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Review on Development and Assessment of an Intravaginal Drug Delivery System for Polycystic Ovary Syndrome (PCOS)

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Abstract : Polycystic Ovary Syndrome (PCOS) is a complex endocrine disorder affecting a significant percentage of women of reproductive age, often leading to hormonal imbalance, irregular menstruation, and infertility. Conventional treatment approaches typically involve systemic drug administration, which may result in suboptimal therapeutic outcomes and systemic side effects. This study aims to develop and evaluate an intravaginal drug delivery system as a targeted and sustained-release therapeutic approach for managing PCOS symptoms. A mucoadhesive intravaginal gel was formulated using bio-compatible polymers and loaded with metformin and clomiphene citrate, two commonly used agents in PCOS treatment. The formulation was evaluated for pH compatibility, viscosity, drug release profile, mucoadhesive strength, and in vitro cytotoxicity. Results indicated sustained drug release over 24 hours, with favorable pH and viscosity for vaginal application, and acceptable mucoadhesive properties. The intravaginal route provided localized drug delivery with potential for enhanced therapeutic efficacy and reduced systemic exposure. This delivery system offers a promising alternative to oral therapy for PCOS, aiming to improve patient compliance and clinical outcomes.

Keywords : Polycystic Ovary Syndrome (PCOS), Metformin, Hormonal therapy, Women's health.

1. Introduction

Polycystic Ovary Syndrome (PCOS) is a common hormonal disorder affecting women of reproductive age. It leads to symptoms such as menstrual irregularities, infertility, hirsutism (excess hair growth), acne, and an increased risk of metabolic diseases. Conventional treatments for PCOS often involve oral medications, such as **anti-androgens**, **insulin sensitizers**, and **oral contraceptives**. However, these treatments may be associated with systemic side effects and reduced patient compliance due to their long-term use and oral administration.

An **intravaginal drug delivery system (IDDS)** offers a potential solution to these challenges by delivering therapeutic agents directly to the site of action (the vaginal mucosa). This localized delivery system can reduce the systemic side effects commonly associated with oral medications, increase bioavailability, and improve treatment outcomes by providing sustained drug release over time.

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The causes of polycystic ovary syndrome (PCOS) are multifaceted and varied. Insulin resistance (IR) and increased insulin levels are the major causes of the condition in 65–70% of cases. Another subpopulation of people with PCOS who are exceedingly thin and have increased insulin and fat levels has been uncovered by a recent research study. In spite of the fact that it is more often linked with those who are overweight, insulin resistance may affect both thin and overweight women. The symptoms of polycystic ovary syndrome (PCOS) grow more severe when there is an excess of testosterone in the body, and infertility (IR) lowers testosterone levels. Insulin resistance and hyperglycemia are the consequences of insulin receptors in ovarian tissue losing their sensitivity to insulin via repeated exposure. According to Azziz et al. (2016), this is connected to the metabolic and endocrine-related biological effects that are associated with polycystic ovarian syndrome or PCOS.

An irregular pulsatile release of gonadotropin-releasing hormone (GnRH) is associated with a combination of a sedentary lifestyle, a genetic predisposition, and gut dysbiosis. This combination exacerbates the already complex hormonal abnormalities that are associated with polycystic ovary syndrome (PCOS). According to Gibson-Helm et al. (2014), an imbalance in the release ratio of luteinizing hormone and follicle stimulating hormone is connected with an imbalance in the levels of luteinizing hormone (GnRH). Indicative of low levels of FSH and high levels of LH would be this. The inability to produce folic acid, which is the root cause of anovulation, is one of the most significant factors contributing to infertility in people who are being affected. As time passes, the shape of the cysts begins to change as a result of the fact that certain embryonic cells remain undetermined.

When a significant quantity of luteinizing hormone (LH) is released, it encourages the ovarian tissue to create more testosterone. Increased levels of both free LH and blood insulin contribute to the problem that causes anovulation to become even more severe. According to March et al. (2010) and Diamanti-Kandarakis and Papavassiliou (2006), when these levels are present, the ovary generates an excessive amount of testosterone.

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Androgens play a significant part in the development of skeletal and muscular skeletal structures, as well as in the maintenance of sexual function in females. A variety of androgens, including testosterone, dihydrotestosterone, dehydroepiandrosterone sulfate (DHEA-S), dehydroepiandrosterone (DHEA), and androstenedione (ANSD), are produced by the adrenal gland, hormones, and external organs (Abruzzese et al., 2022). Polycystic ovarian syndrome, on the other hand, is characterized by hyperandrogenic activity that is mostly centered on the ovaries. Important signs include the capacity to bind to sex hormone-binding globulin (SHBG) as well as a high quantity of testosterone in the blood. The fact that hyperandrogenism affects more than 89 percent of PCOS patients is something that fascinates me. According to Hernández-Jiménez et al. (2022), this disease is defined by insulin's ability to reduce the amount of SHBG that is produced by the liver, which in turn leads to an increase in the activity of androgens such as testosterone.

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According to the findings of the study, people with polycystic ovary syndrome (PCOS) had higher levels of phosphorylation of insulin receptors (IR) and IRS1 (IR substrate 1) in their muscle cells. Insulin signaling becomes defective as a result of this high phosphorylation level, which in turn initiates the MEK1/2 pathways that are related with the pathophysiology of polycystic ovarian syndrome (PCOS).
Insulin resistance (IR) is essential in highlighting hyperandrogenism since it is one of the major factors. Insulin's function as a co-gonadotropin on ovarian cells has been shown in a number of studies, including those using model organisms from both animals and humans. The adrenal glands therefore produce an excessive amount of androgens as a result of this, which in turn causes an increase in the frequency of the release of LH. Additionally, it is crucial since polycystic ovarian syndrome is more frequent in people who have co-occurring illnesses that cause insulin levels to rise (Zeng et al., 2020). Through these links, the molecular processes of insulin resistance and hyperinsulinism are brought to light as being essential to comprehending polycystic ovary syndrome (PCOS).

Hyperandrogenism has also been related to a number of symptoms associated with polycystic ovary syndrome (PCOS), including irregular periods, excessive weight, and severe insulin resistance. This is knowledge that is really important to understand. Polycystic ovarian syndrome (PCOS) is a condition that often manifests itself during puberty and becomes more severe throughout the teenage years, according to medical authorities. However, baldness is a rather uncommon occurrence, whereas hyperhidrosis is the most apparent clinical sign.

- **Disruptions in ovulation and menstrual cycle regularity:**

In spite of the fact that ovulatory failure and irregular periods are two of the most obvious signs of polycystic ovarian syndrome (PCOS), there are a great number of other noticeable symptoms as well. (Hoeger et al., 2021) It is common for adolescents to start experiencing symptoms of hirsutism and ovulation difficulties, such as amenorrhea or oligomenorrhea, after they have had their first menstrual period.

- **Hormonal abnormalities:**

Follicle-stimulating hormone (FSH) and luteinizing hormone (LH) work together to make it possible for immature eggs to grow into fully developed eggs. There is then ovulation, which is followed by the completion of the egg-maturation stage (LH). Chemerinski et al. is the name of the academic group of scholars.

- **Variations in FSH dynamics:**

The levels of follicle stimulating hormone (FSH) in a woman's blood stay within a safe range when her menstrual cycle is regular. It is during the follicular cycle that they are diagnosed with PCOS. During this change in FSH dynamics, which takes place as a result of some follicles being stationary for a protracted length of time, there is an increase in the amount of ovarian steroids that are produced. Additionally, these cells have negative feedback on FSH suppression, despite the fact that they continue to be capable of producing steroids. A significant portion of the imbalance is brought on by anterior follicles, which, as a result of their unfavorable response, prevent the formation of healthy follicles. The findings of Deeks et al. (2011) indicate that this results in the stopping of follicular activity, which in turn leads to anovulation.

- **Excessive release of LH:**

One of the most noticeable symptoms of polycystic ovarian syndrome (PCOS) is significant luteinizing hormone (LH) hypersecretion. This is an endocrine illness that is characterized by high LH pulse frequency and intensity. Increasing levels of luteinizing hormone (LH) cause

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the theca cells in the ovaries to create more androgen. This is because the LH stimulates the theca cells. It is fascinating to note that follicle-stimulating hormone (FSH) often produces a mechanism of negative feedback; yet, large levels of luteinizing hormone (LH) reduce this impact. This results in a disruption of the feedback loop that is ordinarily responsible for the conversion of androgens to estrogens. As a consequence of this, the already increased levels of androgens in the ovaries are even greater, and more androgens are delivered into the environment of the ovary in a roundabout way (Garzia et al., 2022).

- **Follicle arrest in the ovaries:**

PCOS is a complex issue that involves a number of different factors. The androgen-converting enzymes, the luteinizing hormone (LH), the insulin-like growth factor 1 (IGF1), and the anti-Muhlenian hormone (AMH) are some examples of hormones that promote male sexual reproduction. An irregular ovulation, also known as oligo-ovulation or full anovulation, is often brought on by this intricate network of connections, which is a prevalent cause of the condition (Vural et al., 2022).

In polycystic ovarian syndrome (PCOS), the release of testosterone by ovarian theca cells is a crucial factor that contributes to the condition. Changes in these ovarian theca cells are one of the factors that contribute to the occurrence of follicle halt, which is a characteristic of polycystic ovary syndrome. The physical signs of polycystic ovary syndrome are substantially impacted by this problem with the development of the ovary.

- **Fat tissue malfunction:**

Adipocytes in people with polycystic ovary syndrome (PCOS) have a more difficult time functioning properly due to peripheral insulin resistance. The fact that this problem has an effect on important messengers such as tumor necrosis factor and interleukin-6, which is a cytokine that causes inflammation, is quite fascinating. According to the findings of Azziz et al. (2009), this considerably hinders the capacity of insulin to control glucose transport in adipocytes when compared to cells that are not impacted by this.

2. Literature Review

You will discover papers that add to the current body of knowledge on drug delivery systems by presenting innovative formulations and procedures that have the potential to improve local disease management, reduce the frequency of medication administration, or boost treatment effectiveness. These publications may be found below.

Kulsirirat et al. (2021) suggested a complex approach for the long-term distribution of pharmaceuticals. This method involves the incorporation of andrographolide-loaded nanoparticles (AGNPs) into a mixture of gelatin-based hydrogels. They used a gelatin hydrogel in conjunction with a process that included the evaporation of a single emulsion fluid in order to produce AGNPs. The use of this dual carrier strategy resulted in a substantial modification of the drug's release. The AG-loaded low MW acid end group released its contents more slowly than the AG-loaded high MW ester end group. This was due to variations in hydrophilicity between the two groups. In addition, the study successfully showed the use of in vivo imaging to monitor the real-time distribution of medicine in mice after intraperitoneal injection and joint implantation. In accordance with the in vivo imaging system (IVIS), the AGNPs-hydrogel sheet and beads kinds exhibited continuous release for a period of more than sixty days. It has been suggested that a hydrogel product that is based on AGNPs might be a safe and reversible alternative to the continued use of medicine for the treatment of localized osteoarthritis (Kulsirirat et al., 2021).

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Using the syringe sonication approach, Salem et al. (2019) were able to construct nanosized transethosomes that were loaded with progesterone and transported via the vaginal canal. According to Salem et al.'s 2019 research, the ability of these nanovesicles to penetrate the body profoundly after vaginal delivery and to maintain their stability for a lengthy period of time demonstrates the possibility for enhanced pharmaceutical administration.

In 2018, Ali Taghizadehghalehjoughi and colleagues conducted a research on glioblastoma multiforme. The purpose of the study was to explore the effectiveness of PLGA nanoparticles (NPs) loaded with metformin hydrochloride (MET) and irinotecan hydrochloride (IRI). Animals in their natural environments, as well as neuron and U-87 MG glioblastoma cell cultures generated in the laboratory, were used in the research that was conducted to study these implications. When PLGA nanoparticles loaded with MET and IRI were used, there was a discernible decrease in the amount of malignancy that was removed. According to Taghizadehghalehjoughi et al. (2018), the most successful therapy for glioblastoma multiforme was a treatment that was based on NP.

An investigation of the mobility of nanoparticles in freshly extracted human cervicovaginal mucus (CVM) was carried out by Yang et al. (2014) in relation to polyvinyl alcohol (PVA) film. In order to determine how the mobility of nanoparticles in CVM was affected by PVA, which is a hydrophilic, non-charged polymer that is often employed as a buffer in the production of drug carriers, they conducted an investigation. PVA-coated particles, such as polystyrene (PS) particles, poly(lactide-co-glycolide) (PLGA) particles, or diblock copolymers of PEG-PLGA nanoparticles, were shown to be more stable in CVM than untreated particles. This was the conclusion reached by the researchers. Due to the fact that PVA coatings created particles with a mucus adhesiveness, the study suggested that different ways of particle production be investigated in order to develop mucus-penetrating particles for mucosal applications (Yang et al., 2014).

VP5k-coated PLGA nanoparticles were produced by Olcay Mert et al. (2012) by the formation of a new surfactant molecule through the combination of vitamin E with 5kDa polyethylene glycol. It was possible for these nanoparticles to reach human cervicovaginal tissue with relative ease due to the high concentration of paclitaxel that they contained, which made them an excellent choice for oral medicine delivery. In the study that was conducted by Mert et al. (2012), it was shown that this combination was successful in delivering medications to specific mucosal areas and ensuring that they were retained for an extended period of time.

Studies on the topic of intravaginal medication administration:

Many patients are interested in intravenous drug delivery systems because they provide a regulated and sustained release of medication. This makes these systems attractive to patients. An infection caused by a virus and an imbalance in hormone levels are just two of the many possible health problems that these systems have the ability to relieve. There is a link to a key research study on the delivery of intravaginal medicine that describes unique formulations and the impact that they have on the outcomes of therapy after being administered.

By using syringe sonication, researchers Salem et al. (2019) were able to construct nanosized transethosomes that were loaded with progesterone. These transethosomes have the potential

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to improve the administration of medications via the vaginal canal. According to Salem et al.'s 2019 research, their study highlighted the necessity of providing nanovesicles with exact timing and volumetric release in order to increase and extend the stability of medicine while it is being passed through the vaginal canal.

Rezk et al. (2018) focused their attention on this particular medication while they were doing their research on the problem of ovulation in PCOS women who were resistant to clomiphene citrate (CC). Rezk and his colleagues also looked at the possibility of using vaginal dydrogesterone in conjunction with letrozole that was being administered. According to the findings of the study, the clinical pregnancy rate was 48.9% for women who used luteal support in addition to going on letrozole, whereas the rate was just 23.9% for women who were only on letrozole. Based on the findings of Rezk et al. (2018), it seems that luteal phase support may have the potential to enhance the number of pregnancies that occur in women who have CC-resistant PCOS.

For the purpose of their investigation that was conducted in 2016, Saini and colleagues studied the possibility of delivering medicine via the vaginal route by using cationic niosomes in combination with a thermosensitive gel. They were able to generate cationic metformin HCl-loaded niosomes by using the process of reverse phase evaporation, which resulted in the formation of tiny, unilamellar structure. After that, a thermosensitive gel that was made up of chitosan and glycophosphate was put to them. Due to the fact that lower-dose versions did not exhibit any adverse effects, their research revealed that this method had the potential to be useful. As a result of these results, it is possible that a method of intravaginal drug administration for metformin HCl that is both safe and effective might be created, which would decrease the likelihood of experiencing side effects (Saini et al., 2016).

Since 2014, Patricia Bento da Silva and her colleagues have been exploring hypotonic nano-formulations, which is a relatively new area of research. A number of different combinations have the potential to absorb fluid, which would make it easier for nanoparticles and drugs to pass through the vaginal epithelium. This is an exciting possibility. In addition to this, they have the capability of enhancing the absorption of nano-formulations across mucosal surfaces, such as those that are present in the nose and the stomach. According to the findings of the study, particles that are able to penetrate other forms of mucus have the capacity to accomplish the same thing via vaginal mucus, especially when there is pressure-induced fluid present (Patricia Bento da Silva, 2014).

Yoo et al. (2011) conducted research on the use of Eudragit S-100 as the primary component in order to examine the creation of pH-responsive nanoparticles. By focusing on how these nanoparticles burst in situations with low pH, such as vaginal mucus and seminal fluid contact, they were able to establish that the releasing properties of these nanoparticles are reliant on the pH of the environment. According to the results of Yoo et al. (2011), pH-responsive nanoparticles have the potential to transport individualized medicines into the vaginal cavity.
Nanoparticles encapsulating tenofovir/tenofovir disoproxil fumarate were developed and reported by Zhang et al. (2011) for the purpose of administering medicine intravaginally. The release of these nanoparticles, which were composed of polylactic acid (PLGA) and methacrylic acid copolymer (S-100), occurred when the pH of the solution changed, especially when a substance that was similar to human seminal fluid was present. Zhang et al. (2011) shown in their research that PLGA/S-100 nanoparticles have the potential to serve as an

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alternative delivery mechanism for anti-HIV/AIDS microbicides. This is especially true when the nanoparticles are delivered vaginally via the caveolin-mediated pathway.

PEG was used in the synthesis of the modified PLGA nanoparticles that were changed by Cu et al. (2011). These nanoparticles included coumarin-6. It was thus possible for the drug to penetrate the uterus in a more effective manner. Avid-NPs and PEG-NPs, two forms of surface-modified nanoparticles, were shown to have a much longer vaginal retention time when compared to untreated PLGA-NPs, as evidenced by the data. I find it fascinating that PLGA-PEG NPs continued to reach their peak in different layers of vaginal tissue even six hours after the therapy was administered. This demonstrates that they have the potential to improve the delivery of drugs via the vaginal route (Cu et al., 2011).

Researchers have started down a potential new road by creating disease in animals as models in order to better understand and battle polycystic ovarian syndrome (PCOS). With the use of these models, it may be possible to get a better understanding of the intricate processes that contribute to polycystic ovarian syndrome (PCOS) as well as potential therapies for the condition. A research study that illustrates how new techniques affect the design of the PCOS model is presented in the following document.

It is Ming-xing W. who is the author. The researchers et al. (2020) took a risk with their PCOS study by constructing an IR-PCOS model for rats. The rats were administered letrozole and a diet rich in fat for a period of thirty days in order to generate this model. The groups that served as controls were given either carboxymethylcellulose solution or letrozole solution in addition to their typical diet. On the 31st day, a large number of tests were carried out in order to ascertain the influence that the beginning of the sickness has on the therapy. Individuals who were diagnosed with IR-PCOS had significantly bigger ovaries and total bodies when compared to the control groups. After doing external exams of the ovaries, it was discovered that what seemed to be bigger sacs that were more translucent were really follicles. Furthermore, during the last week of therapy, the levels of FINS and HOMA-IR were significantly greater in the group who had IR-PCOS analysis. Furthermore, the levels of hormones in their bodies were considerably found to be raised. Our findings indicated that the PCOS-IR rat model, which is characterized by hormonal abnormalities and modifications in ovarian cysts, may be produced by either letrozole or a diet that is rich in fat (Wang et al., 2020).

A hormonal and metabolic illness that cannot be cured, polycystic ovarian syndrome (PCOS) is a condition that is not well understood and is difficult to treat. The extent to which dietary variables impact the PCOS profile was not well understood. The purpose of this study is to illustrate, using rats, how injecting DHEA at birth might potentially cause polycystic ovarian syndrome (PCOS). The rats were administered the 45 of the HFD as well as the 60 of the HFD. We discovered a wide range of reproductive issues in rats that were given DHEA and DHEACHFDs. These issues included polycystic ovaries, irregular periods, and hyperandrogenism. Hormonal changes, such as increased body fat and weight, lower glucose tolerance, and higher blood insulin levels, were among the many adverse effects of adding HFDs, especially 60% HFDs, which induced a more drastic shift in ovulation shape than is normal. These changes were among the numerous negative effects of adding HFDs. Based on the results of quantitative polymerase chain reaction (qPCR), the rise in LH and androgen receptor expression in the brain that was caused by DHEA was eliminated when 60% was

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added.

In a study that was published in 2016 by Zhang H. and colleagues, it was only after the inclusion of sixty percent high-fat diets that the expression of insulin receptor mRNA and LH receptor mRNA in the ovaries rose. Based on these findings, it seems that DHEA and DHEACHFDs may exert their impact on various types of polycystic ovarian syndrome in a variety of distinct patterns: LH is the mechanism by which DHEA has its impact on the regular functioning of the hypothalamus-pituitary-ovarian axis. The incorporation of HFDs aggravated hormonal and metabolic difficulties by causing a change in the ovarian response to insulin-related activities. In conclusion, we came to the conclusion that high-fat diets (HFDs) might be exploited to investigate the metabolic and reproductive components of polycystic ovarian syndrome (PCOS) by establishing unique PCOS phenotypes that are induced by DHEA.
In a rat model of polycystic ovary syndrome (PCOS), dehydroepiandrosterone (DHEA) promotes ovarian hyperfibrosis (and others 2018). Mr. Wang D. was the one who made this discovery. Examination is conducted on the pathway of TGF-β signaling. Through the enhancement of MMP2 and the inhibition of TGF-β's signals that extend farther, TGF-βRI inhibitors effectively limit the accumulation of collagen. A TGF-βRI inhibitor, which suppresses the production of genes that accelerate fibrosis and modifies the mediator of the epithelial-mesenchymal transition (EMT), has the potential to diminish ovarian hyperfibrosis in rats with polycystic ovary syndrome (PCOS) caused by DHEA. This particular inhibitor has the ability to lessen the severity of ovarian hyperfibrosis. In rats, the author has shown that DHEA has the potential to stimulate the TGF-β signaling system, resulting in the development of ovarian over-fibrosis.

Objective of the Study

The primary objective of this research is to develop and evaluate an intravaginal drug delivery system specifically designed for the treatment of **PCOS**. The goal is to formulate a system that can deliver active ingredients such as **anti-androgens** (e.g., spironolactone), **insulin sensitizers** (e.g., metformin), or **progestins** (e.g., micronized progesterone) directly to the vaginal mucosa. This system aims to improve the localized effectiveness of these drugs while minimizing systemic exposure and side effects.

3. Key Research Goals

1. **Formulation Development**: To design a suitable intravaginal delivery system (e.g., suppositories, gels, or tablets) that provides controlled, sustained release of active pharmaceutical ingredients to treat PCOS symptoms.
2. **Release Kinetics Assessment**: To evaluate the release profile of the formulation, ensuring that it provides a consistent therapeutic dose over an extended period, suitable for the management of PCOS.
3. **Bioavailability and Pharmacokinetics**: To assess how effectively the active ingredients are absorbed through the vaginal mucosa and compare this to traditional oral administration in terms of bioavailability and therapeutic effects.
4. **Safety and Toxicity Evaluation**: To ensure that the intravaginal drug delivery system is safe, well-tolerated, and non-irritating to the vaginal tissues, with no adverse effects on local or systemic health.

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5. **Preclinical Efficacy Testing**: To test the developed system in **PCOS animal models**, evaluating its effectiveness in reducing ovarian cysts, regulating menstrual cycles, and improving insulin sensitivity.
6. **Clinical Validation**: To conduct pilot clinical trials assessing the safety, efficacy, and patient satisfaction with the intravaginal system among women diagnosed with PCOS.

4. Methodology

- **Formulation and Delivery Systems**: The study will explore different intravaginal formulations (e.g., gels, tablets, or hydrogels), optimizing the excipients and active pharmaceutical ingredients to ensure stability, ease of use, and sustained drug release.
- **In Vitro Release Studies**: Dissolution tests using simulated vaginal fluid (SVF) will evaluate the release rate of active compounds, ensuring that the system provides controlled, extended release over several hours or days.
- **Pharmacokinetics and Absorption**: Animal models will be used to study the absorption and distribution of the active ingredients delivered intravaginally, comparing bioavailability and therapeutic efficacy to oral administration.
- **Safety and Toxicity Testing**: Standard irritation and sensitization tests will be performed in vitro and in vivo to assess potential vaginal tissue irritation or systemic toxicity.
- **Preclinical Efficacy**: The system's ability to manage key PCOS symptoms, such as hormonal imbalance, cyst formation, and insulin resistance, will be tested in animal models.
- **Clinical Pilot Studies**: A small-scale human trial will assess the safety, comfort, and effectiveness of the intravaginal drug delivery system for treating PCOS.

Expected Outcomes

1. **Optimized Drug Delivery System**: A safe and effective intravaginal formulation that provides controlled release of active ingredients to treat PCOS with reduced side effects compared to oral treatments.
2. **Enhanced Bioavailability and Targeted Delivery**: By delivering the drugs directly to the vaginal mucosa, this system aims to improve drug absorption, ensuring higher local concentrations while minimizing systemic exposure.
3. **Improved Patient Compliance**: The ease of use, reduced side effects, and targeted delivery could enhance patient compliance, offering a more convenient and comfortable alternative to oral medications.
4. **Efficacy in Managing PCOS Symptoms**: The developed system is expected to effectively manage key symptoms of PCOS, such as irregular menstruation, ovarian cysts, hyperandrogenism, and insulin resistance, as demonstrated through preclinical and clinical trials.

Conclusion

This study aims to provide a significant advancement in the treatment of **Polycystic Ovary Syndrome (PCOS)** by developing an **intravaginal drug delivery system** that offers a more

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efficient, localized, and patient-friendly treatment alternative. By improving bioavailability, reducing systemic side effects, and ensuring consistent drug release, the intravaginal system could significantly enhance the therapeutic management of PCOS. This research has the potential to not only benefit women with PCOS but also contribute to the broader field of localized drug delivery systems for other gynecological conditions.

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