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Case Report

The World's First Obesity Surgery Performed by a Surgeon at a Distance

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Background: In recent years, laparoscopic procedures have gained popularity. The laparoscopic technique is, however, more difficult than the conventional approach, especially in obese patients. The purpose of this article is to demonstrate a solution to these difficulties.

Method: On September 16, 1998, a laparoscopic gastric banding procedure was performed by a surgeon ***while he was actually sitting at a distance from his patient.*** **The surgeon's assistant was scrubbed and gowned and stood at the patient's side. The surgeon manipulated handles that were connected to a computer in command of robotic arms mounted on the operating table near the patient. The robotic arms contained surgical tools with articulated tips, well inside the abdominal cavity. The system constituted a master-slave construction called Mona (Intuitive Surgical, Mountain View, CA). The entire procedure (adjustable silicone gastric banding) was performed solely by this system without any other intervention.**

Results: The entire procedure lasted 90 minutes. The blood loss was 25 mL. The patient left the hospital on the second postoperative day.

Conclusion: This procedure demonstrates that telesurgical procedures are feasible, can be performed safely even in obese patients, and improve the surgeon's comfort by restoring ergonomically acceptable conditions, by increasing the number of degrees of freedom, and by recreating the eye–hand connection lost in videoendoscopic procedures.

Key words: Obesity surgery, telesurgery, robotic, gastric banding, adjustable silicone gastric banding, laparoscopy, morbid obesity.

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Introduction

In recent years, laparoscopic procedures have gained popularity because of decreased hospital stay,[1] less pain, quicker return to normal activity, better cosmesis,[2] and better immunologic response[3] than with conventional surgical techniques. In October 1992, we performed the world's first laparoscopic procedure for the treatment of obesity.[4] Since then, our results as well as those of other authors have suggested the advantage of the laparoscopic approach in the surgical treatment of obesity.[5]

The laparoscopic technique is, however, more difficult than the conventional approach, especially in obese patients, for two reasons. First, the significant thickness of the subcutaneous fatty layer causes the cannulas to be relatively immobile. The laparoscopic tools are therefore even more difficult to manipulate. Second, the size of the patient does not allow an acceptable position for the surgeon to reach the instruments in the upper part of the abdomen.

This article proposes a solution to these two problems.

Method

On September 16, 1998, a laparoscopic gastric banding procedure was performed by a surgeon *while he was actually sitting at a distance from his patient* (Figures 1 and 2). The surgeon's assistant was scrubbed and gowned and stood at the patient's side. The surgeon manipulated handles that were connected to a computer in command of robotic arms mounted

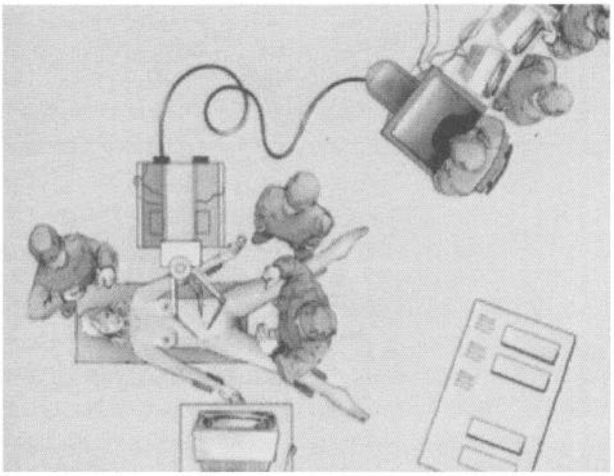

Figure 1. Diagram of set-up of telesurgical procedure.

on the operating table near the patient. The robotic arms contained surgical tools with articulated tips, well inside the abdominal cavity.

The system constituted a master–slave construction called Mona (Intuitive Surgical, Mountain View, CA). The entire procedure was performed solely by this system, without any other intervention.

The procedure had been authorized by the ethical committee of the University Hospital Saint-Pierre in Brussels, Belgium. Fully informed consent had been obtained. The patient was a 34-year-old woman, weight 110 kg, height 171 cm (body mass index 38 kg/m^2), with hypertension. She was given general anesthesia with endotracheal intubation. She was positioned supine with the legs apart, slightly flexed at the hips. Abdominal insufflation with CO_2 was obtained with the Veress technique, and the first cannula was introduced by the assistant at the level of the patient's xiphoid process.

Five cannulas in all were placed in the upper abdomen. Three cannulas harbored instruments that were activated by the slave arms as well as an optical system controlled by a pedal-commanded robot. This optical "trocar" located at the xiphoid contained a camera mounted on a 10-mm rigid endoscope, which projected a three-dimensional picture on two screens, one placed at the level of the patient's right shoulder and clearly visible to the assistant, and the other placed in front of the surgeon, who was sitting at a console. The two other robotically activated instruments were a grasper and a dissecting and electrocoagulating hook, placed in a subcostal position to the right and to the left. The instruments themselves were significantly different from regular laparoscopic tools (Figure 3) because they had articulations placed close to their tips, thereby allowing motions in a different plane than the shaft. The retractor of the liver placed in a trocar on the right anterior axillary line just distal to the right costal margin was held by an articulated arm. The assistant stood between the patient's legs and manipulated a suctioning device through a supraumbilical cannula. The surgeon manipulated two handles located in front of the console (Figure 4).

His elbows were resting on a bench. By manipulation of the handles, electrical impulses were sent to the computer and translated into movements of the

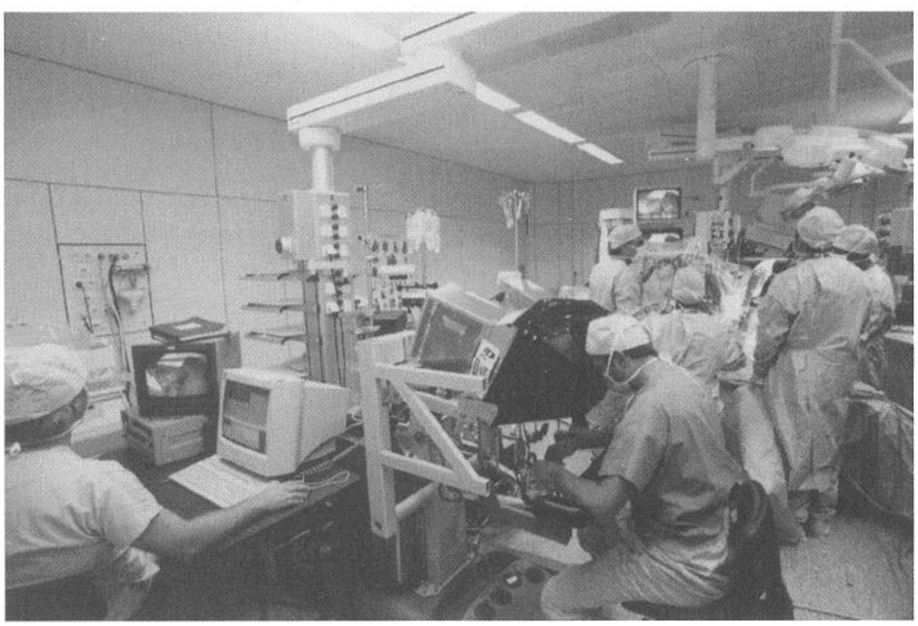

Figure 2. Set-up of telesurgical procedure.

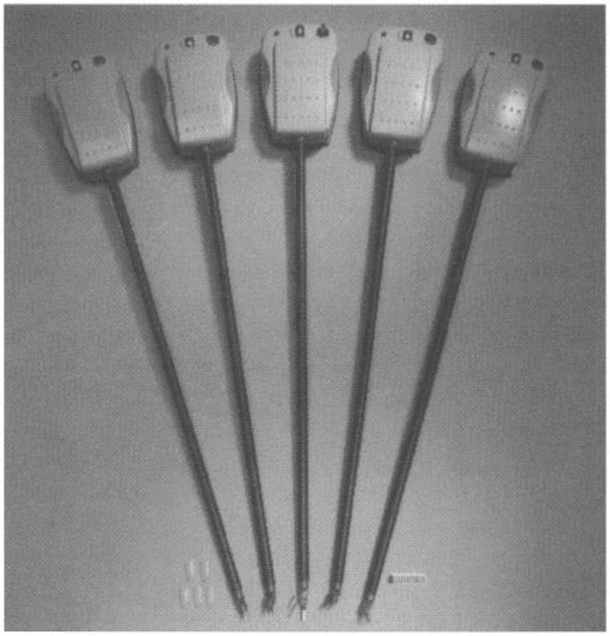

Figure 3. Instruments with articulated tips.

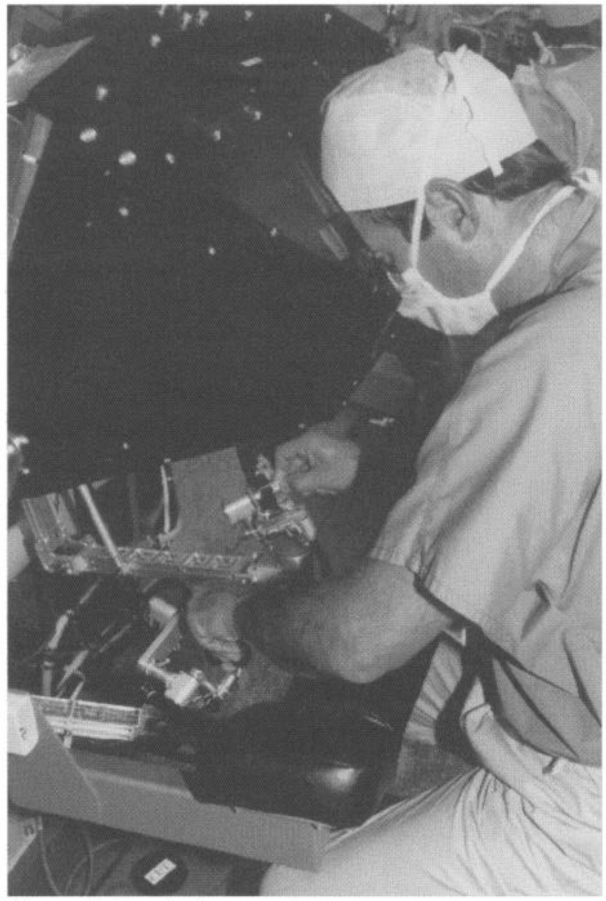

Figure 4. Front of a console.

robotic arms and tools. The surgeon's motions were downscaled. A deflection of 1 cm created a deflection at the tip of the slave tools of 25 mm (downscaling 1 to 4). The activation of the articulation near the tip (endowrist) of the instrument mimicked the surgeon's finger, wrist, and elbow motion. The entire procedure (laparoscopic adjustable gastric banding) (Figure 5) was performed as has been extensively described elsewhere.[5]

In brief, a retrogastric tunnel was created at the upper pole of the stomach, and the Lap-Band was introduced into the abdominal cavity, looped around the stomach at its upper pole, and tightened. The tubing connected with the Lap-Band was then exteriorized and connected to a subcutaneous reservoir.

Results

The entire procedure lasted 90 minutes, measured as the time between the placement of the Veress needle and the removal of the last cannula. The blood loss was 25 mL. The patient made an uneventful recovery. Normal positioning of the prosthesis was checked by Gastrografin® swallow the next day. The patient left the hospital on the second postoperative day.

Discussion

The rapid evolution of minimally invasive surgery, generated by general public demand rather than by strictly medical considerations, has triggered the massive explosion of laparoscopic or keyhole surgery. Obesity surgery, quite logically, was no exception. This technique, however, created new problems that are specific to this surgical approach in this kind of patient. The technique of working through puncture holes in the abdominal wall demands long and narrow instruments, hence the comparison of

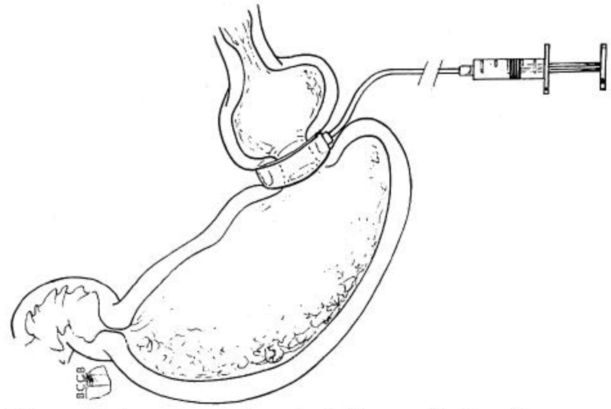

Figure 5. Laparoscopic adjustable gastric banding.

laparoscopic surgery to operating with chopsticks.[6] Because of the need to enter the body through cannulas, the instrumental range of motions is impaired. Straight tools that are inserted through entrance cannulas can be manipulated with certain significant restrictions, i.e., the range of motion is limited within a cone-shaped figure with the base around the target zone and the top at the entrance site. This restriction in the use of tools is described as a reduction in the number of degrees of freedom.[7]

In the obese patient, this problem can become very significant because the thickness of the fat layer adds relative immobility to the trocar, thereby reducing the freedom of motion even further. In laparoscopic surgery, the surgeon's position is determined by the entrance sites for the instruments, unlike in conventional surgery, where the surgeon can move freely around the patient. In obese patients, the surgeon often has to crawl on top of the patient in order to reach the instruments. The surgeon's movements performed under such difficult conditions are jerky and less precise.[8]

In summary, the most significant shortcomings of laparoscopic obesity surgery in its present embodiment are (1) unadapted long instruments with a reduced number of degrees of freedom and (2) ergonomically poor positioning of the surgeon. Improvements are needed to include substantial changes in the laparoscopic tools thus far available, to avoid the limitations created by their shape and length.[9] The interposition of a master-slave system, activating endoscopic tools that are articulated near their tips to allow more complex motions within the body cavities, seems to do away with the problems mentioned.

In this new setting, the surgeon sits comfortably with arms resting on a support. The manipulation of the articulated instruments is performed by activating handles mounted right underneath a three-dimensional videoscreen, thereby eliminating the problem of eye-hand disconnection.[10] Impulses coming from the handles are transmitted to a computer that activates the slave arms mounted on the operating table. The computer interface can translate large deflections of the handles into minute motions on the operative field. Minor involuntary motions like physiologic tremor can be eliminated. The number of degrees of freedom increases because the instruments' tips can move in a different plane than the shaft. This device guarantees perfect mimicking of the surgeon's wrist, allows motion, and realizes the concept of a master-slave system.

We began robot-assisted procedures in March 1997 and since then have performed 12 cholecystectomies, 2 arteriovenous fistulas for dialysis, and 23 Nissen fundoplications. In our experience with the master-slave robotic setup in minimally invasive surgery, three major facts have been demonstrated so far:

1. Telesurgical procedures are possible and can be performed safely.
2. Telesurgical procedures improve the surgeon's comfort by restoring ergonomically acceptable conditions, by increasing the degrees of freedom, and by recreating the eye-hand connection lost in videoendoscopic procedures.
3. The advantages of robotic surgery are particularly obvious in obesity surgery.

The robot-assisted procedure has proved feasible. However, this procedure must be put into perspective, as robot-specific strategies still need to be developed.

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