



## Original article

# Multidisciplinary development of robotic surgery in a University Tertiary Hospital: Organization and outcomes

Elena Ortiz Oshiro,<sup>a,\*</sup> Ángel Ramos Carrasco,<sup>a</sup> Jesús Moreno Sierra,<sup>b</sup>  
Cristina Pardo Martínez,<sup>a</sup> Isabel Galante Romo,<sup>b</sup> Fernando Bullón Sopelana,<sup>c</sup>  
Pluvio Coronado Martín,<sup>c</sup> Iván Mansilla García,<sup>d</sup> María Escudero Mate,<sup>d</sup>  
José A. Vidart Aragón,<sup>c</sup> Ángel Silmi Moyano,<sup>b</sup> and Jesús Álvarez Fernández-Represa<sup>a</sup>

<sup>a</sup>Servicio de Cirugía I, Hospital Clínico San Carlos, Universidad Complutense de Madrid, Madrid, Spain

<sup>b</sup>Servicio de Urología, Hospital Clínico San Carlos, Universidad Complutense de Madrid, Madrid, Spain

<sup>c</sup>Servicio de Ginecología, Hospital Clínico San Carlos, Universidad Complutense de Madrid, Madrid, Spain

<sup>d</sup>ATS-DUE del Bloque Quirúrgico, Hospital Clínico San Carlos, Universidad Complutense de Madrid, Madrid, Spain

## ARTICLE INFORMATION

## Article history:

Received July 14, 2009

Accepted October 27, 2009

Online January 12, 2010

## Keywords:

Robotic surgery

Da Vinci robot

Telesurgery

Robotic surgery programme

New technologies

## A B S T R A C T

**Background:** Da Vinci system (Intuitive Surgical®) is a surgical telemanipulator providing many technical advantages over conventional laparoscopic approach (3-D vision, ergonomics, highly precise movements, endowrist instrumentation...) and it is currently applied to several specialties throughout the world since 2000. The first Spanish public hospital incorporating this robotic technology was Hospital Clínico San Carlos (HCSC) in Madrid, in July 2006.

We present the multidisciplinary organization and clinical, research and training outcomes of the Robotic Surgery Plan developed in the HCSC.

**Material and methods:** Starting from joint management and joint scrub nurses team, General and Digestive Surgery, Urology and Gynaecology Departments were progressively incorporated into the Robotic Surgery Plan, with several procedures increasing in complexity. A number of intra and extra-hospital teaching and information activities were planned to report on the Robotic Surgery Plan.

**Results:** Between July 2006 and July 2008, 306 patients were operated on: 169 by General Surgery, 107 by Urology, and 30 by Gynaecology teams. The outcomes showed feasibility and a short learning curve. The educational plan included residents and staff interested in robotic technology application.

**Conclusion:** The structured and gradual incorporation of robotic surgery throughout the PCR-HCSC has made it easier to learn, to share designed infrastructure, to coordinate information activities and multidisciplinary collaboration. This preliminary experience has shown the efficiency of an adequate organization and motivated team.

© 2009 AEC. Published by Elsevier España, S.L. All rights reserved.

\*Author for correspondence.

E-mail address: ortosh@hotmail.com (E. Ortiz Oshiro).

## Desarrollo multidisciplinario de la cirugía robótica en un hospital universitario de tercer nivel: organización y resultados

### R E S U M E N

#### Palabras clave:

Cirugía robótica  
Robot Da Vinci  
Telecirugía  
Programa de cirugía robótica  
Nuevas tecnologías

**Introducción:** El sistema Da Vinci (Intuitive Surgical®) es un telemanipulador quirúrgico que proporciona numerosas ventajas técnicas al abordaje laparoscópico convencional (visión tridimensional, posición ergonómica, precisión en los movimientos, instrumental multiarticulado, etc.) y que se viene utilizando en diversas especialidades en todo el mundo desde el año 2000. El primer hospital público español que incorporó esta tecnología robótica fue el Hospital Clínico San Carlos (HCSC) de Madrid en julio de 2006.

Presentamos la organización multidisciplinaria y los resultados asistenciales, docentes e investigadores del programa de cirugía robótica (PCR) desarrollado en el HCSC.

**Material y método:** Con una dirección común y un equipo común de instrumentistas, se incorporaron progresivamente al PCR los servicios de Cirugía General, Urología y Ginecología, con procedimientos variados y de complejidad creciente. Se programaron numerosas actividades docentes y de difusión tanto intrahospitalarias como extrahospitalarias para dar a conocer el PCR.

**Resultados:** Entre julio de 2006 y julio de 2008 se intervinieron 306 pacientes en el ámbito del PCR-HCSC: 169 en Cirugía General, 107 en Urología y 30 en Ginecología. Los resultados demostraron la factibilidad de los procedimientos y su corta curva de aprendizaje. La actividad docente realizada incluyó a residentes y especialistas interesados en la tecnología robótica.

**Conclusión:** La incorporación estructurada y gradual de la cirugía robótica mediante el PCR-HCSC ha permitido facilitar el aprendizaje, compartir la infraestructura diseñada, coordinar las actividades de difusión y la colaboración multidisciplinaria. Esta experiencia inicial ha demostrado la eficacia de una organización adecuada y un equipo motivado.

© 2009 AEC. Publicado por Elsevier España, S.L. Todos los derechos reservados.

## Introduction

Although it is not a correct term from the conceptual standpoint, "robotic surgery" is understood as that which is conducted with the assistance of a telemanipulator. Today, the most widely used robotic surgical system is the Da Vinci robot (Intuitive Surgical®).

When operating with this system, the surgeon sits at a console located some distance from the table, with a 3-dimensional and broad vision of the surgical field and the movements performed in the manipulators are transmitted with extreme precision to the surgical field through the robot arms, connected to the instruments.<sup>1</sup>

The assistance of laparoscopic surgery with the Da Vinci system provides a number of advantages over the conventional laparoscopic environment: three-dimensional magnified vision, articulated instruments with more degrees of movement, stability and accuracy, and sensory, physical and cognitive ergonomics for the surgeon.<sup>2</sup> The disadvantages include the lack of tactile perception in the systems currently in use and the high cost of equipment.

The first robotic intervention carried out was a cholecystectomy in 1997 in Belgium.<sup>3</sup> In 2000, the FDA approved the clinical use of the Da Vinci robot for gastrointestinal procedures. Since then, robotic surgery has been developed

intensively in diverse applications around the world.<sup>4,5</sup> Ongoing research aims to solve the problems posed by the practice, and reveals a fascinating future for surgery in the near future.<sup>6,7</sup>

In Spain, the first Da Vinci robots were installed in private schools in Barcelona and Bilbao and urologic procedures were implemented, mainly radical prostatectomy.<sup>8</sup> The third site which incorporated the robot was the Hospital Clínico San Carlos (HCSC) in July 2006 and, in this case, a robotic surgery program (PCR-HCSC) was designed with a triple focus of care, teaching and research. The interested surgical services were integrated and the development was planned of research and training activities consistent with a university teaching hospital.<sup>9</sup>

In this paper, we present the overall multidisciplinary organization and outcomes of care, teaching and research of the PCR-HCSC.

## Material and methods

Before the arrival of the Da Vinci robot to the Hospital, many organizational activities were performed and intensive training in foreign centres with experience was carried out, to address the onset of robotic surgery in the best possible conditions.<sup>9</sup>

As mentioned, the organization of the PCR-HCSC had 3 components:

### **Health care aspect**

Robotic surgery was applied to patients that were going to undergo laparoscopic procedures. Different selection criteria were not applied. All patients were previously seen in a consultation held for that purpose to receive timely information and obtain the consent document (previously designed with the Ethics Committee of the hospital). This document was complementary to the usual documentation and was used for all procedures in all specialties.

A gradual incorporation was scheduled of the interested specialties: starting with general surgery, soon after urology (October 2006) and later Gynaecology (April 2007). The robotic surgical weekly activity was distributed among the 3 departments: Surgery 2 days, Urology 2 days, and Gynaecology 1 day.

The procedures initially programmed by general surgery were cholecystectomies and anti-reflux surgery (Nissen). Colon surgery and some bariatric surgery procedures were subsequently introduced. On behalf of Urology, the experience was initiated with radical prostatectomies and shortly thereafter the indications for surgery were expanded to pelvic floor surgery and others. The robotic colposacropexy was conducted by a joint team (Urology and Surgery). The Gynaecology Department began its experience with the visit of Prof Magriñá (Mayo Clinic, Rochester, Arizona, USA), who performed a hysterectomy in April 2007, and included oophorectomies, hysterectomies and other advanced procedures.

The team of surgical nurses was common to all specialties and initially had 2 people, but was later extended.

### **Robotic techniques**

The Da Vinci robot (Intuitive Surgical®) consists of 3 elements: the master console, the vision column (with a dual optical system that allows three-dimensional vision in the console), and the robot arms, which transmit the surgeon's movements to the patient.

Before starting the operation, the auxiliary health personnel prepare the operating room as required for the intended procedure and to get the system ready. The intervention is started using common laparoscopic techniques (in our case, Hasson's open transumbilical trocar technique). Once the trocar is placed and the robot is positioned, the intervention is initiated from the console, with the help of a surgeon at the table (Figure 1).

### **Teaching aspect**

Among other activities, briefings were conducted on robotic surgery for different department and units of the hospital, inviting interested parties to attend on-site surgical activities. Workshops were also organized where they explained the functioning of the robot and preparation of the equipment in the operating room, and the attendees, in small groups,



**Figure 1 – Arrangement of elements of the Da Vinci robot during a procedure.**

carried out simulation exercises. Furthermore, robotic surgery was implemented with the planned laparoscopic continued education courses and surgical training of residents.

### **Research aspect**

The data collection was systematized from the outset, including information related to the approach (preoperative, intraoperative and postoperative monitoring), along with the specific information of each procedure. The "operating time" parameter was divided into 4 phases: T1: system preparation (set-up), T2: approach and positioning of the robot arms (docking), T3: the intervention itself, and T4: end of procedure.

All data were analyzed using SPSS for Windows V15.0 software. We applied the Mann-Whitney test to compare continuous variables, expressed as mean (standard deviation) or median and interquartile range, while qualitative variables were expressed as percentages. Null hypothesis was rejected when  $P < .05$ .

The PCR programme provided the initial dissemination of the results obtained through the participation of its members in national and international meetings, and through the publication of scientific papers.

## **Results**

### **Health care related results**

The health care activity was started on July 11, 2006, by conducting a laparoscopic cholecystectomy. From then until July 2008, the General Surgery team performed 182 procedures in 169 patients (Table 1). Of these, 118 were women (69.4%). The mean age of the group was 57.8 years (16.16). The standard laparoscopic technique was performed in all cases, with modifications imposed by the robot, such as the position of the trocars (Figure 2). From the outset, the feasibility of procedures and the technical advantage provided by the robot in the complex steps of interventions became clear.<sup>10-12</sup>

In order to analyze trends in learning general surgery team, we divide the overall experience in 3 equal groups (group 1: cases 1 to 57, group 2: cases 58 to 114, and group 3: cases from 115 to 169) and Comparing the results of the medians of T1 and T2 in the 3 groups. In the case of T1, a statistically

significant reduction in time required to complete this phase was found, and for T2, the difference between the 3 groups did not reach statistical significance (Table 2).

None of the intraoperative incidents in the series could be attributed to the use of the robot, except 2 times when there were difficulties in the positioning of the arms (1.2%). Both interventions were completed without specifying conversion to open surgery or laparoscopy. This was not the case in one of the first cholecystectomies, in which the inability to achieve adequate exposure of the field led to completion of the procedure by laparoscopy (0.6%). The rest were conversions to open surgery (16 cases [9.4%]), mostly in colorectal surgery and due to the presence of severe intra-abdominal adhesions, the discovery of locally advanced tumours or difficulty in tumour localization. Five cases were converted to open surgery due to haemorrhaging (cystic bleeding in a cholecystectomy, a fundoplication splenic haemorrhage and 3 cases of bleeding in colon surgery) (2.9%).

The Urology team carried out their first intervention, a radical prostatectomy on October 9, 2006, and they completed 107 procedures during the study period (Table 3), without any severe intraoperative complications and only 3 conversions (4.8%): one to laparoscopy and 2 to open surgery.<sup>8,13</sup> The colposacropexy series was conducted by a joint team with General Surgery, with good technical and clinical results (one conversion to laparoscopy [2.9%]).<sup>14</sup>

The Gynaecology Department joined the PCR in April 2007. During the study period, 30 procedures were completed (Table 3), with 2 complications in the series (6.6%), both solved by conversion to laparotomy.

Table 1 – General Surgery procedures in 2006-2008		
Procedures	Start	No.
<i>Biliary surgery</i>		
Cholecystectomy	July 2006	91
Choledochotomy + Kehr		1
Choledochoduodenostomy		1
<i>Surgery of the EG junction</i>		
Nissen	August 2006	28
Closure of pillars		1
Mesh hiatal plasty		1
Heller + Dor		1
Splenectomy	December 2006	1
<i>Colorectal surgery</i>		
Reconstruction Hartman	October 2006	4
Left colon		24
Rectocele		2
Right colon		14
Gastric bypass	October 2006	4
Others		3
Overall		182

PLACEMENT OF TROCARS IN CHOLECYSTECTOMY



1. Initial trocar (introduced using open technique) for the camera (10-12 mm Hasson)
2. R-arm of the robot (and the surgeon) (8 mm metal trocar)
3. L-arm of the robot (and the surgeon) (8 mm metal trocar)
4. 10 mm auxiliary trocar (handled by a surgeon from the operating table: rinse and suction, clip placement, introduction of sutures...)

PLACEMENT OF TROCARS IN OESOPHAGOGASTRIC UNION



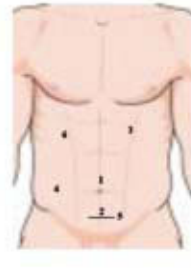
1. Initial trocar (introduced using open technique) for the camera (10-12 mm Hasson)
2. R-arm of the robot (and the surgeon) (8 mm metal trocar)
3. L-arm of the robot (and the surgeon) (8 mm metal trocar)
4. 4" arm of the robot (for the pincer that retracts the liver) (8 mm metal trocar)
5. 12 mm auxiliary trocar (handled by a surgeon from the operating table: rinse and suction, gastric retraction, introduction of sutures...)

PLACEMENT OF TROCARS IN RIGHT HEMICHOLECTOMY



1. Initial trocar (introduced using open technique) for the camera (periumbilical) 10-12 mm Hasson
2. R-arm of the robot (and the surgeon) (suprapubic) (8 mm metal trocar [...])
3. L-arm of the robot (and the surgeon) (8 mm metal trocar)
4. 12 mm auxiliary trocar (handled by a surgeon from the operating table: rinse and suction, cholic retraction, introduction of bands...)
5. Sub-costal R Mini-laparotomy to extract the piece and conduct anastomosis.

PLACEMENT OF TROCARS IN LEFT HEMICHOLECTOMY



1. Initial trocar (introduced using open technique) for the camera (transumbilical) 10-12 mm Hasson
2. R-arm of the surgeon (yellow). Sub-costal L (8 mm metal trocar)
3. L-arm of the surgeon (green). Suprapubic (8 mm metal trocar)
4. 12 mm auxiliary trocar (handled by a surgeon from the operating table: rinse and suction, cholic retraction, introduction of bands...) R Iliac fossa
5. Pfannestiel incision to extract the piece and conduct anastomosis
6. Optional trocar for the 4th arm of the robot (red) to retract the sigma

Figure 2 – Usual position of ports in the most frequent interventions in General Surgery.

**Table 2 – Results of T1 (set-up) and T2 (approach and positioning of the robot) over time in general surgery (in minutes)**

T1 (set-up)	Mean	Medium <sup>a</sup>	SD	Range
Group 1	32.3	30	14.74	10-0
Group 2	25.3	20	11.24	10-0
Group 3	23.5	20	10.38	10-0
T2 (approach and positioning)	Mean	Medium <sup>b</sup>	SD	Range
Group 1	33.2	30	16.21	15-80
Group 2	27.7	25	10.36	10-50
Group 3	24.8	20	11.11	10-75

SD indicates standard deviation.  
<sup>a</sup>Significant difference (P<.01).  
<sup>b</sup>Downward trend that does not reach statistical significance (P=.16).

**Table 3 – Urology and Gynaecology procedures for the 2006-2008**

Procedures	Start	No.
Radical prostatectomy	October 2006	66
Colposacropexy	November 2006	34
Pyeloplasty	November 2007	5
Other Urology		2
<b>Total Urology</b>		<b>107</b>
Oophorectomy	May 2007	10
Hysterectomy	April 2007	17
Hysterectomy + lymphadenectomy	May 2008	3
<b>Total Gynaecology</b>		<b>30</b>

### Teachers

During the study period, 11 informational meetings were held in departments and units of the hospitals involved, and in December 2007, a multidisciplinary meeting was organized to publicize the preliminary results of the 3 departments involved. Thirty residents and specialists (10 of General Surgery, 8 of Urology, and Gynaecology, 12) attended the workshops.

We included robotic surgery practices in continuing education courses (such as the course “La tecnología al servicio de la formación en cirugía mínimamente invasiva” [The technology for training in minimally invasive surgery], in March 2008) and in training courses in minimally invasive surgery by residents.

### Discussion

Satava considered the laparoscopy as a transition toward “information-based surgery.”<sup>15</sup> Robotic surgery not only improves the quality of surgery, but the computer becomes a technological process that can be implemented on both the afferent aspect (obtaining the image or information) and its efferent aspect (surgical manipulation through multi-jointed and “intelligent” instruments, or micro-instruments), as recently stated by Giulianotti.<sup>16</sup> The known benefits of robotic

surgery are still only “the tip of the iceberg” of the changes that we will soon see in surgery.

Our experience is unique in several respects: it is the introduction of robotic surgery in the Spanish public health system through a centre with a major link to the university and that has also been done while integrating the process in a gradual and coordinated manner into different specialties. This has many practical benefits derived from teamwork: learning is simplified as the PCR progresses, the development of documentation is done by all and is applicable to all cases, the nursing staff works with all computers, thus accumulating a great amount of very useful experience,<sup>17</sup> and form multidisciplinary teams for certain procedures, facilitating their implementation, as has happened in the case of the colposacropexy.<sup>13</sup> The success of a project like this depends heavily on having a motivated and excited team of professionals, and with the support of the institution, without which the project is not logically viable.<sup>18</sup>

Similar to other published series that include multiple techniques, in this one, the feasibility of the procedures became evident from the first cases.<sup>19,20</sup> In General Surgery, although cholecystectomies and surgery of benign disease of the EG junction were scheduled to start the learning process, in complex cases (complicated gastroesophageal vesicles or large diaphragmatic hernias) we found great advantages in using the robot, which most likely prevented conversions to open surgery. Talamini et al concur with their observations on the subjective feelings perceived by the surgeon who operates using the Da Vinci robot: the vision and the mobility of the instruments is better, it is more comfortable and some steps of the intervention require more time but others require less (for example, it greatly simplifies the implementation of sutures).<sup>20</sup> As for the lack of tactile perception, although it is initially manifested in the breaking of sutures and even some vesicular ruptures, it is quickly offset by three-dimensional magnified vision.<sup>20,21</sup>

At times, the robot allows carrying out a procedure by laparoscopy that would otherwise require open surgery, but may also involve difficulties when surgery requires position changes, as in colorectal surgery. The learning and transfer of what is learned within the team is what overcomes the



difficulties. In our view, the role of the surgeon who is at the operating table and assists in the intervention is crucial, particularly in complex surgeries.<sup>21</sup> The usefulness of the robot in a particular procedure depends on its systematization and learning. Each team must establish its selection procedures based on their activity. In colorectal surgery, we have found advantages in the rectal dissection and control of bleeding and the realization of sutures,<sup>22</sup> but sometimes it was necessary to perform some steps of the intervention by laparoscopy (hybrid technique) from difficulties in reaching all fields with the robot.

This experience encouraged the expansion of the indications in all teams. In General Surgery, the outlined indications were kept and they included spleen surgery and some indications of non-colorectal cancer surgery.

Robotic surgery is undergoing changes from the intense technological research being carried out and its current version will probably be obsolete in no time. As Satava says: "Science does not wait for anyone and we must be prepared to control the technology as it emerges."<sup>23</sup>

## Funding

We appreciate the support given by the Management and the Medical Directors of HCSC, the Koplovitz Foundation and HCSC Research Foundation to carry out the PCR.

## Conflict of interest

The authors affirm that they have no conflicts of interest.

## REFERENCES

- Ballantyne GH, Moll F. The Da Vinci telerobotic surgical system: Virtual operative field and telepresence surgery. *Surg Clin North Am.* 2003;83:1293-304.
- Stylopoulos N, Rattner D. Robotics and ergonomics. *Surg Clin North Am.* 2003;83:1321-37.
- Himpens J, Leman G, Cadiere GB. Telesurgical laparoscopic cholecystectomy. *Surg Endosc.* 1998;12:1091.
- Lanfranco AR, Castellanos AE, Desai JP, Meyers WC. Robotic surgery: A current perspective. *Ann Surg.* 2004;239:14-21.
- Ito F, Gould JC. Robotic foregut surgery. *Int J Med Robotics Comput Assist Surg.* 2006;2:287-92.
- Taylor GW, Jayne DG. Robotic applications in abdominal surgery: Their limitations and future developments. *Int J Med Robotics Comput Assist Surg.* 2007;3:3-9.
- Herron DM, Marohn M, SAGES-MIRA Robotic Surgery Consensus Group. A consensus document on robotic surgery. *Surg Endosc.* 2008;22:313-25.
- Moreno Sierra J, Nuñez Mora C, Galante Romo I, Prieto Nogal S, López García-Asenjo J, Silmi Moyano A, et al. Prostatectomía radical asistida por robot Da Vinci: un año de experiencia en el Hospital Clínico San Carlos. *Arch Esp Urol.* 2008;61:385-396.
- Ortiz Oshiro E. Introducción de la cirugía robótica en la red sanitaria pública española. Incorporación de un robot Da Vinci a la cirugía del Hospital Clínico San Carlos de Madrid. *SECLAEndosurgery* n.o 17 (October-December 2006). Available from: <http://www.seclaendosurgery.com/seclan17/articulos/reportaje.htm>.
- Ortiz Oshiro E, Ramos Carrasco A, Anula Fernández R, Álvarez Fernández-Represa J. Técnica antirreflujo Nissen laparoscópica con asistencia robótica (video). *SECLAEndosurgery* n.o 19 (April-June 2007). Available from: <http://www.seclaendosurgery.com/seclan19/videos/video03.htm>.
- Ortiz Oshiro E, Ramos Carrasco A, Sánchez Egido I, Anula Fernández R, Álvarez Fernández-Represa J. Hemicolecotomía derecha laparoscópica con asistencia robótica (video). *SECLAEndosurgery* n.o 21 (October-December 2007). Available from: <http://www.seclaendosurgery.com/seclan21/videos/video04.htm>.
- Ortiz Oshiro E, Pardo Martínez C, Ramos Carrasco A, Hernández Pérez C, Álvarez Fernández-Represa J. Tratamiento de la achalasia esofágica mediante abordaje laparoscópico robótico (video). *SECLAEndosurgery* n.o 24 (July-September 2008). Available from: <http://www.seclaendosurgery.com/seclan24/videos/video03.htm>.
- Moreno Sierra J, Nuñez Mora C, Corral Rosillo J, Senovilla Pérez JL, Galante Romo I, Silmi Moyano A. Prostatectomía radical robótica (video). *SECLAEndosurgery* no. 19 (April-June 2007). Available from: <http://www.seclaendosurgery.com/seclan19/videos/video02.htm>.
- Moreno Sierra J, Galante Romo I, Ortiz Oshiro E, Nuñez Mora C, Silmi Moyano A. Colposacropexia laparoscópica asistida por robot en el tratamiento del prolapso pélvico. *Arch Esp Urol.* 2007;60:481-8.
- Satava RM. Robotics in colorectal surgery: Telemonitoring and telerobotics. *Surg Clin North Am.* 2006;86:927-36.
- Entrevista a PC Giulianotti (Grosseto, Italia). *SECLAEndosurgery* n.o 24 (July-September 2008). Available from: <http://www.seclaendosurgery.com/seclan24/entrevista.htm>.
- Mansilla García I, Escudero Romo M, García Y. Papel de la enfermería en el desarrollo de la Cirugía Robótica en el HCSC. *SECLAEndosurgery* n.o 21 (October-December 2007). Available from: <http://www.seclaendosurgery.com/seclan21/articulos/art01.htm>.
- Patel VR. Essential elements to the establishment and design of a successful robotic surgery programme. *Int J Med Robotics Comput Assist Surg.* 2006;2:28-35.
- Cadiere GB, Himpens J, Gernay O, Izizaw R, Deguelldre M, Vandromme J, Capelluto E, et al. Feasibility of robotic laparoscopic surgery: 146 cases. *World J Surg.* 2001;25:1467-77.
- Talamini MA, Chapman S, Horgan S, Melvin WS. A prospective analysis of 211 robotic-assisted surgical procedures. *Surg Endosc.* 2003;17:1521-4.
- Giulianotti PC, Coratti A, Angelini M, Sbrana F, Cecconi S, Balestracci T, et al. Robotics in general surgery. *Arch Surg.* 2003;138:777-84.
- D'Annibale A, Morpurgo E, Fiscon V, Trevisan P, Sovernigo G, Orsini C, et al. Robotic and laparoscopic surgery for treatment of colorectal diseases. *Dis Colon Rectum.* 2004;47:2162-8.
- Satava RM. Robotic surgery: From past to future, a personal journey. *Surg Clin North Am.* 2003;83:1491-500.