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CHANGES IN FATIGUE AND PHYSICAL FUNCTION FOLLOWING LAPAROSCOPIC COLONIC SURGERY*

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The aim of the study was to describe changes in postoperative fatigue, quality of life, physical performance, and body composition in patients undergoing laparoscopic colonic cancer surgery.
Material and methods. In a follow-up study from 2009-2011 at two regional hospitals in Denmark we examined 62 patients having a right hemicolectomy ora sigmoid resection performed. The main outcome measures were fatigue level subjectively scored from 1 ("fit") to 10 ("fatigued") on a modified visual analogue scale and by objective measurements of hand grip and knee extension strength, work capacity, weight, and lean body mass. Quality of life was assessed using the SF-36 questionnaire and pain using an ordinal scale. Patients were examined preoperatively, 1–2 and 4 weeks postoperatively.
Results. Eight patients (13%) were converted to open surgery and the median bleeding (95% confidence interval of the median) was 75 (50-100) ml. One to two weeks after surgery the fatigue level and pain when moving had increased significantly (p=0.0011 and p=0.0002 respectively) and the SF-36 physical component quality of life score decreased (p<0.0001) when compared to preoperatively. However, at 4 weeks postoperatively fatigue level, pain, and quality of life scores were at the preoperative level. There were no significant changes from preoperatively to postoperatively in any of the measures of physical performance, whereas there was a slight reduction in weight and lean body mass after the operation.
Conclusions. Laparoscopic colonic cancer surgery was associated with a short lasting increased fatigue and pain and reduced quality of life, but no significant reduction in physical performance after surgery.
Key words: laparoscopic surgery, postoperative care, fatigue, body composition

Following major surgery, patients are fatigued (1, 2) and have impaired physical performance, including reduced work capacity (3) and muscular function (2, 4). Much research has considered how to reduce postoperative stress responses and improve rehabilitation following major surgery (5). The most successful strategy has been a fast-track care programme that includes multiple elements, e.g. preoperative counselling, early mobilisation, sufficient oral nutrition, effective pain relief, small incisions, and a minimal use of tubes and restrictions (6).

To reduce the negative physiological effects of surgery further, the standard procedure for treating colonic cancer has changed from open surgery to laparoscopic surgery, which is combined with a fast-track care programme (7, 8). However, there is a need for more information about the postoperative changes in fatigue and physical function of patients undergoing laparoscopic colonic surgery, in or-

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der to advance their postoperative rehabilitation further.

The aim of this study was to describe the postoperative changes in fatigue, pain, quality of life (QoL), physical performance, and body composition following laparoscopic colonic cancer surgery.

MATERIAL AND METHODS

From September 2009 to November 2011, patients undergoing elective laparoscopic colonic cancer surgery (right hemicolectomy or sigmoid resection only) were included in a prospective follow-up study at the surgical departments oft he regional hospitals in Randers and Herning, Denmark (fig. 1). Patients with disseminated cancer, contraindications for laparoscopic surgery, dementia or serious psychiatric disease, or other diseases or aspects that prohibited participation were all excluded from the study.

Assessments

The following parameters were registered from the hospital records: American Association of Anaesthetists (ASA) score, cancer location, surgical procedure, cancer classification (TNM), blood loss, and postoperative complications. Complications were classified as either divided into major (such as acute myocardial infarction and re-operation) or minor (such as pneumonia and superficial wound infections).

Patients were scheduled to be examined by physiotherapists, who were trained in the use of the test equipment, prior to the operation, around postoperative day 10 (from days 7 to 13), and day 30 (from days 25 to 35).

Fatigue,QoL, and pain

Fatigue was assessed using a vertical scale with "1" to "10" marked at 1 cm intervals (10). Patients were asked to mark their degree of fatigue for the past week. Quality of life during the past week was measured using the SF-36 acute QoL scale (10 ,11) ; the physical and mental health component scores were computed as well as the bodily pain scale. Pain was also assessed with an ordinal scale from "0" (no pain) to "10" (maximal pain), marked at1 cm intervals. Patients were asked about the pain present at rest and when moving.

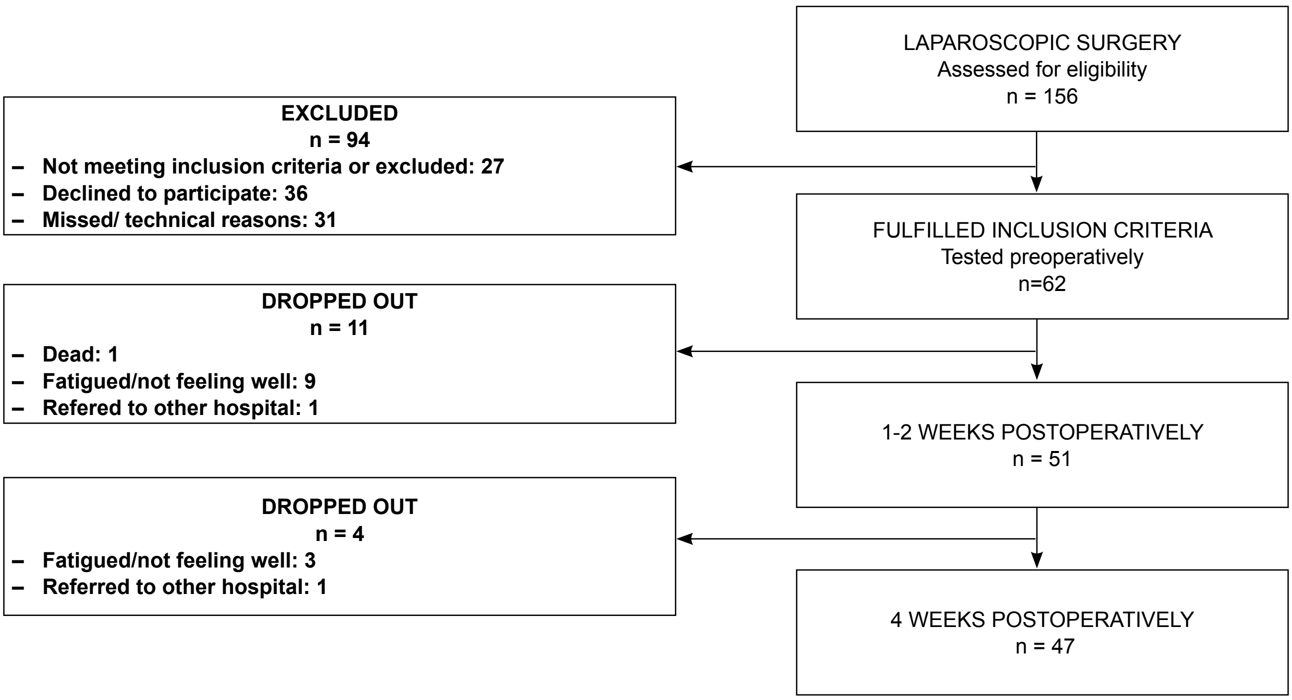

Fig. 1. Flow of patients

Physical performance

The maximal voluntary isometric hand grip (HG) and knee extension (KE) strength were measured on the side of the patient's dominant arm with strain-gauge transducers that were mounted on a dynamometer chair (Good Strength, Metitur Oy, Jyväskylä, Finland). The patient sat with the knees and hip flexed to 90° for measurement of KE strength, and the elbow was flexed to 90° for measurements of HG strength. Data from the best of three attempts was recorded.

Work capacity was measured using a bicycle ergometer (Ergometer 900, Ergoline, Bitz, Germany in Herning, and Monark Ergometer, 828E, Monark Exercise AB, Vansbro, Sweden in Randers). The initial load was 25 W and the load increased by 25 W every second minute until the patients worked at 65% of their expected maximal heart rate, which was calculated using the formula: "220 – age". The patient then cycled for 5 min, so that their heart rate at this load could be recorded. Changes in heart rate between postoperative and preoperative tests were used as an indicator of changes in work capacity.

Postural sway was measured with open and closed eyes on a dynanometer platform (Good Balance; Metitur Oy, Jyväskylä, Finland). The velocity moment was calculated as the mean area (mm/s) covered by the movement of the centre of pressure during each second of the test; the test lasted 30 seconds.

Weight and body composition

Patients were asked to estimate their weights 3 months prior to the time of examination, and the values were recorded. With the patient lightly dressed and having emptied their bladder, their body weight was measured to the nearest 0.1 kg. Body mass index (BMI) was calculated as weight/height^2 (kg/m^2).

Body composition was assessed using a 50 Hz bioimpedance assay (BIA) (Animeter, HTS-Engineering, Odense, Denmark in Herning, and SFB7, Impedimed Pty Ltd, Brisbane, Australia in Randers). The lean body mass was computed from the resistance, body weight, and height of each patient using the Heitman formula (12, 13). Fat mass was calculated in kilograms as the body weight minus lean body mass.

Living situation and care in the home

The living situation (living in own home, nursing home, living alone, etc.) and the weekly use of home care was recorded. The home care included any personal care, home nursing, and assistance, including professional care as well as help from family and friends.

Ethics

Patients gave written informed consent and the study was registered with the Danish Data Protection Agency (registration number 2007-58-0010); the Clinical Trials.gov identifier was NCT00938210. The surgical departments involved each covered their expenses forthe study.

Statistics

Data were analysed using Stata (Stata® Version 12.0, College Station, Texas, USA) and are presented as frequencies and medians (95% confidence interval of the median). Changes over time were tested with the Wilcoxon matched-pairs signed-rank test. The reported probability values were based on the two-sided alternative hypothesis. A probability (p-value) of less than 0.05 was regarded as indicating statistical significance.

RESULTS

Table 1 describes the baseline values of patients. There were slightly more men than women and 59 of 62 patients (95.2%) were either healthy or had only mild systemic disease (ASA score I or II).

Of 62 laparoscopic operations 8 (12.9%) were converted to open surgery (6 sigmoid resections and 2 right hemicolectomies). The reasons for conversion were: adherences (3), large heavy tumour (1), colonic perforation (1), fixed tumour (1), and poor overview (2).The perioperative blood loss was a median (95%

Table 1. Baseline values of included patients (1)

	Included patients
	Laparoscopic n = 62
Age (years)	68,1 (66,3–72,4)
Women (%)	26 (41,9%)
American Association of Anesthetists (ASA) score:	
1) healthy patient	21 (33,9%)
2) mild systemic disease	38 (61,3%)
3) severe systemic disease	3 (4,8%)
Operations performed:	
1) right hemicolectomy	22 (35,5%)
2) sigmoid resection	40 (64,5%)
Pathology	tumor: T1: 4 (6,5%) T2: 8 (12,9%) T3: 40 (64,5%) T4: 10 (16,1%) nodes: N0: 33 (53,2%) N1: 17 (27,4%) N2: 12 (19,4%) metastasis: M0: 62 (100%)
Patients with complications	16 (25,8%)
Major complications:	
1) re-operations (2)	9
2) wound infections needing surgical revision or drainage of abscess and/or sepsis	5
3) transitory cerebral ischaemia/respiratory insufficiency – ventilator treated/ renal insufficiency	3
Minor complications:	
1) gastric ulcer, gastric or rectal bleeding	3
2) infections (e.g. pneumonia, cystitis)	2
3) other	5
Days with gastric tube postoperatively:	
0	56 (90,3%)
1-6	6 (9,7%)
Days with indwelling urethral catheter:	
0	34 (58,6%)
1-22 (3)	24 (41,4%)

(1) Values are medians (95% CI of median) and numbers (% of total)
(2) Two patients were re-operated twice
(3) One patient had an indwelling urethral catheter for 22 days, the others for 1–7 days

confidence of median) 50 (50–100) ml and five patients received blood transfusions (from 0.30 to 5.50 l). Three patients spend 1, 3, and 10 days in the intensive care unit (ICU).

Fatigue, QoL, and pain

One to two weeks after surgery there was a significant increase in fatigue, a decrease in the SF-36 physical component score, and an increase in the SF-36 pain score (tab. 2). The preoperative pain measured with the ordinal scale was 0 (0–0) units at rest and when moving 0 (0–1) units. There was no statistically significant change in pain at rest by 1 to 2 weeks ($p=0.09$) or 4 weeks after surgery ($p=0.17$). However, the pain when moving was significantly increased by 1.0 (1.0–2.0) unit 1–2 weeks postoperatively ($p=0.0002$), but the change was 0 (0–0) units by 4 weeks after surgery ($p=0.76$). Hence, after 4 weeks all measures of fatigue, QoL, and pain were not significantly different from the preoperative values.

Physical performance

There were no significant changes from preoperatively to postoperatively in any of the measures of physical performance (tab. 2). There were many missing work capacity test values; the reasons reported for failure to perform the tests were problems with the bike in two tests, in addition to health and performance problems (such as dyspnoea, knee pain, abdominal pain, and fatigue).

Body mass and fat-free mass

The preoperative BMI was 25.3 (24.8–27.0), hence, approximately half of the patients were overweight (BMI ≥ 25). As estimated from the patients' recall, the preoperative weight change was 0.1 (–1.1–0.9) kg. Postoperatively, there was a small loss of weight and lean body; the weight loss had not been regained 4 weeks after the operation (tab. 2).

Living situation and care in the home

Preoperatively, 23% of the patients lived alone. All but one patient were discharged to their own homes.The proportion who reported that they received care in the home was 13% before surgery, 61% at 1–2 weeks after surgery, and 30% 4 weeks after surgery.

Sub-group analysis of patients converted to open surgery

Preoperatively, the patients who were converted to open surgery had similar fatigue scores (p=0.41) and pain scores at rest (p=0.91) compared with those who were not converted. However, on examination 1–2 weeks postoperatively, the converted patients had signifi-

Table 2. Preoperative fatigue, quality of life (QoL), pain, physical performance, and body composition in patients undergoing laparoscopic colorectal surgery (1)

	Preoperatively	Change from pre- to postoperatively	
		1-2 weeks	4 weeks
	n = 62	n = 46	n = 47
Fatigue, quality of life, and pain			
Fatigue (score)	3,6 (3–4)	1** (0,5–2)	0 (–0,7–0,4)
High fatigue score (> 5.5) (number)	12 (19,4%)	16 (34,8%)*	8 (17%)
QoL –SF-36: physical health component (score)	53,2 (49–56,4)	–9,8*** (–14 to –6,4)	–1,6 (–7,7 to –0,6)
QoL – SF-36: mental health component (score)	52,5 (48,5–56,5)	1,3 (–0,4 to –5,4)	0,8 (–1 to –2,2)
QoL – SF-36: bodily pain scale (score)	100 (84 to –100)	–12** (–14,9 to –0,5)	0 (0–0)
Physical performance			
Pulse rate, bicycle test (beats/min) (2)	115 (112–119)	1 (–1,9 to –6,0)	–3 (–6,8 to –3,4)
Maximal voluntary hand grip (n)	279 (239–297)	8 (–8 to –33)	–5 (–24 to –13)
Maximal voluntary knee extension (n)	330 (276–372)	–9 (–21 to –8)	0 (–17 to –11)
Balance, eyes open (mm/s)	8,8 (7,2–10,7)	1,25 (–0,24 to 2,47)	0,70 (–0,77 to 2,05)
Balance, eyes closed (mm/s)	20,4 (14,4–28,1)	1,80 (–1,16 to 2,97)	1,20 (–0,97 to 5,05)
Anthropometry			
Weight (kg)	74,3 (69,2–78,6)	–1,1*** (–1,3 to –0,5)	–1*** (–1,4 to –0,6)
Lean body mass (kg)	53,9 (46,4–57,6)	–0,8*** (–1,2 to –0,3)	–0,5 (–1 to –0,1)

(1) Values are medians (95% CI of median) and numbers (% of total). *p<0.05, **p<0.01, ***p<0.001.
(2) Only 37 patients performed the ergometer test 1–2 weeks postoperatively.

cantly higher fatigue scores (p=0.03) and pain at rest (p=0.003). The changes in muscular strength, work capacity, and body composition were not significantly different between converted and non-converted patients.

Sub-group analysis of patients with complications

In patients who had postoperative complications significantly more had a high fatigue score preoperatively compared to patients without complications (p=0.002) and were heavier (p = 0.037), whereas there were no differences in preoperative pain and physical performance. Postoperatively, 11 of 16 patients with complications did not attend the examination 1-2 weeks after the operation and 8 patients missed the examination 4 weeks postoperatively. Despite this, those with complications had statistically significantly greater loss of KE strength both at 1-2 weeks (p = 0.011) and 4 weeks (p = 0.0012) after the operation. Complications also led to a significantly greater weight loss of -1.8 (-4.4 to -1.0) kg 4 weeks after the operation compared to a change of 0.7 (-1.1 to -0.2) in patients without complications, a statistically significant difference (p = 0.017).

DISCUSSION

The postoperative changes in fatigue, QoL, pain, and body composition were small in most patients. Conversion and complications negatively affected rehabilitation.

This study included a wide range of measures to evaluate different aspects of postoperative rehabilitation. The conversion rate was low (12.9%); the reasons given for conversion were peroperative problems in relation to surgical technique, such as adherences and poor overview. The study was analysed on an intention-to-treat basis, i.e. patients undergoing conversion remained in the study. It was not, however, a randomised study. The fact that several patients dropped out before the postoperative examinations (fig. 1) and a few did not attend for examinations 1–2 weeks postoperatively may have led to underestimation of the postoperative changes because they are more likely to have felt too weak or too fatigued to attend examinations.

The postoperative changes in fatigue in the patients undergoing laparoscopic colorectal surgery were less than the fatigue levels reported previously for open colorectal surgery (2). This is in line with the results reported from the randomised Color trial (14), which used two QoL questionnaires (EQ-5D and EORTC-QLQ-C30). At 2 weeks postoperatively the authors found that patients undergoing laparoscopic surgery had significantly lower scores in relation to usual activities (EQ-5D), role, and social function (EORTC QLQ-C30). However, they found no significant differences in the many other domains of the two QoL instruments. Others have also reported small benefits in favour of laparascopic surgery (15), but in the large randomised CLASICC trial (16) comparing laparoscopic-assisted surgery with conventional open surgery, patients (n=749) were followed for 36 months postoperatively and no significant differences were found in QoL between groups. That laparoscopic surgery is associated with less postoperative pain compared with open surgery has previously been reported (17). HG strength has been regarded a marker of nutritional status (18) and prognostic indicator in surgical patients (19, 20). To our knowledge, the finding that patients undergoing laparoscopic colorectal surgery preserved their HG strength postoperatively has not previously been reported.

There has been much improvement in perioperative care since F.D. Moore wrote his classic monograph 'Metabolic Care of the Surgical Patient'. The combination of laparoscopic surgery and fast-track perioperative care has now advanced to a point where many patients only experience small and temporary increases in fatigue, and correspondingly few effects on body composition and physical performance. In such patients, the possible improvements in future studies will be small and it will require large randomised studies to document the clinical benefits of new changes in perioperative procedures.

In conclusion, most patients undergoing elective laparoscopic colonic cancer surgery can expect to have only small postoperative changes in fatigue, pain, quality of life, physical performance, and body composition.

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