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A Compressive Review of Intrauterine Drug Delivery System Classification, Evaluation and Application

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ABSTRACT

For women seeking a very effective, long-lasting, trouble-free reversible method of contraception, an IUD is an excellent choice. It might be useful females who are unable to employ hormone administration methods that are positive, like manipulating capsules. The copper IUDs that were utilized as emergency contraception and those forms of contraception are more effective than emergency contraceptives when they are implanted five days following unprotected sexual activity. Tablets Getting an IUD implanted within 7 days of unprotected vaginal sex can prevent pregnancy. An IUD is a tiny, delicate T-shaped device with a nylon string attached. The objective of composing this review on intrauterine drug delivery systems was to assemble the latest research, with a particular emphasis on diverse intrauterine techniques that have emerged as prominent approaches in the pharmaceutical sector.

Keywords: intrauterine device, IUD, copper T, IUDDS, Uterus, contraceptives.

INTRODUCTION

An intrauterine device (IUD) is the device used in the intrauterine drug administration method. Intrauterine devices, or IUDs, are tiny artificial items or devices that are implanted into the uterus to stop conception from occurring by interfering with the process of fertilization that occurs as a result of sexual activity. They are among the most reliable long-term contraceptive techniques available and have grown in popularity recently. It is adaptable and simple to install. Usually tiny in size, these devices are placed through the cervix. IUDs work by effectively stopping the migration of sperm and eggs, therefore reducing the need for abortion in cases of unintended pregnancy. With the aid of the attached strings, IUDs are placed into the vaginal upper tract. A wide range of medical and non-medical devices are used in the uterine drug delivery system to continually carry out the act of contraception in the uterus for an extended period of time. They are primarily utilized for family planning these days. [1]
IUDs are a kind of long-acting, reversible contraception (LARC), and depending on where the uterine tubes enter, they can give birth control for three to ten years. The body is the part that is situated below the plane. It is the short, constricted section of the uterus that is situated above the body and inferior to superior to the cervix. [2] IUD use has substantially decreased in the US, despite the fact that IUDs are the most widely used form of reversible female contraception, with over 168 million women using them worldwide. [3]

ANATOMY OF UTERUS

Uterus consists of mainly 3 parts such as
Fundus
Body
Cervix. [4]

Fundus

The peritoneum covering the fundus is convex in both directions and is contiguous with that on the vesical and intestinal surfaces. The side borders have a small convex shape. The upper end of each uterine tube pierces the uterine wall. The ovary's ligament is attached behind this location, while the uterus' round ligament is fixed below and in front of it. The broad ligament, a peritoneal fold that runs from the uterine margin to the pelvic wall, contains these three structures.

Body

As the body moves from the fundus to the isthmus, it gradually gets narrower. The vesicouterine excavation is created when the peritoneum flattens and covers the vesical or anterior surface, which is reflected onto the bladder. The bladder and the surface are in contact. The peritoneum, which covers the posterior or intestinal surface and descends onto the cervix and vagina, is transversely convex.

Cervix

The bottom constricted portion of the uterus is called the cervix. It is wider in the middle than it is above and below, and it has a slightly conical shape with a blunted apex that faces downward and backward. Because the cervix is composed of fibrous connective tissue, it has a stiffer consistency than the body of the uterus. It is not as flexible as the body. A cervix that protrudes through the anterior period of the vagina divides the vagina into an upper, supra vaginal section and a lower, vaginal portion, as illustrated by the anatomy in figure 1.

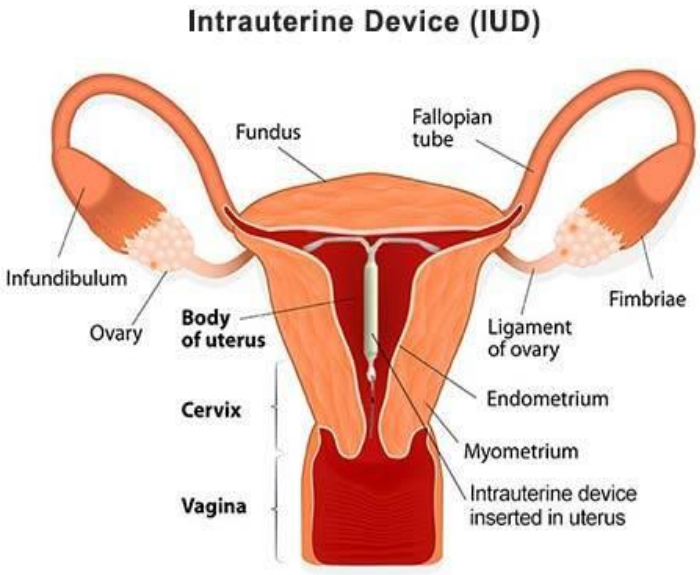

Figure 1: Anatomy of Uterus

RATIONALE OF IUDDS

One type of long-acting, reversible birth control is the IUD.
IUDs are commonly used for family planning purposes and as a form of contraception.
Even after years of use, fertility quickly returns to normal when an IUD is removed.
Within the first year of use, copper devices have a failure rate of approximately 0.8%, whereas hormonal devices have a 0.2% failure rate.
After five days of unprotected sex, it can also be used as an emergency contraceptive method.
IUDs can be put in right after delivery and have no effect on nursing. They can also be applied right away following an abortion. [5]

Classification of IUDs

Intrauterine devices (IUDs) are primarily classified based on their composition and mechanism of action as shown in the figure 2.

Non-Hormonal IUDs [6]

Copper -bearing IUDs

These are the most common type of non- hormonal IUDs. They release copper, which has spermicidal properties.
Examples: ParaGard (also known as copper T 380A)

Hormonal IUDs

Progestin -releasing IUDs

The progestin hormone that these IUDs produce thickens the cervical mucus to keep sperm from fertilizing the egg and may also stop ovulation.
Example: Mirena, Kyleena, Skyla

Inert IUDs [7]

These are composed of non-reactive elements that, when they encounter a foreign body, cause an environment that is harmful to both sperm and eggs in the uterus.
These are less commonly used today due to lower efficacy compared to copper or hormonal IUDs.
Example: Lippes Loop, stainless steel Rings.

Bioactive IUDs

These IUDs have active substances other than hormones or copper, such as silver or gold, to enhance their efficacy or longevity.

Frame vs. Frameless

Framed IUDs

These have a plastic frame, usually in a T-shape, which holds the active component (like copper wire or hormonal reservoir).
Example: ParaGard, Mirena.

Frameless IUDs

These do not have a plastic frame. Instead, they attach directly to the uterine wall. Potentially reducing the risk of expulsion and discomfort.
Example: GyneFix .

Size and Design variation

IUDs also differ in size and design, catering to a diverse range of uterine sizes and shapes.

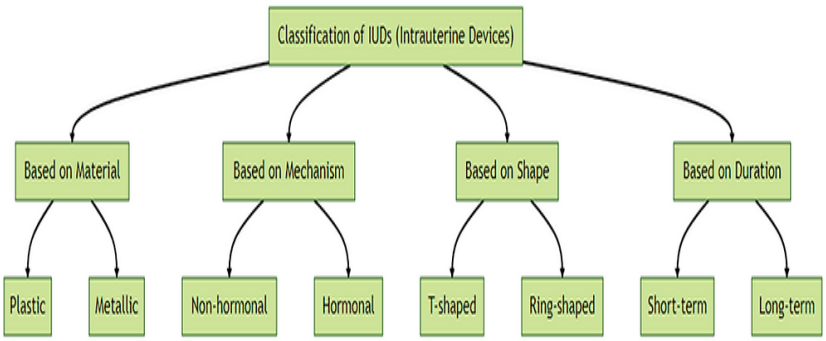

Figure 2: Classification of IUDs

Mechanism of Action Based Classification

NON-Medicated IUDs (like copper IUDs)

- The presence of the IUD in the uterus causes a local inflammatory response.
- The copper ions release acts as spermicides, impairing sperm function and preventive fertilization as shown in figure 3.

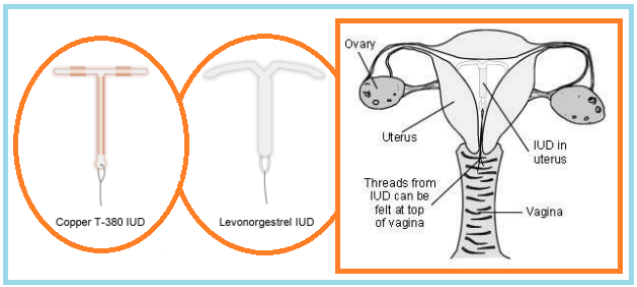

Figure 3: Intrauterine device used in uterus

2. Hormonal IUDs

- The release of progestin inhibits ovulation, thins the lining of the uterus, making it less susceptible to fertilized eggs, and thickens the cervical mucus, which prevents sperm from accessing the uterus (see figure 3).

ADVANTAGES

Intrauterine devices have several advantages as a highly effective form of contraception.

- Because IUDs are long-acting reversible contraceptives, or LARCs, they provide long-term contraceptive protection. Depending on the kind, they can last anywhere from three to ten years, which reduces the need for ongoing contraceptive care. [8]
- IUDs are among the most effective forms of birth control available today, with failure rates varying from 0.1% to 0.8% depending on the kind used. [9]
- IUDs provide continuous contraception; once inserted, the user does not need to take any more action.
- Fertility can be restored with other types of contraception, such as hormonal infections or implants, when the IUDs are promptly removed. In the "Journal of contraception," a 2018 study found that 87% of women who stopped using IUDs were able to become pregnant within a year. [10]
- Less expensive.
- May be used as an emergency technique of deliver manages.

Disadvantages:

Although intrauterine devices (IUDs) are generally a safe and effective method of contraception, they do include some dangers, much like any medical procedure. Here are a few common IUD disadvantages, along with links to further reading.

- There is a slight yet potential risk that the IUD will penetrate the uterine wall during implantation. A perforation might result in pain, bleeding, and the need for surgical device removal as complications. A 1,000 insertion study that was published in the 2020 issue of the "Journal of Minimally Invasive Gynecology" showed an overall perforation rate of 1.3.
- Some people may experience spotting, cramps, or irregular bleeding after having an IUD placed. Some people may find these side effects unpleasant, even though they usually fade away with time. Unpredictable bleeding was the most frequently reported side effect of IUD use, according to a 2013 systematic analysis published in "Obstetrics and Gynecology".
- Although rare, there is a small possibility of pelvic infection following IUD placement. Infection can arise from both the entry of bacteria into the uterus and the migration of germs from the cervix. Early identification and treatment are essential to prevent issues. A 2017 study that was published in the "Journal of Family Planning and Reproductive Health Care" discovered that the risk of pelvic infection following IUD insertion is low when the proper insertion techniques and infection prevention measures are used.
- Requires several days of abstinence.
- Not suitable to ladies with medical contraindication to being pregnant.[11]

ILLNESS OF IUDs

- Endometriosis
- Adenomyosis
- Fibroids
- Endometrial Hyperplasia
- Endometrial

- Wilson Disease
- Sensitivity To Copper[12]

MECHANISMS OF ACTION

Every progestin IUS has a primarily local mode of action. The primary method involves thickening the cervical mucus to prevent sperm from entering the upper vaginal tracts; ovulation is suppressed in only about 50% of cycles during the first year of treatment and much less frequently in subsequent years. Research indicates that during ovulation, sperm can only pass through the cervix mucus in LNG-IUS users by 2-3 mm, and that this effect lasts the entire life of the IUD. Additionally, progestin reduces tubal motility, which may account for the higher chance of an ectopic implantation pregnancy that arises when using LNG-IUS. [13-14]

EVALUATION

Considerations for IUD evaluation include acceptability, safety, effectiveness, and user satisfaction. When evaluating the location of an IUD in patients experiencing pelvic pain, atypical bleeding, or missing retrieval strings, ultrasonography is the first-choice imaging method.

Effectiveness: When it comes to preventing conception, IUDs work much better than most other forms of birth control. Since IUDs often have a failure rate of less than 1%, they are among the most dependable methods of contraception. [15]

Safety: For the most part, IUDs are safe for women. Although they are uncommon, serious side effects can include infection, device ejection, and uterine perforation during implantation. IUD use carries a minimal overall risk of problems, making them safe for the majority of women, including teenagers and those who have never given birth. [16]

User Satisfaction: Research has repeatedly demonstrated that women who use IUDs are very satisfied with their devices. The ease of long-acting contraception that doesn't require daily or frequent administration is valued by many consumers. [17]

Acceptability: IUDs are becoming a better recognized form of birth control globally. Major health organizations including the American College of Obstetricians and Gynecologists (ACOG) and the World Health Organization (WHO) promote them, and many nations include them in their national family planning programs. [18]

THE SYMPTOMS OF AN INFECTION

- Lower abdominal pain
- Vaginal discharge
- Possibly with a foul odor
- Pain when urination
- Painful intercourse
- A fever
- Irregular menstruation [19]

APPLICATION

Intrauterine devices, or IUDs, are reversible, long-acting contraceptives that are inserted into the uterus and are very successful. Hormonal IUDs, which release progestin, and copper IUDs, which contain copper wire, are the two varieties available. Here are a few uses for IUDs:

- **Contraception**: One of the best methods of contraception currently on the market is the IUD. For women seeking long-term birth control, they are convenient since, once implanted, they offer protection against conception for a number of years (up to 3–12 years, depending on the kind), without requiring daily action. [20]
- **Reducing unintended pregnancies:** IUDs are quite effective at preventing unwanted pregnancies. IUDs are less likely to fail than other forms of birth control, such as patches, pills, and condoms, according to studies. [21]
- **Treatment of menstrual disorder**: Women who experience unpleasant periods (dysmenorrhea) or profuse menstrual flow (menorrhagia) may occasionally be prescribed hormonal IUDs. Menstrual discomfort might be lessened and periods can become lighter as a result of the hormonal IUD's progesterone release thinned uterine lining. [22]
- Emergency contraception.[23]
- Long -term family planning.

- **Cost -**effective option.
- **Management of Heavy Menstrual Bleeding**: Some IUD types—especially those that contain hormones—are used to treat excessive menstrual bleeding. They can lessen the flow of blood during menstruation and ease the discomfort of heavy periods. [24]

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CONFLICTS OF INTEREST

The authors have no conflicts of interest.

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