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Review: Use of Man-made Fallopian Tubes in Animals and their Outcomes.

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Abstract
The major problem that women are facing nowadays is infertility. Due to many reasons, they are not able to give birth. One such major issue is tubal infections and tubal diseases. Many experts and scientists have taken efforts to design man-made uterine tubes and have also tried oviduct transplantation. The main idea of this review paper is to tell about the man-made Fallopian tube that was constructed and tried on mice, Teflon Fallopian tubes used on rabbits, cannulation of the Fallopian tube of sheep, and also tells about the details bothering the success of the occlusion of the Fallopian tube in treatment of tubal obstructive infecund.

Keywords:Fallopian tubes, cannulation, Teflon, biocompatibility, tubal obstructive infertility.

INTRODUCTION

According to World Health Organization's report, nearly,48 million couples and 186 million people are infertile worldwide. Among them, nearly 20 percent in the USA and 8 percent in India suffer from diseases of the oviduct or absence of uterine tube or oviduct dysfunction.[1] Many advances made in the biomedical field, tissue engineering, and regenerative medicine have opened a wider aspect to suggest new approaches. The Fallopian tubes are also called uterine tubes or oviducts or salpinx. It is a female accessory duct. Each oviduct is 10-13 cm long and its diameter is about 0.5-1.2 cm. The oviduct is wadded by the ciliated epithelium, which helps migrate sperms and secondary oocytes. The Fallopian tube or oviduct is a bearing between the periovarian space with the uterus. They are a pair of ducts located in the abdominal region of females. This tube is designated to perform many vitalroles and play a major role in childbirth.

The fallopian tube has three major parts. The infundibulum part is near the ovary that collects the ovum after ovulation. The fimbriae are a finger-like projection. Fertilization takes place in

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the ampulla. The last part of the fallopian tube is Isthmus, which helps to pass the fertilized egg to the uterus for implantation. The uterus and the fallopian tubes meet at the uterine horns (or Cornua of Uterus). If any of these parts get damaged, it affects the mobility of the sperm and oocyte, leading to infertility.[3]The most imperative role of the oviduct is to carry sperms towards the egg. Other functions of this duct are to provide sufficient nourishment to the sperms, bestow them with the befitting environs for fertilization and carry the egg to the lumen of the uterus. If any infection or disease causes any disturbance to these tubes women may find it difficult to give birth. Some common abnormalities of these ducts are a para tubal cyst that blocks the fallopian tube, leading to tuboplasty, extrauterine pregnancy where the duct may burst if not noticed early, endosalpingiosis, etc.

ANALYSING THE BIOCOMPATIBILITY OF MATERIAL

Bio-compatibility is "the central theme for biomaterials". Before going to transplantation or implantation we should check the properties of biomaterials (cytotoxicity,genotoxicity, mutagenicity, carcinogenicity, and immunogenicity) being compatible with the living tissue and we should study the interactions between the bio-material and host tissue. In consonance with the studies, there are eight factitious polymers with bio-compatible properties: *polytetrafluoroethylene (Teflon); polydimethylsiloxane; polyethylene; polyurethane; polyvinylchloride (PVC); polyethyleneglycol (PEG); polyhydroxy ethylmethacrylate (PHEMA). Among them, we have selected Teflon and hydrogel materials such as PEG and PHEMA because of their high gamete compatibility.*[3]

ATTEMPT TO DEVELOP ARTIFICIAL OVIDUCTS FOR RABBITS:

a-Main purpose

The ultimate aim of developing a man-made duct for rabbits was to satisfy 3 major functions. Firstly, to encapsulate the ova at ovulation. Secondly, injecting sperms through the tubing, and finally, transfer the fecundated ova into the womb at the right time for impregnation.[5]

b-Materials and methods used

10 rabbits from New Zealand were used for this study. Rabbits were weighing roughly 3 to 3.5 kgs. After providing halothaneanesthesia the rabbits were ready for the replacement of the tube. At first, both proximal oviducts were ligated with silk sutures and divided between 2 sutures.[5]Following this treatment,a 0.17 cm inner diameter polytetrafluoroethylene tube was immediately introduced via one cornu into the uterus and secured to the uterus's horn with one loop of prolene suture.[5]The tube stated above served as a substitute for proximal tubes. The abdominal muscles were sutured to the fascia using prolene for distal tubing, and the termination was formed near the mid-line incision.Then, as egg donors, sexually mature rabbits were employed. Gonadotropin was administered intramuscularly into the eggs. The does were later paired with males for breeding. The ensuing 4 to 8 cell embryos emerged from the oviducts after 2 days. The embryos were then cultivated, and the resultant blastocysts were pooled and delivered to the recipients who seemed to be healthy.The recipient rabbits were anesthetized and the embryos were injected into the cavity.[5]

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c-Outcome

This method was only partially successful. The following are the problems that the experts faced doing this process in rabbits.The far end of the tube was not followed down in three of the ten circumstances because it had been renounced into the peritoneal cavity. 4 of the rabbits had normal implantation. The uterine horn was movable and it had no adhesion to the prosthesis, as shown in table-1. It was also observed that the implantation showed minimal inflammatory reactions and minimal fibro-blast proliferation was also observed.[5] as demonstrated in table-2.

ATTEMPT TO DEVELOP AN ARTIFICIAL FALLOPIAN TUBE FOR MICE

There are three main additives used in this technique. They are as follows, a microinfusion pump (which affords a pulsatile flow of nutrients), supply tubes (transfer the nutrients from the pump to the oviduct), and an inflatable balloon (which retains the egg and sperm collectivity till the activation of the pump). This prototype device is implanted in the mice for further research.[2]

a-Materials and methods used

The first step started with preparing Ham's F-10 culture medium. The ova from 21 to 33 old black virgin B6D2F1 female mice and the sperm from two 3 to 6-month-old black B6D2F1 male mice had been amassed. The egg masses were placed in a petri dish containing Ham's F-10 medium with sperms and were incubated for 24 hours. then sucked by the Teflon tubing where three-milliliter syringes with 2.5mL of Ham's F-10 /BSA medium were placed over it. After placing egg masses and sperm at the end of the Teflon tubing proximal to the syringe, the programmed pump was activated and delivered 0.065mL pulses every 90minutes.[2] The embryos moved approximately 2cm/d and collected at the distal end of Teflon tubing 60-70hours after the pump was activated. This embryo was analyzed under the light microscope and surgically transferred to the uterine horn of surrogate white female ICR mice that were pseudo pregnant by mating with vasectomized ICR males.[2]

b-Outcome

Thus, the recipient received experimental (artificial tube/pump) embryos. Six of 10 became pregnant and gave birth to new B6D2F1(black) offspring. 60 to 80 percent of oocytes fertilized and developed to the morula stage.[2]

TABLE-1

NUMBER OF RABBITS USED	RESULT AND OUTCOMES
THREE	The far end of the tube was revoked in the peritoneal cavity.
FOUR	Normal implantations were observed. Cornua was able to move in the gut, and no adhesions were observed

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TABLE-2

EXAMINATIONS DONE	REPORT
Histological examination.	Truancy of phonological adjustments at the cornua and the gastric wall.
Light microscopy	Showed least fomenting results at the site with giant cells and PMN

CANNULATION OF THE FALLOPIAN TUBE OF THE SHEEP

The procedure used on sheep for cannulation of Fallopian tubes had no change in the morphology of the duct. This was achieved by the use of a silicon rubber cannula e. This technique produced successful long-term cannulation of the oviducts. They succeeded in this procedure by removing the cause of irritation to the animal and care in preventing bacterial contamination.[4]

a-Materials and methods

Mature Merino ewes were used for the procedure. Ewes were anesthetized and the procedure was carried out in a completely sterile environment. The uterus, and ovaries were exposed and kept in gauze pads and the Fallopian tubes were located. The cannula was lodged into the ovarian end and they were secured with fine silk sutures. They made sure that blood vessels don't interrupt. 6 ewes were cannula-ted with nylon catheters through the subcutaneous channel. 10 ewes were cannula-ted with nylon as mentioned above but they were sutured to the skin. Another 10 ewes were cannula-ted through flank punctures. Then 20 other ewes were cannula-ted with silicone rubber cannulae.[4] as shown in table-3.

b-Outcome

When ewes were treated with different surgical procedures, they showed the following reactions. Firstly, when 6 ewes cannula teds with nylon catheters through a subcutaneous channel the animal removed the cannulae. Secondly, when 10 ewes were sutured to the skin, the cannula was removed by the mechanical actions of the animals, infections were observed, and twisting of the cannula also was reported.[4] Thirdly, when another 10 ewes were cannulated through flank punctures, it resulted in blood clots, twisting of the cannula, and tissue growth in the cannula. Finally, when ewes were cannulated with silicone rubber the animals died for a period of 40 to 54 days.[4]

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TABLE-3

COUNT OF EWES UTILIZED	PROCEDURE FOLLOWED	REACTIONSANDRESULTS
SIX	Cannula teds with nylon catheters through a subcutaneous channel.	The animal removed the cannulae.
TEN	Cannulasutured to the skin.	The cannula was removed by the mechanical actions of the animals, infections were observed, and twisting of the cannula also was reported.
ANOTHER TEN	Cannulated through flank punctures.	This resulted in blood clots, twisting of the cannula, and tissue growth in the cannula.
TWENTY	Canulated with silicone rubber.	Animals died for a period of 40 to 54 days.

For successful cannulation, the following points are to be remembered

- No bacterial infections should be observed.
- Reaction of the tissue to the cannulae should not be present.
- Animals should not remove or interfere with the reaction of the cannula.
- Below the cannula there must be proper tubal tissue.

FACTORS AFFECTING THE ACHIEVEMENT RATIOOF CANALIZATION

Intervention tubal re-canalization or Fallopian Tube re-canalization is a surgical procedure for treating women with proximal tubal occlusion. The success rate of FTR is more than 90%, remaining of the patients have deficient results after the intervention procedure.[6]
Infertility is multifactorial and may be associated with malefactorsor amalgamation of male and female elements. In females, the parts that cause infertility are ovulation disorders, tubal factors, cervical, and uterine disorders, and idiopathic infertility. After analyzing the patient, FTR was performed and the patient with cardiovascular and cerebrovascular illness or severe hip joint and gut sepsis, an obstruction in the far end of the ampulla, tubal ligation, severe thwarting at the cornua of theuterus, tubal tuberculosisare excluded from the study.[6]

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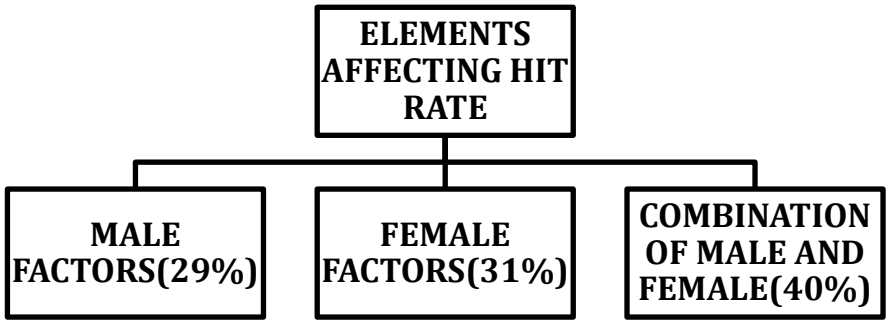

fig-1: factors affecting achievement rate

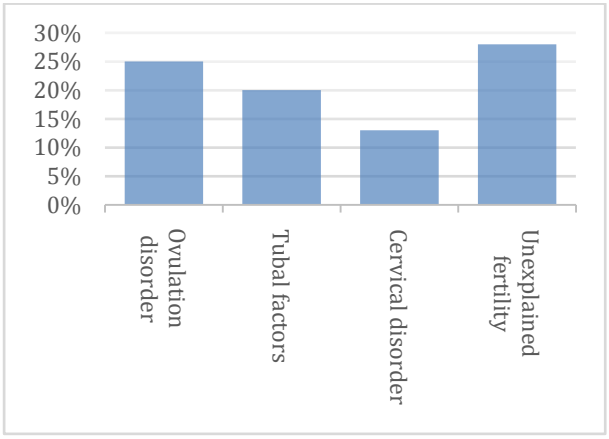

fig-2: female factors that cause infertility

The potential risk factors Auxilliarytonormal oviducts which bothers the hit ratio of FTR are:

- Age elements.
- Lower level infecund.
- The period of sterility.
- Backlogs of extrauterine pregnancy, guttherapy and
- Artificial feticide curettage.

CONCLUSION

From this review paper, we can understand and conclude that there are proven methods to replace and repair the disrupted Fallopian tube with minimal side effects. This review also tells about the design, procedure, testing, and outcomes of an artificial Fallopian tube on mice, and rabbits, and the recanalization of oviducts in sheep. These results and methods have provided a shred of supporting evidence that man-made oviducts can serve the purpose of natural Fallopian tubes and aid in fertilization.

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