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Original Article

ROBOTIC ABDOMINAL SURGERY: A BRAZILIAN INITIAL EXPERIENCE

Cirurgia abdominal por robótica: experiência brasileira inicial

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ABSTRACT - ***Background***: Robotic brought to laparoscopy the enrichment of movements, the easy to perform maneuvers and procedures, visualization in three dimensions, and ergonomics for the surgeon. ***Aim***: To describe Brazilian experience with robotically-assisted abdominal surgery. ***Methods***: From July 2008 to April 2010, patients were admitted for abdominal surgery and agreed to being operated with the help of the robot by a trained medical staff. All patients were operated by the same surgical robotic approach. Time required for complete surgery, and console time, were recorded. ***Results***: Forty-four patients were operated, most for hernial hiatal correction or bariatric surgery. All patients, except one, were discharged in the day after surgery. The only complication was a fistula due to a videolaparoscopic clamping procedure during bariatric surgery. There was no hemorrhage. No re-operation was necessary, neither conversion to laparoscopic or open surgery. Mean surgery time for the whole sample was 249.7 minutes (4.1 hours) and console time was 153.4 minutes (2.5 hours). Patients' blood lost was minimal. ***Conclusions***: Robotically assisted abdominal surgery is safe for the patients, with reduced bleeding and acceptable surgical time, and also ergonomic for the surgeons.

HEADINGS - Robotically-assisted abdominal surgery. Minimally invasive surgical procedures. Laparoscopy. Robotic.

RESUMO - ***Racional***: A robótica adicionou à laparoscopia o enriquecimento dos movimentos, a facilidade das manobras e procedimentos, a visualização em três dimensões e a ergonomia para o cirurgião. ***Objetivo*****:** Descrever a experiência com cirurgia abdominal assistida por robô meio brasileiro. *Métodos*: De julho de 2008 a abril de 2010, pacientes foram admitidos para cirurgia abdominal e concordaram em ser operados com auxílio do robô por equipe treinada. Registraram-se o tempo necessário para completar a operação e o tempo de console. ***Resultados*****:** Quarenta e quatro pacientes foram operados, a maioria para correção de hérnia hiatal ou para cirurgia bariátrica. Todos, exceto um, tiveram alta no dia seguinte ao da operação. A única complicação foi uma fístula devida ao procedimento de clampeamento videolaparoscópico, em operação bariátrica. Não houve hemorragia. Nenhuma re-operação foi necessária, nem conversão para procedimento laparoscópica ou laparotômico. O tempo médio total da amostra cirúrgica foi de 249,7 minutos (4,1 horas) e o tempo médio de console foi de 153,4 minutos (2,5 horas). A perda de sangue pelos pacientes foi desprezível. ***Conclusões*****:** Operação abdominal assistida por robô é segura para os pacientes, com sangramento reduzido e tempo aceitável de operação, além de ser mais ergonômica para os cirurgiões.

DESCRITORES - Cirurgia abdominal assistida por robô. Procedimentos cirúrgicos minimamente invasivos. Laparoscopia. Robótica.

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INTRODUCTION

Minimally invasive surgical approaches have proven to reduce abdominal incisions, bringing less patient discomfort and aesthetical benefits, shorter time of surgery and decreased recovery time. The recent advances in robotic technology have successfully provided intuitive motion and enhanced precision and accuracy to these surgeries, in a much more stable and ergonomic environment for the surgeon[10]. The feasibility and safety of the surgeries using these robotic systems have been reported in several series. The rates of conversion and to laparoscopy or open surgery and the complication rates are low, and short-term clinical results are comparable to those of conventional laparoscopy[10]. However, besides the obviously high cost of care, due to the cost of the equipments, it seems that another drawback to be solved is that robotic technology is still a timing consuming surgery[10].

The objective of the present study is to describe the Brazilian experience with robotic abdominal surgery and to report the results. The hypothesis was that the experience with robotic surgery would prove to be safe for the patient and ergonomic for the surgeons.

METHODS

Study design, materials and patients

From June 2008 to April 2010, patients were admitted for laparoscopic abdominal surgery in one private hospital in São Paulo, SP, Brazil. All of them agreed to be operated through robotic surgery. A staff of gastrointestinal surgeons, with laparoscopic expertise were also certified and trained in robotic skills before operating the patients. All patients were informed of the small Brazilian experience in robotically assisted procedures and that all surgeons were certified-trained in robotically assisted surgery, and they signed the consent agreement. All ethical standards were followed regarding patient care and all patients signed informed consent forms for the surgical procedure. This is a retrospective study based on medical records.

All patients were operated in proper surgical rooms with the da Vinci S System (Intuitive Surgical Inc, Sunnyvale, CA, USA), using needle drivers, forceps, scissors, cannulas, cauteries, camera and other instruments and accessories by the same provider, as necessary. The equipment manufacturer had no participation in this study nor made any payment or financial contribution for the research or the authors. The equipments were the hospitals' property.

Table 1 refers the patients' indication for laparoscopic surgery; all of them underwent procedures relating to the upper gastrointestinal tract, most for hiatal hernias corrections or bariatric surgery (gastric banding and septation).

TABLE 1 - Indication for surgical procedures

Procedures	n
Hernias: hiatal or incisional hernias correction	17
Gastric bypass or banding	16
Cholecistectomy	2
Hernia plus colecistectomy	2
Nodules, tumors or lymph nodes excision	3
Gastric bypass plus cholecistectomy	1
Gastric bypass plus cholecistectomy plus correction of hernia	1
Others	2
Total	**44**

Pre-operative procedures and operating room configuration

The patients were placed on the operation table with arms alongside the body, in reverse Trendelenburg position as needed. Patients were carefully secured with restriction strips to avoid any risk of injury. They were submitted to general anesthesia with intravenous anesthetic drugs and intubation (in general with propofol). An orogastric tube and a urinary catheter were inserted. Blood pressure monitoring and pulse oximetry were used. Sequential compression devices were applied to the legs for deep venous thrombosis prophylaxis. Cushions supported all body parts under pressure.

The operating room was configured at the same way depending on what type of surgical procedure took place (bariatric surgery or hiatal hernia repair, for instance). The robot with its four mechanical arms was positioned opposite from the disease side. The camera arm was pointed to the side against the other two arms to save space and mobility, with the camera arm "sweet spot" (the ideal positioning of the camera) in the so-called blue zone. The surgeon console was in the direction of the lower left side of the table in one of the room corners. Scrub nurse and first assistant stayed by the side of the patient, contralateral to the side of robot column. The anesthesiologist was positioned close to the head of the patient, dislocated to the right shoulder. A space was left between the robot and the anesthesiologist for access to the patient head during the procedure. Three main monitors were located around the patient, one in the left side, one close to the head, and the third by the right foot, together with the hardware rack.

The surgical approach

The same surgical approach was generally used in all cases: once the patient was positioned and under general anesthesia, before any incision and puncture, lidocaine was used (3 ml in any of them). First incision was placed close to the umbilicus. Insufflation was achieved through a Veress needle in the camera port until a pressure of 12 mmHg was achieved, sometimes 15 mmHg for obese patients. A 12 mm trocar was placed for the camera. A complete cavity revision was done with the robotic camera and any adhesions or other potential difficulties were identified and treated before the robotic docking. One epigastric puncture was made and a Nathason retractor was used to hold the left lobe of the liver during most of the procedures. Other three punctures were done in the right mid collarbone line: one 3 cm far from the right sub-costal margin; the second 2 cm in the left sub-costal margin, 8 cm far from the camera; and the third puncture was placed in the left side, at the mid axillary line. The assistant surgeon could use the puncture in the left side as an assistant port for aspiration or introductory access. The time taken for the whole surgery was recorded, including patient preparation, room set-up, robot and instruments preparation (such as draping and docking) and the surgical procedure itself (console time). The console and surgery times were registered for each patient, and the mean time for each group of consecutive 11 patients (Group 1: patient #1 to patient #11; Group 2: patient # 12 to patient # 23 and so on) was calculated.

Postoperative period

After recovering from anesthesia, patients were allowed to have clear liquids, and followed nutritional protocol suggested by hospital service. Their restriction was mostly in volume. The patient was discharged in the following day after surgery, provided he/she had had a good nutrient and liquids ingestion, and if there was no complication. They were oriented to walk (early walking), and they were allowed to use common painkillers such as dipyrone or acetaminophen if they had pain. Early postoperative clinical evaluations included abdominal tenderness, vomiting or fever, as well as the presence of complications. Patients were clinically evaluated again one week after discharge. Patients were followed-up for from two to 24 months. Data were described as frequencies, means and variation.

RESULTS

In the study period (24 months), 44 patients were operated using the robotic system. There was no mortality, even during surgery nor in the early postoperative period. No patient died from the health conditions they were operated for. No patient needed to be re-operated because of the robot procedure. No surgery had to be converted to laparoscopic or open types. There was no case of infection and no major hemorrhage in the whole series. Patients lost less than 100 ml of blood per surgery. One patient had an enteral fistula caused by clamping in bariatric surgery.

Mean surgery time for the whole sample was 249.7 minutes (4.1 hours) and console time was 153.4 minutes (2.5 hours). Table 2 brings the time taken for surgery and console robotic procedures for each group of patients. Both surgery and console times dropped in the second group of patients, but then rose again, as shown in Figure 1. The last mean time of surgery was 267.7 minutes (4.4 hours) and of console 152,2 minutes (2.5 hours).

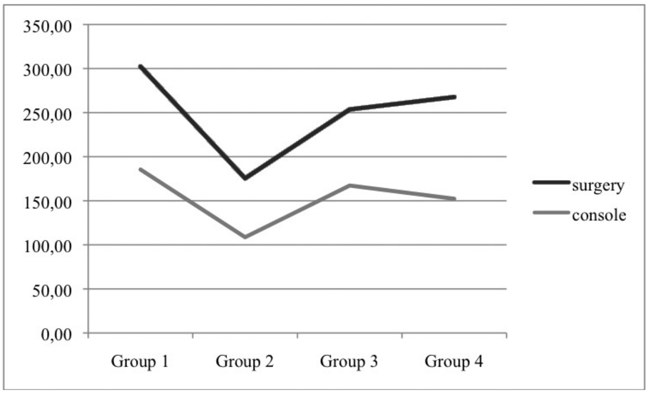

FIGURE 1 – Surgical and robotic console procedure time (in minutes) in the four groups of 11 consecutive patients

DISCUSSION

Laparoscopic techniques have brought to the surgical scenario the small abdominal incisions, less patient discomfort, earlier recovery, improved cosmetic appearance, and in some cases reduced economic burden on the healthcare provider. Brazil is still initiating the use of robots in laparoscopic surgery. The first equipment in country was installed in March 2008. This is the largest case series in robotically assisted abdominal surgery in Brazil. The results are promising in terms of complications and clinical outcomes. Despite the surgery total time was not considered long, there is still some need for improvement regarding to the duration of surgery. Although much more ergonomic for the surgeon than the conventional laparoscopy surgery, the duration of the surgery with the assistance of robots can still be reduced.

The time required for the preparation of instruments and the room setup time, as always happens in video-assisted surgeries is considerable high. It is believed that the learning curve in this case is directly dependent on the number of robotically assisted surgeries performed in the hospital, no matter what specialty (urological, gynecological, cardiac, etc.). Theoretically, the experience gathered by the staff (nurses, surgical scrub nurses, responsible for calibrations and room and instrument organizations) with all surgeries benefit surgeons and patients, since it will eventually allow faster preparation and turnover operating rooms.

Console time, which is the time of the operation itself, depends mainly on the surgeon's experience and ability, and some of the console time registered here refers to the period that was necessary to the surgeons to get used with the robot movements before the real surgical movements were made, i.e., before cutting or suturing, the surgeon tried the use of the instruments with the robot's arms. Confidence in these procedures ¾ the same confidence a pilot needs to feel when

TABLE 2 - Description of the surgical procedures and duration of surgical treatment

Date surgery	Procedures	Surgery time	Console time	Total per group	
25/6/2008	Excision of gastric wall nodule	240	120		
26/6/2008	Cholecystectomy and Incisional hernioplasty	285	220		
27/6/2008	Correction of hiatal hernia	240	150		
5/7/2008	Bilateral inguinal hernioplasty	200	60		
28/7/2008	Gastric bypass	380	250	3325	2040
29/7/2008	Correction of hiatal hernia	195	80		
12/8/2008	Gastric bypass and Removal of gastric band	600	360		
19/8/2008	Hepatic lobectomy	420	300		
22/8/2008	Gastric bypass	260	150		
1/10/2008	Gastrectomy	180	80		
17/10/2008	Gastric bypass	325	270	302,27	185,45
18/10/2008	Fundoplication and Correction of hiatal hernia	120	35		
29/10/2008	Gastric banding	190	80		
3/11/2008	Cholecystectomy	120	70		
4/11/2008	Gastric banding	135	40		
13/11/2008	Correction of epigastric hernia	190	155	1930	1195
14/11/2008	Cholecystectomy	90	50		
20/11/2008	Correction of hiatal hernia	240	165		
28/11/2008	Correction of hiatal hernia	190	130		
29/11/2008	Correction of hiatal hernia and Cholecystectomy	280	225		
2/12/2008	Fundoplication and Gastric banding	150	90		
19/12/2008	Gastric bypass and Removal of gastric band	225	155	175,45	108,64
20/12/2008	Fundoplication and Correction of hiatal hernia	165	115		
16/1/2009	Gastric bypass	245	155		
30/1/2009	Valvuloplasty of diaphragmatic pylorus and Excision of lymph node	175	100		
18/2/2009	Gastric bypass	225	150		
20/2/2009	Correction of hiatal hernia	205	155	2790	1840
9/3/2009	Correction of hiatal hernia	120	60		
23/3/2009	Gastric bypass and Cholecystectomy	370	230		
29/4/2009	Correction of hiatal hernia and Lysis of adhesions	525	330		
8/5/2009	Gastric septation	285	215		
11/5/2009	Gastric banding, Correction of hiatal hernia and Colecistectomy	225	135		
2/6/2009	Correction of hiatal hernia	240	195	253,64	167,27
25/9/2009	Incisional hernioplasty	240	195		
29/9/2009	Correction of hiatal hernia	180	95		
16/10/2009	Gastrectomy and Gastroenterostomy	385	250		
2009/07/11	Gastric septation	180	105		
9/11/2009	Gastric septation and Removal of gastric band	210	130		
13/11/2009	Correction of hiatal hernia	180	100	2945	1675
6/1/2010	Correction of epigastric hernia, Correction of diastasis ectus and Umbilical herniorrhaphy	350	220		
8/1/2010	Gastric banding	240	170		
25/2/2010	Correction of hiatal hernia	240	80		
23/3/2010	Rectumsigmoidectomy + colo-anal anastomosis	500	240		
15/4/2010	Retroperitoneum tumor excision	240	90	267,73	152,27
				10990	6750
				249,77	153,41

holding an airplane joystick in his first flights ¾ will certainly shorten the duration of surgeries.

It was already published that "difficulties accessing multiple quadrants of the abdomen with the first robotic system led to a rather slow introduction of the Da Vinci into the field of abdominal surgery compared with its success with urologic and cardiac procedures"[4]. This could be an explanation for the still long duration of the abdominal surgeries in this series. In a recently meta-analysis by the Cochrane Library, the total time of surgery was not different comparing robot assistance with laparoscopy in cholecystectomies in three clinical trials. The instrument set-up time was significantly lower in the laparoscopic group, and the robotically assisted surgeries were considered safe[2]. In another literature review, telerobotic operations have shown to require more time than the laparoscopic operations, although for telerobotic cholecystectomy and telerobotic fundoplication, this difference disappeared in 10 to 20 operations[1]. The number of single cholecystectomies in this series precludes any statistical preview of the number of surgeries necessary to reduce the duration of this type of surgery. However, other case series studies, with different types of surgeries, have shown that surgery duration is still larger than in laparoscopy[3,9].

Another reason why it is difficult to compare the total surgery and console time in this series with those from other studies is that this authors had many combined procedures taking place at once: in more than 10% of the cases two or even three procedures (such as gastric bypass and cholecystectomy or cholecystectomy and hernia repair) were made in the same operation, and the time taken for each was not recorded separately. If this can be viewed as a limitation of this study, it also shows one advantage of robotics: robotically assisted systems allow the performance of two to three different organs operations safely and easily as seen here.

In a study held in Antwerp, the rate of conversion to laparoscopic procedures was 2.5% in the first series of 70 patients operated for gastrointestinal problems[6], i.e., for any reason the robot was left aside and the surgeon preferred to continue using only the laparoscopy instruments. In this series of 44 patients, there was no need for conversion either for laparoscopy of open surgery. This indicates that all operations could be undertaken and closed with the robot assistance, including hernia repair, gastric bypass, gallbladder removals and the abovementioned combined surgeries (more complex to plan and to proceed). Surgeons felt confident in performing all procedures they were used to do with the conventional laparoscopy, now with the aid of tremor-free joysticks and 3-D vision (not the 2-D vision provided by laparoscopy monitors).

The visualization in three dimensions is the main reason that surgeons who are used to laparoscopic techniques feel thrilled with the robots: the equipment improves suturing capabilities compared to conventional laparoscopy. However, these benefits have not yet been sufficiently reproduced in clinical or experimental studies. It is believed that robotic devices can shorten the learning curve of laparoscopic procedures[11]. A recent consensus on the subject states that "articulated-arm robots will potentially reduce technical skill acquisition time"[5].

Apart from the benefits for the patient, surgeons may choose the robot benefit from the three 3-D imaging, the hand-like motions of the robotic instruments and especially the ergonomically comfortable position[1,7,10]. Robots in surgery overcome some limitations of laparoscopy: fixed axis points at the trocar insertion sites, limited dexterity at the instrument tips, elimination of physiological tremor, and worse ergonomics. Besides, monitors in laparoscopy allow 2-D visualization, compared to the 3-D video monitors in robotically-assisted equipments[1,3,6-8,10,12]. These characteristics of the robotically assisted abdominal surgery point to the elevated potential for growth and dissemination of the technique[7]. Future larger cohort and also randomized clinical trials are necessary for evaluation of clinical results according to each type of surgery.

CONCLUSIONS

Robotic abdominal surgery in this series proved to be safe for the patient, with minimal bleeding, low complications rate, with acceptable surgical time and ergonomic for the surgeons.

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