



A cost-minimization analysis of first intention laparoscopic compared to open right hemicolectomy for colon cancer



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HIGHLIGHTS

- Morbidity, mortality and survival were equivalent.
- Total theatre cost was €643 ± 256 higher in the laparoscopic group.
- The reduced LOS in the laparoscopic group saved €1960 ± 636/patient.
- Overall first intention laparoscopic right hemicolectomies saved €1316 ± 733/patient.

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ABSTRACT

Background: The morbidity, mortality and survival following a laparoscopic right hemicolectomy for colon cancer are equivalent to an open operation. However, the cost of a longer operating time and consumables may offset savings from a shorter length of stay (LOS). A cost minimization study was undertaken to compare the relative costs.

Methods: A retrospective cohort study of consecutive elective right hemicolectomies for colon cancer performed over 5 years by two teams. One team performed an open operation (OG), the other intended to perform all operations laparoscopically (LG). Clinical outcomes and relative costs were evaluated. Results expressed as mean ± SEM.

Results: There were 58 patients in the open group and 56 in the first intention laparoscopic group, of which 77% were completed laparoscopically. There was no difference in age, gender or cancer stage. The complications, mortality and 5-year survival were similar. Anaesthetic (LG = 63 ± 3, OG = 62 ± 2 min) and surgical times (LG = 144 ± 8, OG = 143 ± 5 min) were similar. Consumables cost €571 more and the total theatre cost was €643 ± 256 higher in the laparoscopic group compared with the open group ($p = 0.01$). The LOS in the laparoscopic group (4.6 ± 0.5 days) was less than in the open group (8.3 ± 1 days, $p < 0.01$) saving €1960 ± 636 per patient. Overall, first intention laparoscopic right hemicolectomies saved €1316 ± 733 per patient. A probability sensitivity analysis indicated a 62% probability that a laparoscopic right hemicolectomy was cheaper than an open operation.

Conclusion: Laparoscopic right hemicolectomy is oncologically equivalent but less costly and should be considered the procedure of choice for right-sided colon cancer unless contraindicated.

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1. Introduction

Colorectal cancer is the fourth most common cancer in the UK with 41581 new cases diagnosed in 2011. About 25% of colorectal cancers occur in the proximal colon and most are treated with a

right hemicolectomy [1]. An open right hemicolectomy is currently the standard operation but an increasing number of operations are performed laparoscopically. The post-operative mortality is similar and the long-term survival after laparoscopic right hemicolectomies is as good as after open surgery [2–7]. Laparoscopic surgery has the advantage that it is less invasive than open surgery and, for most operations, is associated with fewer post-operative complications. However, it is uncertain whether this applies to right hemicolectomies. Some studies have shown that post-operative morbidity is reduced compared with open right

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hemicolectomies [2,6–10], but others have not shown any difference [5,11–13]. This indicates that there is little difference in outcome for a patient whether a right hemicolectomy is performed open or laparoscopically.

There is no doubt that the length of stay (LOS) after laparoscopic surgery is shorter than after open surgery suggesting that laparoscopic right hemicolectomies may save money. However, the reduced LOS following the implementation of enhanced recovery protocols has made the benefit of laparoscopic surgery less compelling [2,3,14]. In addition, laparoscopic right hemicolectomies take longer than open operations [8,10,14,15] and use more consumables [10,15,16]. To further complicate an economic evaluation not all operations can be completed laparoscopically and it is likely that operations in excluded patients are technically more difficult, take longer, have more post-operative complications and a longer hospital stay. As a consequence the higher theatre costs of a first intention to undertake right hemicolectomies laparoscopically may offset savings made from a reduced LOS. To investigate this we undertook an economic evaluation of a first intention to treat laparoscopic right hemicolectomy compared with an open operation. A cost minimization study from the healthcare system perspective was performed [17]. Cost minimization analysis was selected because outcomes of laparoscopic compared to open right hemicolectomy for colon cancer are equivalent.

2. Methods

A retrospective cohort study was undertaken of consecutive right hemicolectomies for colon cancer performed by two surgical teams at the Royal Cornwall Hospital (a District General Hospital) over a 5-year period between 2006 and 2011. Patients were referred from primary care to one or other of the surgical teams. The hospital does not get tertiary referrals. Patients were identified from a prospectively collected cancer database and double-checked by reviewing histopathology and operating theatre records. Where necessary the medical records were reviewed. Patients excluded from this study comprised emergency right hemicolectomies and non-cancer operations. All patients had a pre-operative colonoscopy and staging CT scan of the chest, abdomen and pelvis. At the colonoscopy a tattoo was placed 5 cm distal to the tumour unless the colonoscopy was incomplete. A consultant or senior colorectal trainee assisted by the consultant undertook all operations. All patients operated on by one team had a conventional open right hemicolectomy (OG). After 2006 the other surgical team attempted to undertake all elective right hemicolectomies laparoscopically: the “laparoscopic” group (LG). In some patients in the first intention laparoscopic group the operation was converted to an open operation after either a diagnostic laparoscopy (strategic conversion) or a period of dissection (reactive conversion).

Patients were cared for on the same ward by the same team, which included 3 junior doctors and an enhanced recovery nurse all adhering to similar post-operative protocols. Cornwall has a stable population allowing long-term follow up of patients. Patients were followed up in the out patient clinic for a minimum of 5 years. The following data were collected on each patient: age, gender, date of operation, operation details, histology, post-operative complications, date of discharge and, if dead, the date of death and cause of death.

2.1. Surgical technique

Open right hemicolectomies were performed through a midline or transverse incision using a standard technique. All patients in the laparoscopic group initially underwent a diagnostic laparoscopy and trial dissection to assess suitability for a laparoscopic resection.

Laparoscopic right hemicolectomies were performed using a 4-port technique including two disposable 5 mm ports; a Lotus™ ultrasonic scalpel (SRA Developments Ltd) and major vessels were divided between disposable titanium clips. The specimen was retrieved through a transverse incision in the right upper quadrant. The anastomosis in both laparoscopic and open right hemicolectomies was usually hand sewn extra-corporeally.

2.2. Cost estimations

All costs are given in Euros, 2014 level at a conversion rate of £1 = €1.30. Cost estimations were based on the duration of the operation, the cost of consumables and the LOS. The consumables did not change during the course of the study. Operating times and consumable costs were collected using galaxy (Galaxy™) operating department software. The procedure time was the time an anaesthetic started to the time the patient was taken into recovery. Surgical time was the time from the start of the operation to the time it finished. Anaesthetic time was procedure time minus surgical time. The estimated cost of an elective operating theatre in the UK is about €1560 per hour, or €26/minute. The estimated average cost for a ward bed was €520 per day, and €1950 per day for an intensive care unit (ICU) bed.

2.3. Data collection and analysis

Data on all resections was collected on a Microsoft Excel™ spreadsheet (Microsoft Corporation). Results are expressed as mean ± SEM or with 95% confidence intervals quoted in parentheses. Results were analysed on an intention to treat principle. Descriptive statistics and statistical analysis was undertaken using Graph Pad Prism™ (GraphPad Prism 6™, GraphPad Software). Fisher's exact test was used to analyse contingency tables, Mann–Whitney test to compare 2 groups and Kruskal Wallis test to compare 3 or more groups. Survival curves were created and compared using the Kaplan Meier method. The level of significance was $P < 0.05$.

For the post hoc cost minimization analysis it was assumed that the clinical outcome measures (morbidity, mortality and survival) were similar in both groups. Incremental cost was calculated as the difference between the costs of the operation divided by the difference in LOS. To assess the likelihood of first intention laparoscopic right hemicolectomies resulting in lower costs than open operations a non-parametric bootstrapping approach was used. Procedure data was stored in the following arrays from where they were re-sampled randomly 10,000 times:

- $S_{j,k}$ the surgical time for operation j (minutes)
- $A_{j,k}$ the anaesthetics time for operation j (minutes)
- $C_{j,k}$ the monetary value of the consumables used in operation j (Euros)
- $L_{j,k}$ the postoperative length of stay in a non-ICU hospital ward (days)
- $T_{j,k}$ the postoperative length of stay in ICU (days)

The index “ j ” ran from 1 through 56 for laparoscopic operations and from 1 to 58 for open operations. The variable k held the value 1 for the first intention laparoscopic right hemicolectomies and 2 for the open operations.

The cost of each of 10,000 bootstrapped procedures was obtained by taking random samples from each of the variable arrays and feeding into the following equations:

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