REPRODUCTIVE ENDOCRINOLOGY AND INFERTILITY: ROBOTIC APPLICATIONS

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ABSTRACT: Surgical procedures for the infertile patient, such as tubal re-anastomosis and myomectomy, are frequently performed using minimally invasive techniques. In recent years, robots have been used to carry out these operations. Laparoscopic and robotic tubal reanastomosis & myomectomy are discussed in the context of reproductive medicine in this article. The current robotic approaches employed at our facility will also be examined. Robotic-assisted surgery is a viable option for minimally invasive procedures in reproductive medicine.

KEYWORDS: Endocrinology, Computer-assisted surgery, Infertility, Myomectomy robotic surgery, Tubal anastomosis, Reproductive medicine.

INTRODUCTION:

Unplanned pregnancy is a growing source of anxiety for many people nowadays. Infertility affects around one in 14 couples each year, or 7.4 percent of the population, according to 2002 research [1]. Many of these patients can be managed medically, but others will have surgery. Laparotomies were used for both exploratory and operative treatments in early gynaecological surgery. A big abdominal incision and enhanced analgesia are just some of the drawbacks of laparotomy despite its advantages in depth perception and intraabdominal articulation. As a result, gynaecologists have worked hard over the last four decades to use minimally invasive surgical procedures to treat individuals seeking reproductive treatment [2, 3]. Gynecologists began using laparoscopic surgery consistently in the 1970s [2], and it has since been widely adopted for a wide range of surgical procedures, including minor treatments and major gynecologic surgeries. It's easier on the patient's appearance, takes less time to recuperate, is less painful, and uses less blood than open surgery [4]. Because sponges and retractors can no longer be used, and because the contents of the abdominal cavity are no longer exposed to the outside world, laparoscopy is expected to reduce new adhesions [4]. There is a steep learning curve for doctors, two-dimensional vision, a limited range of motion (4°), and counterintuitive movements using laparoscopic tools that limit the benefits of laparoscopic surgery. Surgeons also experience pain and numbness in the upper limbs during long procedures due to ergonomic consequences [5, 6]. As a result, laparoscopy is frequently used for uncomplicated procedures, whereas laparotomies are still used for more sophisticated surgery.

Robotic surgery incorporates the advantages of minimally invasive surgery while also addressing many of its drawbacks. Improved ergonomics, tremor reduction, & intraabdominal dexterity with 7° of articulation are all provided by robots. In this research, we'll look at how the surgical robot is currently being used in reproductive treatments and compare it to more traditional open or laparoscopic approaches.

GYNECOLOGICAL ROBOTIC SYSTEMS:

Robotics have been used in gynaecological surgery three times thus far. Automated endoscope device for optimal positioning was the first robot certified for use in abdominal surgeries. It was (AESOP). The laparoscopic camera is held and controlled by this robotic system [7–9]. Developed by Computer Motion in the early 1990s, the Zeus surgical device is one of two telerobotic systems still in use today. The Zeus system has been upgraded to include three-dimensional vision and better intra-abdominal dexterity for both the surgeon and the patient.

In the year 2000, the FDA approved the first use of the da Vinci robotic system for intra-abdominal surgery. There are three parts to the da Vinci robot, the patient-side surgical cart, the surgeon console, and a stereoscopic vision system. Laparoscopic trocars are inserted into the patient's abdomen by four robotic arms that are attached to the surgical cart [10][11]. The surgeon can then control the robotic arms via the console's master controls. For intra-abdominal articulation, each laparoscopic instrument has 7 degrees of freedom. This console also has binoculars, which allow the surgeon to see his or her work in 3D. The FDA approved the use of the

da Vinci in gynaecology in 2005 after preliminary trials at the University of Michigan demonstrated its safety in robotic-assisted hysterectomies and myomectomies. Gynecological surgery can only be performed with this technology, the only one now available on the market. There are presently three commercially marketed da Vinci surgical systems in addition to the first prototype. The da Vinci Series, a thinner version of the original system, reduces the robot's bulkiness. The da Vinci S HD features a touchscreen monitor, tele station, and Teleport multi-input display, all of which work together to provide improved teaching and team communication.

INFERTILITY AND REPRODUCTIVE ENDOCRINOLOGY CAN BENEFIT FROM ROBOTS:

- **TUBAL ANASTOMOSIS**:

In 1977, Gomel was the first to perform a tubal anastomosis using a microsurgical approach, and he reported better outcomes than with macrosurgery. Pregnancy rates (PR) of 30–63 percent at six months, and 53–80 percent at 12 months, have been observed following open microsurgery. An open incision and a higher risk of adhesion formation were also drawbacks of this technique. In order to reverse sterilisation, surgeons started adopting minimally invasive procedures. However, with low conception rates, Sedbon et al. in 1989 performed the first laparoscopic unilateral sterilisation reversal utilising biologic glue and intraluminal guiding. Laparoscopic tubal anastomosis without laparoscopic suturing was introduced by subsequent authors in 1992 [13]. Laparotomy had a lower pregnancy rate than open microsurgery in the early investigations, but as experience grew, subsequent research showed equivocal pregnancy rates. Yoon et al. examined 202 cases of laparoscopic tubal anastomosis and their effects on fertility in a comprehensive retrospective research. At six months, twelve months, and 18 months, the pregnancy rates were 60 percent, 79.4 percent, and 83.3 percent, respectively. A similar anastomosis technique utilised in a large open microsurgery trial resulted in comparable pregnancy rates, as demonstrated by the results of this study. After 15 cases, the operational time for bilateral anastomosis was lowered from 4 hours to an average of 2 hours, according to the research. Laparoscopic procedures have been used in a variety of ways to carry out this surgery. With four interrupted sutures at 3, 6, 9, and 12 o'clock, several writers reapproximate and re-close the muscularis layer and the serosa. Techniques such as the one-stitch or two-stitch closure of muscularis and serosal layers have been described by different writers. Although the number of procedures used to accomplish this process is vast, many research evaluating their outcomes are constrained by this fact. There are several drawbacks to using laparoscopy for tubal anastomosis, such as the lack of stereoscopic vision, difficulties in securing intra-abdominal sutures, and inability to handle fine suture with laparoscopic instruments.

To solve several of the limitations of laparoscopy, robots began to be employed in 1998 to carry out this treatment. Robotic microsurgical anastomosis can be performed utilising the Zeus surgical system, according to a study in animal models [12]. In a 1999 pilot trial, laparoscopic tubal anastomosis was performed with the Zeus system. All patients were able to complete the surgery without any issues. At the conclusion of the procedure, achromatization revealed patency in all tubes, with a mean operative duration of 159 33.8 minutes. Pregnancy rates at 6- and 12-month follow-ups were 89 percent and 50 percent, respectively, according to a hysterosalpingogram. Conventional laparoscopic tubal anastomosis and the Zeus device were evaluated by Golderberg et al. Four 8–0 polygalactin sutures were inserted at 3, 6, 9, and 12 o'clock. While the predicted blood loss from robotic-assisted surgeries was higher (albeit not clinically significant), there was no discernible change in clinical outcomes. For open microsurgery, Degueldre et al. found that the da Vinci robotic system was as fast as open surgery, and they also found that 2/8 patients became pregnant after surgery in the four months afterwards. The absence of tensile feedback associated with suturing, which resulted in broken suture material, was a common downside of employing the robot. At the University of Alabama, a feasibility study comparing open microsurgery with the da Vinci surgical system in tubal anastomosis on 18 patients seeking sterilisation reversal was conducted in 2004. Operative times were much longer with robot-assisted procedures, but hospital stays, recuperation times, and time to return to independent daily activities were significantly shorter than with open microsurgery procedures. According to a cost analysis comparing robotic surgery with open microsurgery, the two procedures had comparable overall costs. There has to be additional research comparing conventional laparoscopy with robotic surgery to see if robotic technology is better for sterilisation reversal in terms of operative time, patient happiness, and pregnancy result [14].

METHOD OF DOING ROBOTIC TUBAL REATTACHMENT SURGERY:

The procedure for robotic tubal reanastomosis at our centre is outlined below. Setting up a robot for surgery Patient's uterus is mobilised with an intrauterine cannula after generalised anaesthesia has been administered to the patient in Trendelenburg position. A 12-mm trocar inserted via the umbilicus is used to get peritoneal

access. Two 8-mm da Vinci ports are inserted 2 cm below the umbilicus in the mid-axillary line, with a minimum distance of 8 cm between each port. A diagnostic laparoscopy is conducted at this time to determine whether a reanastomosis with adhesion lysis is required. Suture material can be introduced, removed, and irrigated using an additional 10-mm port located between the umbilical as well as the lateral ports. Afterward, the robot is placed between the patient's legs, and the robotic arms are attached to the appropriate ports. The method the distal tubal segment is next stripped of its serosa with microscissors and its tip is excised when the setup is complete. As the proximal section is transected, it is mobilised. The proximal tubal segment's patency can be demonstrated by chromopertubation. An interrupted 6–0 polygalactin suture is used to re-adjust the distance between the mesosalpinx and the spinal cord. Four 7–0 polypropylene sutures are used to join the tubal segments' mucosal and muscle layers. The patency of the serosa is proven by chromotubation, which is an interrupted 7–0 polypropylene suture.

IVF's IMPACT ON TUBAL ANASTOMOSIS:

Tubal surgery is a topic of contention in the modern era of assisted reproductive technology (ART). IVF should be the primary line of treatment for any patient with tubal injury, according to several experts who report pregnancy rates ranging from 21% to 46%. Pregnancy rates of 36.5% per IVF cycle have been reported by the American Society of Reproductive Medicine's IVF monitoring study. Reversing sterilisation through laparotomy or laparoscopy has better success rates than using IVF technologies. Even though IVF can only produce one pregnancy per cycle, surgical tubal reversal can lead to many pregnancies beyond the initial one. It is also time-consuming and expensive, with the potential for numerous pregnancies and pharmacological side effects. All patients should have their treatment tailored to their specific needs, so that the most effective treatment plan may be devised.

MYOMECTOMY:

The surgical removal of uterine fibroids in women who are trying to conceive is fraught with difficulty. Uterine fibroids and infertility have no known cause, and myomectomy is not without risk, according to some who oppose surgical treatment. Contrary to popular belief, some researchers believe that uterine myomata are linked to infertility and miscarriage. Fibroids in the uterus may affect fertility by altering the normal uterine contractility, or they may be linked to vascular alterations that affect embryo implantation and interfere with sperm migration. Patients with fibroids in the inner myometrium were studied by Gianaroli et al. Patients having inner myometrial fibroids larger than 3 centimetres in diameter or with several fibroids, according to this study, should have surgical myomectomy performed. Surgery is recommended only if the myoma causes deformation of the uterine cavity, according to the American Society for Reproductive Medicine (ASRM) [15]. Patients should also be checked for other causes of infertility before undergoing surgery. Abdominal myomectomy was established by Bonney in 1931 as the therapy of choice for women who wanted to preserve their fertility after a hysterectomy. Patients who presented with symptoms of infertility, abortion, abnormal uterine bleeding, or pelvic pain were candidates for this surgery. Although abdominal myomectomy can save a woman's fertility, it comes with the risk of postoperative meets established, myoma recurrence, and greater intraoperative blood loss. Patients must also endure extensive abdominal surgery.

While laparotomy is still widely used, laparoscopic myomectomy (LM) has been shown to be an option since 1980 [16]. A number of studies in the following decade, as laparoscopic equipment advanced, established the safety and practicality of LM. LM decreased tissue healing, analgesia, decreased hospital stays without increasing operating duration or blood loss in a randomised controlled trial (RCT) in 1996. Another RCT conducted by Seracchiolo et al. found that LM, when compared to abdominal myomectomy, significantly reduced febrile mortality, haemoglobin decline, and hospital stay. No significant differences in operating time or blood loss were found, though, according to the research. More than four to five myomas, the largest of which measured more than 5 cm, and an anterior position of the fibroid were all related with a higher probability of conversion from LM to laparotomy. Laparoscopic suturing, according to some authors, can be challenging, and proper closure is a worry. Robotic-assisted LM is an attempt to enhance intra-abdominal suturing in light of this. Patients with uterine fibroids were treated with the da Vinci robot in a retrospective study [17]. For each patient who underwent surgery, the average diameter of their fibroid was 7.9 cm, the weight of the tumour was 223 g, and an average of 1.6 fibroids were removed. The robotic to laparotomy conversion rate was 8.6%, which is comparable to the conventional LM rate. The average estimated blood loss was 169 198 ml, with surgical times averaging 230 83 minutes, according to the research. Additionally, the length of the surgical procedure decreased as the surgeon's experience grew. Our university conducted a retrospective study to see if robotic-assisted myomectomies might be performed on university students. In 15

patients, robotic-assisted myomectomy was attempted, with the second patient requiring a laparotomy. This procedure took, on average, around two-thirds of an hour to complete. Approximately 160.7 ml of blood was shed on an average. The uterine myoma measured anywhere from 4 to 15 centimetres in diameter. The majority of patients were discharged from the hospital on postoperative day 1 and returned to work an average of 2.8 weeks later. After surgery, three patients had successful pregnancies, with two full-term deliveries and one premature delivery at 28 weeks.

MYOMECTOMY BY MEANS OF ROBOTIC SURGERY:

The following is a description of the robotic myomectomies performed at our facility using this technology. Setting up a robot for surgery Patient's uterus is mobilised with an intrauterine cannula after generalised anaesthesia has been administered to the patient in Trendelenburg position. To reach the peritoneum, a 12-mm trocar is inserted 2–5 centimetres above the umbilicus. Da Vinci ports are implanted in the mid-axillary line 2 cm below the level of the umbilicus and at least 8 cm apart. A fourth da Vinci port is positioned 8 cm lateral and 2 cm above to the left lateral port at the level of the anterior superior iliac spine. It is positioned 8 cm lateral to the lateral port on the right side for suture removal, installation, irrigation, and traction. A diagnostic laparoscopy is performed at this time to determine whether a myomectomy with adhesion lysis is required. Afterward, the robot is placed between the patient's legs, and the robotic arms are attached to the appropriate ports.

The method Percutaneous injections of Pitressin are administered through the umbilicus into the uterine serosa. Hook cautery is used to make an incision into the myoma through the serosa. A tenaculum for countertraction is implanted once the pseudo capsule and the myoma have been identified. A bipolar cautery dissector and a hook are used to remove the myoma while being careful not to remove any of the myometrium during dissection. The advance for enucleation or the tenaculum for traction can be housed in the fourth arm. Chromotubation is used to show the entry into the cavity once enucleation is complete. If this is the case, an interrupted repair is made using a 3–0 absorbable suture. If this is not the case, the muscle layers are healed in a similar fashion to the open approach in two or three layers. A slip-knot approach can be utilised to approximate the muscle layers correctly if the faults are considerable. Morcellation of the fibroid takes place when the repair has been done and the lateral port has been changed to receive the morcellator.

PREGNANCY AND FERTILITY RESULTS FOLLOWING LAPAROSCOPIC MYOMECTOMY ARE DISCUSSED:

Fertility & pregnancy outcomes after LM are just as important as surgical risks and results. Many studies have found ambiguous pregnancy rates of LM with abdominal myomectomy with just an average PR of 55% in patients with prior infertility following an LM operation. Also in 2000, 131 women with uterine myomas associated with infertility were randomly assigned to have treatment either via laparotomy or laparoscopy; there was no difference in the number of premature births, abortions, or caesarean sections.

After a myomectomy, uterine rupture is common. Concerns about an increased risk of uterine rupture following LM surgery rather than laparotomy surgery have arisen because to technical concerns involving the greater use of electrocautery and insufficient suturing. Several studies have shown that LM causes uterine rupture. In addition, uterine rupture prior to delivery has been a regular occurrence in these instances. A high caesarean delivery rate in this cohort substantially complicates the risk of uterine rupture with laparoscopic and abdominal myomectomy. In 2000, Dubuisson et al. studied 100 women who had 145 births following LM and concluded that the risk of uterine rupture was only about 1%. Some researchers have found no evidence of uterine rupture in women who had undergone laparoscopic myomectomy (LM). More over half of the 158 pregnancies that were studied by Seracchioli and colleagues in 2006 were delivered via caesarean section without uterine rupture. In order to evaluate the overall risk in this population and whether patients who choose LM are more at risk, more monitoring and examination of uterine rupture following myomectomy is required. There is a paucity of research comparing the outcomes of robotic-assisted LM with those of conventional LM or laparotomy in terms of uterine rupture and pregnancy [18]. Following a da Vinci aided myomectomy in 2007, an uncomplicated term pregnancy was reported. There was a 3-cm-wide fundal myoma that was about 0.3 cm away from the endometrial cavity when it was discovered. Infertile patients may benefit from the surgical robot's ability to conduct a three-layer abdominal myomectomy closure, according to a review of this literature. Larger studies are needed to support the use of robotic assisted laparoscopy myomectomy for the treatment of people who want to have children in the future. To have a better understanding of the risks and benefits associated with minimally invasive myomectomy, more research is needed.

CONCLUSION:

The field of reproductive medicine has embraced minimally invasive surgical procedures. Laparoscopic surgeries have been compared to regular laparotomies in terms of reproductive outcomes. In reproductive medicine, robotic surgical techniques have been shown safe and effective, but little is known about the long-term reproductive effects of these procedures. This means that the demand for robotically qualified surgeons will grow as robotic technology improves in reproductive endocrinology and infertility. Robotic surgery should be studied further to see if it is genuinely superior to laparoscopy when it comes to surgical and reproductive results.

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