these challenges, surrogacy remains a reliable and widely practiced method for individuals with MRKH to achieve biological parenthood, provided there is adequate legal and medical support.[21,22]

Uterine Transplantation (UTx)

Uterine transplantation represents a transformative breakthrough for individuals with Absolute Uterine Factor Infertility (AUFI), a category under which MRKH syndrome is the leading cause. This procedure allows individuals without a functional uterus to experience gestation and childbirth using their own gametes.

The first successful live birth following UTx occurred in Sweden in 2014, marking a historic milestone in reproductive medicine. Since then, over 50 live births have been reported worldwide, indicating growing feasibility and acceptance of this complex intervention.

A more recent systematic review found overall success rates above 80% in surgically successful procedures, but serious complications occurred in 19% of recipients and 18% of donors, and preterm birth rates reached 80%.

Key features of uterine transplantation include:

- **Donor options:** Uterine grafts may be obtained from living donors (commonly the patient's mother, sister, or close relative) or from deceased donors in accordance with organ donation protocols.

- **Temporary nature:** The transplanted uterus is generally removed following one or two successful pregnancies to eliminate the need for long-term immunosuppression, which carries risks of infection, malignancy, and other systemic effects.
- **Multidisciplinary coordination:** The procedure necessitates collaboration among a diverse team of professionals including transplant surgeons, reproductive endocrinologists, obstetricians, immunologists, anesthesiologists, and psychologists to ensure both surgical and emotional readiness.[23]

While UTx has demonstrated proof of concept, it remains experimental and is not yet a routine clinical offering. The procedure is associated with a range of potential risks, including:

- Surgical complications in both donor and recipient.
- Risk of organ rejection, requiring strict immunosuppressive regimens.
- Increased likelihood of preterm labor, low birth weight, and cesarean delivery.
- Ethical concerns related to donor safety, particularly for living donors.[23,24]

Despite these challenges, uterine transplantation is a symbol of reproductive empowerment for individuals with MRKH and AUFI. It offers the unprecedented possibility of carrying one's own biological child—a development once thought to be unachievable. Ongoing research and clinical trials aim to refine surgical techniques, reduce complications, and eventually integrate UTx into mainstream fertility treatment protocols.

Clinical Outcomes of Reproductive Interventions in MRKH

Reproductive interventions for individuals with Mayer-Rokitansky-Küster-Hauser (MRKH) syndrome have shown promising clinical outcomes, offering options for sexual function and biological parenthood despite congenital uterine absence.

ETHICAL, PSYCHOLOGICAL, AND SOCIAL IMPLICATIONS

Ethical considerations in reproductive interventions for MRKH syndrome

The rapid evolution of reproductive technologies for individuals with Mayer-Rokitansky-Küster-Hauser (MRKH) syndrome has brought forth complex ethical dilemmas that require careful scrutiny. Among these, the implementation of Uterine Transplantation (UTx) as a reproductive option remains controversial. While UTx offers the potential for gestation and childbirth, critics argue that its invasive nature, surgical risks, and high resource demands may not justify its routine use, particularly when gestational surrogacy, a safer and less complex alternative, already exists.[24] Questions around prioritization of medical resources, especially in low and middle-income settings, further fuel this debate.

Another ethically sensitive area is the cryopreservation of oocytes in adolescents diagnosed with MRKH. Though preserving fertility early may offer long-term benefits, concerns arise regarding informed consent, psychological maturity, and the unpredictability of future desires. There is an ethical imperative to ensure that minors fully comprehend the implications of such procedures, necessitating age-appropriate counseling and involvement of guardians in decision-making, while still upholding the young patient's autonomy.[25]

Various reproductive interventions have shown promising results in MRKH syndrome, with differing levels of accessibility and risk (Table 1).

Table 1 illustrates that vaginal dilation is most accessible; surrogacy offers biological parenthood, while uterine transplantation remains experimental.

Healthcare professionals also struggle with the tension between respecting patient autonomy and ensuring non-maleficence, especially when interventions are experimental or carry significant physical and psychological risk. This includes not only UTx and fertility preservation but also complex hormonal therapies and surgical interventions for neovaginal creation. Moreover, healthcare inequities cannot be overlooked. Access to cutting-edge reproductive options is often limited by economic disparity, legal restrictions, cultural taboos, and social stigma. For instance, restrictive surrogacy laws in some regions and the high cost of IVF or UTx mean that only a privileged subset of patients can access these technologies. This raises broader questions about justice and fairness in reproductive healthcare. There is a pressing need for international guidelines and ethical frameworks to ensure that advancements in MRKH care do not widen the gap between those with and without resources.[26]

Psychological support and sexual health in MRKH care

The psychosocial impact of an MRKH diagnosis is profound, extending far beyond reproductive concerns. Many individuals experience grief, shame, identity conflict, and disrupted self-esteem, particularly during adolescence, a time when body image and sexuality become salient. The inability to menstruate or carry a pregnancy can lead to isolation, secrecy, and emotional distress, especially in environments where reproductive capacity is closely tied to femininity and social roles.[27]

Research underscores the importance of trauma-informed psychological support as a core component of MRKH

Table1: Comparative Overview of Reproductive Interventions in MRKH Syndrome.

Intervention	Success Rate	Common Complications	Accessibility	Notes
Vaginal Dilation	85-95%	Minor spotting, mild discomfort	Widely available	Non-invasive; first-line therapy with proper counselling.
Surgical Neovagina	75-95%	Infection, stenosis, fistula (rare)	Variable	Higher risk; preferred if dilation fails
Oocyte Cryopreservation + Surrogacy	40-50% live birth per IVF cycle	Legal/ethical issues, emotional burden	Moderately accessible	Allows biological motherhood; laws vary by region.
Uterine Transplantation	60-80% live birth per transplant	Surgical risks (19%), immunosuppression, preterm birth (80%)	Limited to pilot centres	Experimental; offers gestational experience; not yet widely available.

Sources: [6-9] [9-12] [17-22] [23,24].

management. A multidisciplinary approach that includes mental health professionals is essential for helping patients navigate diagnosis, treatment choices, and life transitions. Evidence-based strategies that have demonstrated positive outcomes include:

- **Trauma-informed counseling:** Validates the patient's emotional experiences and helps address the impact of medical interventions and societal expectations.
- **Cognitive Behavioral Therapy (CBT):** Targets maladaptive thoughts, reduces anxiety and depressive symptoms, and promotes adaptive coping mechanisms.
- **Peer support groups:** Online and in-person MRKH communities offer solidarity, shared experiences, and empowerment, which are often not found in traditional clinical settings. These groups help combat feelings of isolation and normalize experiences that patients may otherwise hide.[28]

Addressing sexual health is equally vital. Many MRKH patients face fears around intimacy and disclosure to partners. Education on sexual anatomy, communication, and consent is necessary to build confidence and foster healthy relationships. Including partners in therapeutic sessions, when appropriate, can enhance mutual understanding, reduce relationship strain, and foster shared decision-making around treatment and reproductive planning.[29,30] Ultimately, mental and sexual well-being are inseparable from overall health. Comprehensive MRKH care must integrate these dimensions to ensure patients feel seen, supported, and whole, not just physically treated.

CONCLUSION

With the integration of technology, evolving surgical frontiers, and patient-centred approaches, individuals with MRKH syndrome are now experiencing a more hopeful outlook in terms of sexual and reproductive health. Advances in non-surgical neovagina creation and fertility preservation are breaking barriers, offering new possibilities. With these advancements comes a renewed responsibility to uphold ethical integrity, psychological support, and health equity. Ensuring informed consent, addressing disparities in access, and offering empathetic, trauma-sensitive care are as crucial as the procedures themselves.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

ABBREVIATIONS

ART: Assisted Reproductive Technology; **AUFI:** Absolute Uterine Factor Infertility; **CBT:** Cognitive Behavioural Therapy; **IVF:** *In vitro* Fertilization; **MRKH:** Mayer-Rokitansky-Küster-Hauser; **UTx:** Uterine transplantation.

SUMMARY

Mayer-Rokitansky-Küster-Hauser (MRKH) syndrome is a rare congenital condition affecting individuals with a 46 XX karyotype, characterized by the underdevelopment or absence of the uterus and upper vagina, despite normal secondary sexual characteristics and ovarian function. Typically diagnosed during adolescence due to primary amenorrhea, MRKH significantly impacts sexual, emotional, and reproductive health. Traditional management has focused on anatomical correction and psychological counseling; however, recent advancements emphasize a holistic, patient-centered approach. Non-surgical creation of a neovagina

through dilation remains the first-line treatment, now enhanced with ergonomic, temperature-sensitive dilators and telehealth support. Despite progress, challenges such as emotional distress, societal stigma, and inadequate awareness persist, underscoring the need for multidisciplinary, culturally sensitive care. Fertility options have expanded with oocyte cryopreservation, gestational surrogacy, and experimental Uterine Transplantation (UTx), although these bring ethical, legal, and financial complexities. Comprehensive care must also address ethical concerns like adolescent consent and access equity, while providing strong psychological support to help patients navigate identity, shame, and trauma. Ultimately, the modern management of MRKH calls for an integrated strategy that combines medical innovation with empathetic, individualized support to empower patients and uphold their sexual and reproductive rights.

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