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ROBOTIC Tummy Tucks

Dr. Marco Aurelio Faria Correa is a robotic surgery advocate.

Dr. Marco Aurelio Faria Correa takes us through his experience with the da Vinci Surgical System and the exciting cutting edge of robotics in plastic surgery.

The cosmetic appearance of the abdomen is one of the most popular concerns in modern society. We are seeing an increasing number of female and male patients presenting with small and medium-size abdominal cosmetic deformities coming to our clinics asking for minimally-invasive and scarless procedures that can effectively improve the aesthetic appearance of the abdomen. In many cases the problem is not over-redundant skin, over-weight or abdominal lipodystrophy, but rectus diastasis (see fig. 1, 4, 5, 7). They complain that despite working hard at losing weight, and having a strict and rigorous work out regime, they cannot get rid of that bulging stomach and/or the peri-umbilical deformity (fig. 18). The weakening of the muscle aponeurotic abdominal wall due to congenital conditions, weight variation, aging or pregnancy is a frequent cause of rectus diastasis and/or umbilical hernia that can alter the cosmetic aspect of the abdomen. The rectus abdominal muscle plays an important role, not only in the cosmetic appearance of the abdomen, but also in the stability of the spine. Depending of the degree of the rectus diastasis it can lead to a vicious posture, spine problems, back pain, slipped disc and so on. Rectus plication can effectively restore function, providing a balance between the anterior and posterior muscle of the abdominal wall and can improve the cosmetic appearance of the abdomen. The long-term evaluation by ultrasonography and CT-scan of the plication of the anterior rectus sheath as well as our long term clinic follow-up (fig. 1) has shown the efficiency of the recti plication when properly performed.

Figure 1: 20 years follow up of an endoscopic abdominoplasty showing maintenance of the result of the rectus plication even after the patient has aged 20 years and put on eight kilograms.

In 1991, I started using endoscopy for the treatment of patients presenting with rectus diastasis and no redundant skin, working through their previous C-section scars or even using incisions as small as four to five centimetres hidden in the pubic hair-bearing area and inside the umbilical area. More than 20 years of follow-up shows the effectiveness of the technique and the beauty of restoring the original anatomy leaving minimal and inconspicuous scars (fig. 2).

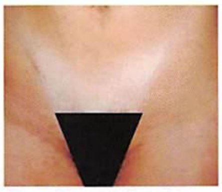


Figure 2: Endoscopic abdominoplasty scars hidden inside the navel/umbilical and inside the pubic hair bearing area.

ADVANTAGES OF ROBOTIC SURGERY

Robotic surgery is becoming the "gold standard" of minimally-invasive surgery in many surgical fields. In urology, robotic prostatectomy is such a solid application, presenting so many advantages over the open methods as well as over the endoscopic methods that, if a patient has the chance to choose which methods to undergo, the best choice would be to go for the robotics-assisted method. In cardiothoracic surgery the surgical robots are also proving to be the key in transforming technically challenging open procedures like mitral valve repair and heart revascularisation into technically feasible, minimally-invasive procedures. In any institution where the robotics da Vinci surgical system is available, the tendency for laparoscopic surgery (in gynaecology, colorectal surgery and general surgery) is being replaced by robotics-assisted surgery due to the many advantages that robotics-assisted surgery presents over laparoscopic methods.

The robot's high definition three-dimentional view and the amplification of images gives us a much better depth sensation of the surgical field than the 2-D endoscopic view. It is even better than our naked eyes. Laparoscopic instruments have a limited range of motion, while the robot's endo-wrist range of movement is comparable to the human wrist. The surgeon's hand tremors are transmitted through the rigid laparoscopic instruments, making delicate procedures more difficult. The superb precision and stability of the robot arms, surgical field and instruments, all controlled by the surgeon seated at the console in a comfortable ergonomic position, without the need to coordinate camera and instrument movement with a surgical assistant makes the surgery much easier, more precise and less stressful.

Robotic surgery is promising technology in many surgical fields.

In reconstructive plastic surgery, it has already been used to harvest the latissimus dorsi for breast reconstruction, and is used in super microsurgery, hand surgery and for hair transplants.

So far, I haven't found any literature on other applications of robotics in aesthetic plastic surgery.

As a cosmetic plastic surgeon, I feel it is very interesting that there is a fast growing trend for the use of robotics for performing trans-axillary robotic thyroidectomy, robot retro-auricular submandibular gland resection, procedures that are improved or tweaked to minimise visible scars or even relocate scars to other body areas where they can be hidden. Yet little is done in the area of aesthetic plastic surgery, where scarring is an important concern for patients.

Minimally-invasive surgery presents many advantages compared to open methods. It allows for fast recover, less pain, lower risk of infection and minimal scars – which are our goals in cosmetic surgery. The da Vinci Surgical System has proven to be superior in compensating for these aspects and limitations. Conventional endoscopy presents with a 2D image view whereas the daVinci system presents with a high definition precise 3D image.

TRAINING TO BE A ROBOTIC SURGEON

Intuitive Surgical developed the da Vinci Technology Training Pathway. The goal is to help teams develop the knowledge and skills needed to use the da Vinci System technology safely and efficiently. The da Vinci Technology Training Pathway is divided into four phases, with reinforcing activities and supporting tools for both surgeons and/or staff.

Phase 1: Introduction to da Vinci Surgery (Product Training) designed to give teams a foundational understanding of the da Vinci Surgical System.

Phase 2: da Vinci Technology Training (Product Training) introduces surgeons to the core of da Vinci Technology (fig. 3).

Figure 3: Working with the real console with a simulator that measures results and evaluates the performance of the trainee before he works on a real case. This practise helps to improve and maintain skills.

Phase 3: Initial Case Series Plan (Skills Application). At this stage, new da Vinci surgeons are assisted by experienced proctoring surgeons during their first da Vinci procedures.

Phase 4: Continuing Development (Skills Application). The Technology Training Pathway does not end after the initial da Vinci cases. Advanced da Vinci training in multiple specialties is available through select training centres. Programmes are led by experienced, independent da Vinci surgeons who contract with Intuitive Surgical.

ROBOTIC TUMMY TUCKS: PATIENT SELECTION

Minimally-invasive methods in plastic surgery are indicated for the treatment of patients presenting with no redundant folds of skin. We have been using "subcutaneouscopy" since 1991 for the treatment of the rectus diastasis, umbilical hernia and for the treatment of the fat diastasis at the peri-umbilical area to restore the anatomy and the beauty of the abdomen through minimal incisions (fig. 4, 5). The robot surgery presents clear and solid advantages over the conventional endoscopic methods for performing stitches for the recti plication.

Figure 4: Long term follow up of endoscopic abdominoplasty after 35 days showing a very fast recover with minimal swelling. After five years showing maintenance of the result of the rectus plications and fat plication.

Before | After one year | After five years

Figure 5: The before photo showing patient had abdominal deformities after delivery of twins and being four kilograms overweight. One year follow up after the patient lost eight kilograms. After five years, patient put on two kilograms. We observed the long-term maintenance of the result.

THE HISTORY OF ROBOTS

The idea of creating machines for carrying or assisting human activities can be found in early Greek mythology.

In the 4th century BC, Aristotle came up with the original concept of automation, self-moving machines constructed for the purpose of imitating the motions of men and animals.

The first generation of such machines can be traced back to the 14th century – an automated rooster erected on top of the Cathedral of Strasbourg in 1350. It was clock controlled ornamentation, designed to flap its wings and crow every day at noon.

The second generation of robots, in the 18th century, were based on self-contained clockwork mechanisms. In 1774, inventors Pierre and Henri-Louis Jacquet-Droz unveiled the 'Automatic Scribe', a lifelike figure of a boy that could draw and write any message up to 40 characters long. A 'robot' woman playing a piano was another great invention.

The invention of the term "Robot" is credited to Karel Eapek, a Czech writer who used such nomenclature in order to describe intelligent machines that functioned as slaves in his play *Rossum's Universal Robots*.

According to the Robotic Institute of America, the term 'robot' can be defined as "a reprogrammable, multifunctional manipulator designed to move materials, parts, tools, or other specialised devices through various programmed motions for performance of a variety of tasks."

In 1927, the first robot, called Televox, was built by the Westinghouse Electric Corporation/USA to mimic specific human function. It was operated through a telephone system, was able to accept phone calls by lifting the receiver and operating some switches depending on the signals that were received.

In 1928, Japan's first robot, Gakutensoku, was designed and constructed by biologist Makoto Nishimura. In the following years a few more models of more advanced robots were built by Westinghouse and can be seen at Westinghouse museum.

In 1948, after the invention of the transistor, many robots were used in conjunction with the computer. The first patent for a computer-controlled industrial robot was developed in 1954 when George Devol created a computerised memory and control system and started the industrial robot revolution.

In 1961, the robot called Unimate was the first robot in the industrial setting and was installed in a General Motors auto assembly line.

In 1983, the first surgical robot, called Arthrobot, was developed by a team led by Dr. James McEwen and Geof Auchinlek, in collaboration with an orthopaedic surgeon, Dr. Brian Day.

In 1985, the PUMA 560 was first introduced in neurosurgery which can be used to hold and manipulate a needle for CT-guided stereotactic biopsy.

In 1987, the NeuroMate platform was developed by Integrated Surgical Systems and was the first robot used for stereotactics. The birth of robots in field surgery was started in 1987. It was first introduced in laparoscopic cholecystectomy applications other than biopsies.

In 1988, the PROBOT, developed at Imperial College London, was used to perform prostatic surgery.

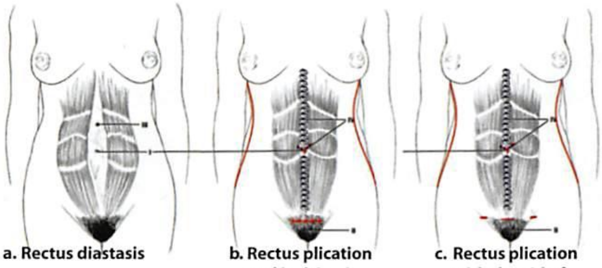
In 1992, the ROBODOC from Integrated Surgical Systems (ISS) was introduced to mill out precise fittings in the femur for hip replacement.

In 1999, the da Vinci Surgical System by Intuitive Surgical was marketed in Europe while waiting FDA approval in the United States.

In 2000, the FDA approved use of the da Vinci Surgical System for general laparoscopic surgery, which can be used to address gall bladder disease and gastroesophageal disease.

In 2001, the FDA approved use of the system for prostate surgery. The FDA has subsequently approved the system for thoracoscopic surgery, cardiac procedures performed with adjunctive incisions.

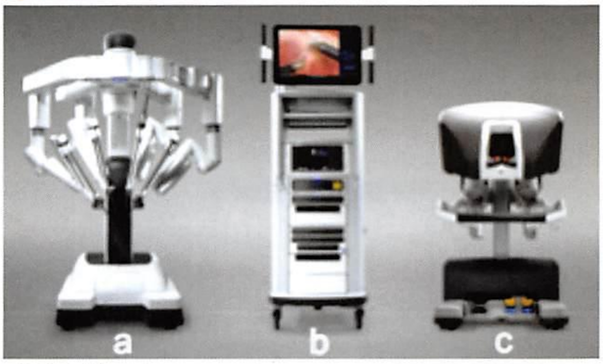
Figure 7



a. Rectus diastasis
b. Rectus plication and incision in endoscopic abdominoplasty technique.
c. Rectus plication with the aid of the robot.

I. Y-shaped umbilicus incision
II. Pubic incision
III. Rectus diastasis
IV. Rectus diastasis repair

Figure 8: da Vinci System



a. Patient side cart
b. 3D vision recorder
c. Surgeon's control console

Figure 9: The surgeon can manipulate the joysticks operating the endo-wrist instruments that have a range of motion comparable to the human wrist. The two lens robotic scopes that provide a fantastic high-definition three-dimensional view.

Figure 10: Before and after: Endoscopic abdominoplasty performed through C-section scar.

Figure 16: Surgeon seated at the robot console operating the robot arms and camera with joysticks and pedals.

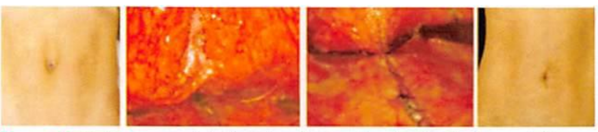


Figure 18: Patients complain that despite working hard at losing weight, and having a strict and rigorous work out regime, they cannot get rid of that bulging stomach and/or the peri-umbilical deformity.

MATERIALS & METHODS

SURGICAL ROBOTS: The da Vinci Surgical System is the equipment that we are using. It consists of three components (fig. 8): (a) The patient site robotic cart with three or four arms; (b) The high-definition 3D vision system; (c) The console where the surgeon sits to operate the robotic arms.

Every single movement is operated and controlled by the surgeon. The robot system does not have autonomy to do anything by its own. It is the surgeon that operates. The surgeon is sited at the console, uses the master control, which is joystick-like, to drive the robot arms and endo-wrist instrument operating very precise miniaturised tools. With his feet, the surgeon controls the camera, zoom-in zoom-out, monopolar, bipolar cut and cauterisation. He also uses his feet to switch use of the second and the third robot-working arms, without the need to coordinate the movements with an assistant. There are a few different robot models with different features. We are using the daVinci S and the daVinci SI.

ANAESTHESIA: I prefer to work with the patient under general anaesthesia.

INFILTRATION: To facilitate dissection and reduce bleeding, the incision areas and the region between the fat tissue and the muscular aponeurosis is infiltrated with 500ml of saline solution and epinephrine (1:500,000).

INCISIONS: If the patient presents with previous scars from caesarean sections or other abdominal surgery, the surgeon assesses the need to repair the scars as well as the possibility of using them for access.

The incision for the camera arm at the midline of the patient's abdomen, inside the pubic hair bearing area at the pubic bone level, three centimetres above the vaginal furcula, measuring 2.5cm (one inch), plus two incisions at the bikini line as small as 0.8cm and an incision hidden inside the umbilical scar. Additional 0.5cm incisions can be made at the iliac crest level each on bilateral sides, in cases of lipo-abdominoplasty when the lower back needs to be treated.

Supra-umbilical or peri-umbilical flabbiness is a frequent finding. This deformity occurs during pregnancy when the abdominal muscles stretch and the subcutaneous fatty tissue attached to them is pulled away, creating a gap with skin flabbiness in the region. This subcutaneous fat gap is repaired from inside by suturing the two edges of the fat tissue together, re-creating a beautiful belly-button like before the pregnancy.