The EndoAssist™ robotic camera holder as an aid to the introduction of laparoscopic colorectal surgery

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ABSTRACT

INTRODUCTION Introducing laparoscopic colorectal surgery is a challenge to the whole surgical team. It is usual for an assistant to hold the laparoscope and be responsible for the surgeon's view of the operative field and a lack of expertise in the assistant can add significant difficulties. The EndoAssist™ is a robotic device that replaces the human assistant and ensures steady visualisation of the operative field and a view which can be controlled by the surgeon. This study describes its use in the introduction of laparoscopic colorectal surgery to a unit.

PATIENTS AND METHODS The EndoAssist was employed for the introduction of laparoscopic colorectal surgery in a unit with previous experience of this device for laparoscopic cholecystectomy. It was used in a consecutive series of 77 laparoscopic colectomy operations.

RESULTS The robotic device proved successful in the whole range of colorectal operations and a reliable assistant. No problems specific to the device were encountered.

CONCLUSIONS The EndoAssist robot is a useful laparoscopic assistant and aided in the introduction of laparoscopic colorectal surgery.

KEYWORDS

Laparoscopy – Robotics – Colorectal surgery

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The laparoscopic approach to colorectal surgery is increasing in frequency. It requires different instruments and skills compared to open surgery and these must be acquired by both operator and assistants. The operator's view of the surgical field is critical, and is determined by the laparoscope. This is usually held by hand by an assistant whose experience and understanding of the task may be variable, especially during the introduction of the technique to a unit. The resultant image that the operator has on the screen may not be optimal.

The EndoAssist is a free-standing device which holds the laparoscope and is controlled by the operating surgeon instead of the assistant. It is activated by a foot pedal and controlled by the surgeon's head movements. It is designed to facilitate laparoscopic surgery by improving the image from which the surgeon works. This has previously been shown to be the case in laparoscopic cholecystectomy in this unit.¹

The EndoAssist robotic assistant was used from the commencement of laparoscopic colorectal surgery in this unit and this series describes its place in the introduction of this technique.

Patients and Methods

A series of patients undergoing laparoscopic colorectal surgery was operated on using the EndoAssist robotic assistant to hold the laparoscope instead of the usual assistant surgeon. An assistant surgeon was also part of the surgical team and held the laparoscopic retractors. The series consisted of the experience of a single surgeon (JMG) from the commencement of laparoscopic colorectal resections. The beginning of the series comprised patients with benign pathology (diverticular disease and inflammatory bowel disease) and continued with a consecutive series of patients with predominantly malignant colorectal disease (Table 1).

Patients were positioned supine on the operating table with legs apart and supported (modified Lloyd–Davies position). The operator stood on the left for right-sided colonic resections and on the right for left-sided resections. Pneumoperitoneum was established and laparoscopic ports were placed. A general laparoscopy was performed and the operating table placed in the desired position. This was usually tilted towards the surgeon with the head down. Once the optimum table position had been established, the

EndoAssist robot was positioned next to the operator in the same place that a human assistant would normally stand (Figs 1 and 2).

The positions of the ports are indicated in Figure 3. The laparoscope was usually placed in the epigastric port and held by the robotic assistant. The arc of movement required for adequate visualisation to perform the mobilisation of the colon is also indicated.

Characteristics of the EndoAssist robot

The device is free-standing and is wheeled in to stand adjacent to the operating table; when in position, a brake is applied. The device is set to the port which will take the laparoscope by two laser lights situated in its arm. This places the device at the mid-point of its range of movements. If the operating table is moved, the device has to be re-aligned; for this reason, it is only brought to the operat-

Table 1 Operations performed

Diverticular resection	6
Reversal of Hartmann's procedure	1
Crohn's right-sided resection	3
Carcinoma	
Right-sided	26
Left-sided	36
Abdominoperineal excision	4
Panproctocolectomy	1
Total	77

ing table once the optimum position of the table for the majority of the dissection has been determined. This will usually be after the preliminary general laparoscopy and any preparatory manoeuvres have been performed.

The arm which holds the laparoscope is detachable and is sterilised and screwed into the device. The EndoAssist robot is able to move the laparoscope up, down, left and right and to zoom in and out. These functions are performed by head movements of the operating surgeon who wears an infrared device on the head which transmits to a receiver placed in front in the line of vision. Movements only actually take place if a foot pedal is pressed to activate the device so that unwanted movements do not occur.

The device has an arc of horizontal rotation (pan) of 350°, of vertical pitch (tilt) from -45° (below the horizon) to +90° (vertical) and a zoom of 300 mm which approximates to the length of a laparoscope. It also has safety features which stop the machine if undue pressure is experienced.

Results

The EndoAssist robot was tried in a variety of positions around the operating table. By the tenth operation, the positions shown in Figures 1 and 2 were established and maintained thereafter; these place the device in the same place that a human assistant would stand. No malfunction or technical issues were found with the EndoAssist device, which performed consistently and reliably throughout this series.

The first seven procedures were all for benign disease; thereafter, malignant disease was included and became the predominant indication for surgery. There were 77 operations performed consecutively to the date of this analysis (Table 1).

The first seven operations were converted to open after 1 h whether dissection was completed or not, by intention, as part of the learning process. Thereafter, conversion was defined as premature opening of the abdomen due to failure to complete mobilisation of the bowel laparoscopically. This is a similar definition to that used in the CLASSIC trial.²

Table 2 Reasons for conversion to open operation

Benign disease	
Difficulty with dissection	2
Malignant disease	
Low tumour (mid rectum)	3
Bleeding	2
Obesity and fatty mesentery	2
Non-resectable tumours	2
Adhesions	2
Faecal loading above tumour	1
Large tumour	1
Total	15

Premature conversion to open operation occurred in 15 of the subsequent 70 operations (21%) for the reasons shown in Table 2. The conversions to open operation were all for clinical reasons and none were due to factors related to the EndoAssist.

A whole variety of colorectal operations were performed and the device proved suitable for all of these. For an operation involving both sides of the abdomen such as panproctocolectomy, the machine had to be moved round the table at the mid-point of the operation. The laparoscope used was usually 0° except where pelvic dissection was required as for anterior resection of the rectum and abdominoperineal excision of the rectum when a 30° laparoscope was used and both types were suitable for use with the EndoAssist.

Discussion

Laparoscopic colorectal surgery requires the acquisition of new skills for both the surgeon and assistant. The assistant is an integral part of the operation with control of the laparoscope, and this is crucial for the surgeon as it provides the operative view. An assistant without experience or understanding of the surgeon's needs for visualisation adds difficulty to the operation.

The robotic laparoscopic holder provides consistent control of the view of the operative field, and eliminates the potential variable of the assistant. It provides a steady and controllable view of the operative field, which is entirely under the control of the operator. This proved to be most beneficial, particularly during the introduction of the technique as it removed one component from the learning experience. The fact that our unit already had a considerable experience with the EndoAssist device was an advantage. For new users of the EndoAssist, we previously showed that it usually took three operations to become familiar with the

Table 3 Comparison of the EndoAssist with a human assistant

EndoAssist	Human assistant
Steady image	Image may shake and wander
Operating surgeon controls the image	May not appreciate the image required
Always available	Variable availability
Reliable	Variable reliability
Set to a single table position	Adapts easily to different table positions
Does not tire	Does tire
Minimal training required	Requires training
Activated by head movements	Voice activated

device as its mechanism of use is intuitive and easily learnt.¹

The steady nature of the image obtained using the EndoAssist was observed to have an interesting influence on the technique of surgery. It encourages the operator to move tissues into the field of vision rather than to move the field of vision itself. This adds a feeling of stability to other observers.

During the course of this study, it became apparent that there were a variety of attributes which were desirable in a laparoscopic holder. These are summarised in Table 3 with comparisons between a human and robotic assistant; it is seen that, especially where the attribute includes a degree of consistency, they are more likely to be present in a machine than a human. As long as the function of intelligence and control remains with the operator, all that is required of the assistant is subservience to the operator and this can sometimes be performed better by a machine than a person.

A variety of other devices have been used to hold the laparoscope.³⁻⁵ There are mechanical, non-robotic table mounted clamps, but these require manual adjustment. Another robotic device is the AESOP™ which is table-mounted and, therefore, has the advantage of moving with the table, if the table position is changed. The EndoAssist, being floor-mounted, has to be brought to the operating table once the optimal position has been decided and has to be reset if the table position is changed. The AESOP device is voice-activated and needs to be set to recognise each individual operator, whereas the EndoAssist is activated by the infra red head device and the surgeon's head movements and this is transferable between individuals according to who wears the head controller. The operation has also been performed using the da Vinci™ robot but this is a much more sophisticated device and the robotic arms are

Fig 4 The EndoAssist™ robotic laparoscopic holder in use in a laparoscopic anterior resection of the rectum

directed to perform the actual operation.⁵ The result of all of these comparisons is that there is no fundamental difference between the operation performed with and without

the devices, but the machines do contribute to certain aspects of the operations and may help to overcome some of the difficulties encountered in these complex procedures.

Does the use of the EndoAssist interfere with the training of junior surgeons? Experience from this series is limited as the operations described were part of the learning curve for laparoscopic colorectal surgery for the main operator. Previous experience with the EndoAssist in laparoscopic cholecystectomy showed that it did not interfere with training; indeed, the opposite was true. If a trainee surgeon is performing the operation, the EndoAssist head piece and, therefore, control of the laparoscope can be designated to the surgeon or the assistant (the trainer or the trainee). The trainee benefits from all the advantages of having a robotic laparoscopic holder, the greatest of which is the steady image and the ability to control that image.

This study comprises a clinical series and as such consists of subjective rather than objective observation. Could the study have been designed to be scientific? A previous study from this unit used the EndoAssist robot in laparoscopic cholecystectomy and this was set up as a controlled trial comparing the device with a human assistant.¹ Laparoscopic cholecystectomy is a much more consistent operation than colectomy and, therefore, much more suited to a controlled study. By comparison, in colectomy there is a range of different conditions; even within the same condition, there may be a wide variety of findings encountered during the operation and this is reflected in the significant number of cases that had to be converted to open operation. It was felt that it would be difficult to produce two comparable groups of colectomy patients to produce a controlled trial.

Conclusions

The EndoAssist robotic laparoscope holder was successfully used during the introduction of laparoscopic colorectal surgery. The device is suitable for the whole range of colorectal operations, offers an alternative to a human assistant, and has some advantages.

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