Robotic-assisted colon and rectal surgery: a systematic review
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CRD summary
This review found that robotic-assisted procedures for colorectal surgery were safe and feasible options for both benign and malignant disease. Lack of information on study quality and differences in the reporting of complications associated with these procedures mean that the reliability of the authors’ conclusions is unclear.

Authors' objectives
To assess the safety, feasibility and outcomes of robotic-assisted colon and rectal surgery.

Searching
MEDLINE, EMBASE, SCOPUS, DARE, BIOSIS Previews and the Cochrane Library were searched from 2000 up to August 2010; search terms were reported. Bibliographies of all included studies were checked to identify further studies. Google was searched for clinical practice guidelines. Registries of controlled trials (including the ICRTP Search Portal for the World Health Organisation) were searched for ongoing trials.

Study selection
Studies that evaluated robotic-assisted colorectal surgery (including for benign and malignant disease) in 10 or more adults (aged 18 years and older) were eligible for inclusion. The primary outcomes were complications and mortality rates. The secondary outcomes were intra-operative procedure times, oncological outcomes, conversion rates, and postoperative length of hospital stay.

Included studies were published from 2002 to 2010. The mean age of participants was 61.4 years; approximately 56% were males. The mean body mass index was 25.5 kg/m² (where reported). The types of colorectal surgery performed were ileocaecal resection, right and left hemicolectomy, sigmoid resection, low anterior resection, subtotal and total colectomies, total proctocolectomy, abdominal perineal resection, coloanal anastomosis, and rectopexy. Most studies performed robotic-assisted surgery with the da Vinci robot system, except one study where the ZEUS surgical robot was used.

Two independent reviewers performed the study selection; any disagreements were resolved by a second review.

Assessment of study quality
Two independent reviewers assessed methodological quality using the Cochrane (concealment of allocation) and Risk of Bias tools. Any disagreements were resolved by re-examining the data.

Data extraction
Two reviewers independently extracted data on descriptive statistics (simple counts, means and medians) and efficacy outcomes. Data for oncological outcomes were analysed separately, stratified by purely colon surgery, purely rectal surgery, and combined colorectal surgery (for reports where the data could not be separated). Disagreements were resolved by re-extraction of the data.

Methods of synthesis
The results were summarised in a narrative synthesis because of the heterogeneity among the studies and the lack of randomised controlled trials identified in the review.

Results of the review
Twenty studies (854 patients) were included in the review: 14 case series, three case-control studies, two comparative non-randomised studies, and one retrospective analysis of prospectively collected data. One of the case series studies compared robotic-assisted surgery with laparoscopic surgery. Sample sizes ranged from 10 to 131 patients. The mean follow-up ranged from 10 to 36 months (where reported).

Complication rates: Complication rates ranged from 0 to 42.7% across 20 studies; the overall rate of complications was
15.5%. The major complications reported were anastomotic leak (27 cases), postoperative bleeding (10 cases) and surgical site infection (14 cases). Other complications were ileus, urinary retention, cystitis, pulmonary and cardiac complications, hernia, deep vein thrombosis and pneumonia.

**Mortality**: Thirteen studies reported mortality outcomes. There was no intra-operative or 30-day mortality reported in these studies, although one patient died from pneumonia three months post-surgery and another patient died of metastases at one-year post-surgery.

**Conversion rate**: The overall conversion rate to laparoscopic or open surgery procedures was 3.7% (19 studies, range 0 to 12.5%, where reported). Reasons for conversion were obesity with heavy mesentery, inability to identify vascular structures, vascular injury, adhesions, narrow pelvis and technical difficulties (stapler mis-firings and robotic malfunction).

**Length of hospital stay**: Postoperative length of hospital stay was a mean of 5.9 days (+ 2.1; 18 studies).

**Operative time**: The mean operative time reported in all 20 studies was 236 minutes (+ 66.5; range 154 to 383.8). Two comparative studies found no differences in operative time between robotic-assisted surgery and the laparoscopic study groups. One study found a significant difference in operative time between robotic-assisted and laparoscopic surgery, although the length of surgery decreased with increased experience. One case series study found that operative time decreased as the number of cases of robotic-assisted surgery increased.

Nineteen studies included surgery performed for malignant disease and more than 12 lymph nodes were retrieved in eleven studies for oncological staging.

In the three studies that reported on total mesorectal excisions, complete resections were achieved in 78%, 84% and 93% of cases.

**Cost information**
Operative costs were not consistently reported across the studies. One study reported costs of the robotic system at US $42,454 per case, of which $1,577 was directly related to robotic instruments. Another study reported the cost of the robotic system at $2,000,000, with additional costs of robotic instruments of $2,000.

In a study where the costs of robotic and laparoscopic procedures were compared, the cost of robotic-assisted surgery was EUR 6,500 and the cost of laparoscopic surgery was EUR 4,500 plus maintenance costs.

Two studies estimated the costs of robotic procedures to be approximately three times greater than laparoscopic procedures.

**Authors’ conclusions**
The results of the review suggested that robotic-assisted procedures for colorectal surgery were safe and feasible options for both benign and malignant disease, although the technology was expensive and required larger operating theatres, and increased procedural set-up time and expertise to perform.

**CRD commentary**
The review addressed a clearly defined question; inclusion criteria were outlined and reproducible. Appropriate databases were searched for studies and attempts were made to identify unpublished studies. Steps were taken to minimise errors and bias in the review process.

The results of the quality assessment of included studies were not reported, which made it difficult to judge the reliability of the results of the included studies. The authors stated that there was heterogeneity in the reporting of complications as some studies only reported major complications and other studies reported all complications. The authors acknowledged the limitations of the review, particularly: the inherent biases present in the non controlled studies included; the lack of consistent outcome reporting; and the potential for overestimating/underestimating the rate of complications in studies where the outcomes of colon and rectal surgery were not reported separately.

The lack of information about study quality, the heterogeneity in study designs and outcome reporting mean that the
authors’ conclusions should be interpreted with some caution as their reliability is unclear.

**Implications of the review for practice and research**

**Practice**: The authors did not state any implications for practice.

**Research**: The authors stated that further well-designed randomised controlled trials were required to determine any additional benefits of robotic-assisted technology to outweigh the increased operating costs associated with this procedure.

**Funding**
Not stated.

**Bibliographic details**

**PubMedID**
22113977

**DOI**
10.1002/rcs.432

**Original Paper URL**

**Indexing Status**
Subject indexing assigned by NLM

**MeSH**
Colorectal Surgery /mortality; Comorbidity; Female; Humans; Male; Middle Aged; Postoperative Complications /mortality; Prevalence; Risk Assessment; Risk Factors; Robotics /statistics & numerical data; Surgery, Computer-Assisted /mortality; Survival Analysis; Survival Rate; Treatment Outcome

**AccessionNumber**
12011007555

**Date bibliographic record published**
24/02/2012

**Date abstract record published**
14/07/2012

**Record Status**
This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.