European Journal of Surgical Oncology 45 (2019) 1592–1597

Contents lists available at ScienceDirect

European Journal of Surgical Oncology

journal homepage: www.ejso.com

In-hospital resistance training to encourage early mobilization for enhanced recovery programs after colorectal cancer surgery: A feasibility study

Alexandra Schram [a, b], Vanessa Ferreira [a, b], Enrico M. Minnella [b], Rashami Awasthi [b], Francesco Carli [b], Celena Scheede-Bergdahl [a, b, c, *]

[a] Department of Kinesiology and Physical Education, McGill University, Currie Gymnasium, 475 Pine Avenue West, Montreal, Quebec, H2W 1S4, Canada
[b] Department of Anesthesia, McGill University, Montreal General Hospital, 1650 Cedar Avenue, D10-144, Montreal, Quebec, H3G 1A4, Canada
[c] McGill Research Centre for Physical Activity & Health, McGill University, Faculty of Education, 3700 McTavish, Montreal, Quebec, H3A 1Y2, Canada

ARTICLE INFO

Article history:
Received 10 April 2019
Accepted 24 April 2019
Available online 25 April 2019

Keywords:
Early mobilization
In-hospital exercise
Resistance exercise
Colorectal cancer surgery

ABSTRACT

Background: The enhancement of post-operative care is under constant evolution and, with the addition of enhanced recovery programs, is changing the traditional in-hospital paradigm. Despite these advances, there is a clear lack of focus regarding early post-surgical mobilization, which has been identified as an important aspect of recovery. This pilot study investigates the feasibility of initiating resistance exercise to promote early mobilization in colorectal cancer patients during the in-hospital period.
Method: Patients participated in a supervised progressive resistance exercise program, adapted to their physical ability (either in bed, seated or standing), within the first 24 h following surgery. They were seen each day during the hospital stay and encouraged to continue exercising upon discharge. All patients were asked to return to the lab at four weeks after surgery for re-evaluation to establish recovery.
Results: Patient compliance to the in-hospital program was high, with 90% of patients engaging in exercise on the first post-operative day (POD 1) and no adverse effects reported during study. By POD 2, over 70% of patients met enhanced recovery after surgery (ERAS) recommendations.
Conclusion: It is feasible to initiate a progressive post-operative resistance exercise program in patients undergoing colorectal resection. The results suggest the positive aspects of incorporating resistance exercise into post-operative care. This may facilitate a clear and easy to implement exercise intervention that can take into consideration patient physical status and limited facility space in the hospital environment.

Introduction

Despite the implementation of enhanced recovery programs for surgery, there remains a sharp decrease in patient functional capacity that is further accelerated during the in-hospital period. This time frame is associated with pain, sedentarism, fatigue and poor nutritional intake that results from the surgery, subsequent stress response and bed rest [1,2]. These factors can prolong hospitalization, further exacerbate functional impairment and deconditioning, thereby hindering the recovery process [2]. In addition to physical deconditioning, many colorectal cancer patients have pre-existing age-related comorbidities, such as low cardiovascular fitness, sarcopenia and insulin resistance/diabetes, which can further delay recovery and negatively impact their physical function, independence and return to activities of daily living [3,4].

Current guidelines for surgical patients, as outlined in enhanced recovery after surgery protocols (ERAS), aim to mitigate the stress of surgery and facilitate recovery [5]. A key component in this pathway is early mobilization in the immediate post-operative period. Despite the recognition of its importance as a feature of ERAS, the definition of mobilization is vague and inconsistent in its interpretation and implementation. Although there is a general agreement in the literature that prolonged inactivity in the

* Corresponding author. Department of Kinesiology and Physical Education, McGill University, 475 Pine Avenue West, Montreal, QC, H2W 1S4, Canada.
E-mail address: celena.scheede@mcgill.ca (C. Scheede-Bergdahl).

https://doi.org/10.1016/j.ejso.2019.04.015

perioperative period is detrimental to the surgical patient, there is a lack of data that provides clear evidence for early mobilization protocols and no detailed guidelines as to what is recommended and a lack of activity programing [6,7]. Recently, it has been shown that facilitated mobilization (assisted walking) has no benefit over regular implementation of the ERAS mobilization guidelines [8]. These results suggest that simple walking within the confines of the hospital environment may not be enough of a stimulus to provoke a favorable response in these patients, therefore we propose a new alternative to post-operative physical activity intervention.

With little investigation on the effects of immediate post-operative exercise, it is not yet known whether resistance exercise is a feasible method of providing structured physical activity for colorectal cancer patients in the immediate post-operative period. Introducing progressive and personalized resistance exercise is a novel way to reduce post-operative deconditioning, especially in those prone to extended periods of bed rest [9]. Resistance training has been shown to provide a multitude of health benefits that include the preservation of lean muscle mass, metabolic regulation, functional improvements, quality of life, as well as improving cardiovascular, bone and mental health [10]. Additionally, similar metabolic equivalents (METs) can be achieved when comparing resistance to aerobic training, with the benefit that resistance training can be easily adapted to a supine or sitting position. The purpose of this study was to investigate the feasibility of incorporating in-hospital resistance exercise in colorectal resection patients to promote early mobilization, using a stratified approach that takes into consideration post-operative functional status. Given that many patients may be uncomfortable or unable to walk in hospital hallways due to traffic, limitations due to medical devices or lack of space, the goal of this intervention was to provide clinicians with an alternate means of encouraging their patients to perform in-hospital physical activity.

Methods

Subjects

This study was approved by the Research Ethics Board of the McGill University Health Centre, Montreal, Quebec, Canada (NCT 02586701) and was submitted as an addendum to follow a previous study that investigated the effects of a prehabilitation program [11]. Forty patients scheduled for curative colorectal resection were recruited from the pre-operative clinic at the Montreal General Hospital for participation in this study. Enrollment began in June 2015 and was completed in October 2016. Those with known metastases, contraindications to exercise and the inability to communicate in either English or French were excluded from participation in this study.

After providing informed consent, patients underwent a baseline evaluation, which consisted of a medical examination and anthropometric measurements, which took place approximately 4 weeks prior to surgery (just after initial meeting with surgical oncologist). Baseline functional capacity was assessed by distance walked in 6 min (by the 6 min walk test or 6MWT). In the pre-surgical period, all subjects met with an exercise specialist (in our case, kinesiologist) in order to be taught the resistance training program, to personalize exercises if necessary and to review what the post-surgical process will be. They were also provided with an information booklet that contained pictures of all exercises, as well as a log on which to record all exercises completed in order to determine adherence.

Immediate post-operative period

Within the first 24 h post-surgery, patients were seen by a kinesiologist in order to assess the patient's capacity to engage in the resistance exercises, based on a set of modality criteria pre-established by the research team (Table 1). Once cleared of any barriers to exercise by the attending physician, subjects were stratified according to their functional ability and encouraged to take part in either an in-bed, seated or standing resistance routine. All patients were recommended to get out of bed if they showed no adverse symptoms and were pre-mobilized by the nurse as per ERAS protocol [12].

The resistance exercise program (Table 2) consisted of a whole body workout targeting all major muscle groups of the body conducted at a light to moderate intensity as determined by the Borg Scale (11–13 on a scale of 20). Resistance was introduced either by commercially available resistance bands (Therabands®, Akron, OH, USA) or body weight, depending on patient preference or exercise type. The exercise routine was supervised once a day by the team kinesiologist who encouraged the patients to perform at least one set of 10–12 repetitions of each exercise and monitored for progression of intensity (ie: if the exercise becomes too easy) and/or modality stratification (from in bed to sitting to standing). If the patient was found to be easily completing 12 repetitions, the kinesiologist would either adjust the resistance band length/colour or add an additional set of repetitions to promote progression. Abdominal crunches were not prescribed in the immediate post-operative period, in order not to perturb the surgical incision sites. Quality of recovery was assessed via the MILES questionnaire, which is based on the QoR 15 Patient Survey [13], and reflects quality of recovery.

In addition to the resistance training intervention, all patients received standard ERAS care, which specifies dangling their legs on the day of surgery, ambulating between four and 6 h per day after surgery and eating all meals in their chair during their hospital stay. A description of the ERAS protocol has been published elsewhere [12,14].

Table 1
Exercise modality stratification criteria.

IN BED	SEATED	STANDING/MOBILE
• Unmoved by nurse/nurses suggestion	• Slightly low BP (relative to patient normal)	• Stable BP (relative to patient normal)
• Low BP	• Mild dizziness	• Free from dizziness
• Dizziness	• Occasional nausea	• Mild occasional nausea
• Constant Nausea/Vomiting	• Able to move from bed unassisted	• Able to move from bed unassisted
• Unable to get from lying down to sitting unassisted	• Fatigued	• Mild fatigue
• Fatigued	• Feeling of weakness	• Minimal pain
• Feeling of weakness	• Unstable balance	
• Constant moderate/severe pain	• Mild pain	
• Shortness of breath		
• Cognitive impairments		

Table 2
List of in-hospital exercises.

IN BED	SEATED	STANDING/MOBILE
• Chest • Bicep Flexion • Triceps Extension • Leg Flexion/Extension • Leg extension (towel) • Ankle Plantar Flexion/Extension (Theraband) • Alternating leg abduction/adduction	• Chest • Shoulder abductions • Bicep flexion • Triceps extensions • Hip flexions • Knee extensions • Seated Row	• Wall push-ups • Chest • Shoulder abduction • Biceps flexion • Triceps flexion • Knee flexion • Hip flexion • Calf raises • Seated row

Post-operative period

Upon discharge, patients were instructed to continue their in-hospital resistance training program (progressing intensity as required), as well as the instruction to accumulate a minimum of 30 min of activity per day. At the 4 week post-surgical assessment, subject functional capacity was re-assessed with the 6MWT to establish recovery.

Measurements

Primary outcomes: compliance to in-hospital resistance training

In-hospital compliance was assessed through adherence to the resistance exercise program over the three post-operative visits. If the participant performed the resistance training session, regardless of standing, sitting or in bed, it was considered full compliance.

Secondary outcomes: ERAS guidelines for early mobilization and quality of recovery

Secondary outcomes included the ability to meet the ERAS early mobilization, which was established by comparing the average time spent out of bed over the length of hospitalization as compared to the recommended amount of time suggested for surgical patients in the ERAS.

Protocol (4–6 h of ambulation per day) [14]. Subjects were asked how much time they spent outside of bed and how many hours they spent ambulating using the MILES questionnaire. Quality of recovery as also assessed by the MILES questionnaire as well as the results of the 6MWT at 4 weeks post-surgery, as compared to values at baseline. In-hospital and 30 day complications were also recorded.

Results

Subjects

Forty patients had initially provided consent to participate in this study. Patient characteristics and baseline measurements are reported in Table 3. From time of surgical clinic to actual surgery time, 10 patients withdrew from the study (4 patients voluntarily withdrew from the study, 1 moved out of the country, 3 did not end up having surgery, 1 did not have cancer, 1 did not respond to follow up phone calls), therefore 30 were represented in the in-hospital data. One further subject was lost to follow up at 4 weeks post-surgery so the data from 29 subjects was included at this time point. Mean length of hospital stay was 3.24 days.

Primary outcomes: compliance to in-hospital resistance training

On the first day after surgery (Post-operative day 1 or POD1), 90% of patients were able to and participated in a resistance exercise program. Seventeen subjects (56.7%) percent partook in a standing routine, 10% in a seated routine and 23.3% were able to perform in-bed exercise while 10% of patients refused to participate. No patients had been discharged at this point (Table 4). On POD 2, 85.1% (23/n = 27: 3 discharged) of patients complied with the exercise recommendations (3 patients refused to participate and one was not seen by the kinesiologist due to discharge time. By

Table 3
Patient Demographics at baseline (n = 30).

	N = 30
Age, years	63.4 (12.7)
Patients with age > 75 years	6 (20%)
Gender, male	20 (66.7%)
BMI, kg/m^2	26.3 (5.9)
Lean body mass, kg	47.2 (9.9)
ASA Status	
1	4 (13.3%)
2	21 (70%)
3+	5 (16.7%)
Comorbidities,	
Diabetes	6 (20%)
Hypertension	8 (26.7%)
COPD	1 (3.3%)
Dyslipidemia	2 (6.7%)
Tumor stage	
0	3 (10%)
1 or 2	18 (60%)
3 or 4	9 (30%)
Baseline 6-min walking distance, m	487.15 (89.4)
Patients with baseline 6 min walking distance < 400 m	5 (16.7%)
Length of Hospital Stay, days	4.3 (6.1)
Laparoscopic Surgery	29 (96.7%)
Duration of Surgery, minutes	168.1 (74.9)
Albumin, g/L	41.1 (4.2)
HbA1C, %	5.7 (0.5)
C-reactive protein, mg/L	8.5 (21.1)
Alcohol consumption	18 (60%)
Smoker	1 (3.3%)
Neoadjuvant therapy	7 (23.3%)
Rectal Tumor	8 (26.7%)
New stoma	2 (6.7%)

Data are presented as mean (SD) or n (%). BMI = Body Mass Index; ASA = American Society of Anesthesiologist; COPD = Chronic Obstructive Pulmonary Disorder.

Table 4
Proportion of patients performing the resistance training program by exercise modality, over the length of hospital stay.

	Standing	Seated	In-bed	Refused	Not seen	Discharged
POD1 (n = 30)	17 (56.7)	3 (10)	7 (23.3)	3 (10)	0 (0)	0 (0)
POD2 (n = 27)	20 (74.1)	3 (11.1)	0 (0)	3 (11.1)	1 (3.7)	3 (10)
POD3 (n = 12)	8 (66.7)	3 (25)	0 (0)	3 (25)	1 (8.3)	15 (56)

Data are presented as frequency (%). POD = post-operative day. Discharge percentages are calculated from discharge in relation to previous day. The remainder of percentages are based on number of subjects in hospital on each day.

POD 3, 73.3% (11/n = 15; 15 discharged) of patients participated in exercise, 3 patients refused and one was not seen by the kinesiologist due to early discharge time. The reasons for refusal were a combination of fatigue, nausea/vomiting, dizziness and pain. In terms of stratification, by POD2, all patients were able to, at least, sit up in bed to perform their exercise routine (Table 4). No adverse events due to the exercise program were reported.

Secondary outcomes: ERAS guidelines for early mobilization and quality of recovery

On POD 1, 19.4% of patients were able to meet the ERAS guidelines of 6 h of ambulation per day, followed by 71.4% on POD 2 and 73.3% on POD 3 (Table 5).

The average quality of recovery score obtained by the MILES questionnaire on POD1 was 14.2 out of a possible score of 18, with a score approaching 18 indicating a higher quality of recovery. By POD2, the average score was 16.4/18 and on POD 3, the MILES score was 16.2/18 (Table 5).

Distance walked in 6 min (6MWT) at 4 weeks post-surgery was not statistically different from baseline (baseline: 484.0 ± SD 90 m versus 4 weeks post-surgery: 484.7 ± SD 87.1 m).

5 patients out of 7 who were discharged after 5 days reported in-hospital complications that were not related to the resistance training (Table 6). Thirty day complications that were not related to resistance training were reported in 2 patients who had been discharged in 2 days or less, 1 patient who had been discharged in the 3–4 day time frame and in 4 patients who had been discharged after 5 days. This date is also presented in Table 6. Surgical complications included bleeding, mechanical bowel obstruction and ileus. Infectious complications included a urinary tract infection. Other complications included urinary retention. No respiratory, cardiovascular or orthopaedic complications were reported.

Discussion

Based on the compliance to in-hospital resistance exercise and absence of adverse events, initiating supervised post-operative resistance exercise in the immediate 24 h following colorectal cancer surgery is feasible and safe. There were no reported incidence of falls or complications directly related to the resistance exercise. The results from this study demonstrate that patients are capable and willing to participate in light to moderate intensity resistance exercise after colorectal resection surgery, taking into consideration that the program be adaptable to their specific post-operative status and be stratified to reflect their own individual needs. They report high recovery from surgery scores and return to baseline functional capacity by 4 weeks post-operation. Our data also suggests that early discharge (2 days or less) is associated with early standing to perform resistance exercise (Table 6), which is in line with previous studies [15].

Despite being recognized as a crucial component of enhanced recovery programs, early mobilization remains the most vague and least detailed element of the protocols. There is a clear lack on specific guidelines or framework that can assist busy clinicians in the endeavor of mobilizing their post-surgical patients [6,7]. At present time, most ERAS-based guidelines recommend the following: 1) patients should dangle their legs on the day of surgery, 2) patients should eat all of their meals in a chair and 3) patients should ambulate at least 4–6 h each day while they are awake until discharge but this latter point can vary from ambulating as much as possible from POD1 to 8 h of ambulation per day from POD2 [16]. Despite the recognition of the importance of getting the patients out of bed and becoming active as soon as possible, there is little information provided that can either guide a program or result in functional capacity improvements that are detectable by commonly used metrics to evaluate program success (ie: walking tests, strength tests). In this study, we aimed to provide clear guidelines both in regards to the program delivery criteria (ie: standing, seated or lying in bed) and the exercises themselves (including frequency, intensity and type) with the intention of providing a structured framework for post-surgical physical activity. This builds upon a previous study which used elements of in-hospital resistance training as an approach to mobilization [15]. We, however, propose that the program for each patient is individualized and stratified according to their functional status on each POD.

We chose to focus on resistance exercise for this feasibility study as it is an effective means of preserving muscle mass, increasing muscle power, maintaining activities of daily living, enhancing

Table 5
Self-reported time spent out of bed over length of hospital stay and corresponding MILES scoring.

	POD1	POD2	POD3
Average time spent out of bed, hrs	2.28 (2.86)	6.27 (4.04)	7.63 (5.84)
Number of patients meeting ERAS mobilization guidelines	6/30 (19.4%)	20/27 (71.4%)	11/15 (73.3%)
Patient MILES scoring (/18)	14.2 (2.78)	16.4 (1.98)	16.2 (2.08)

Data are presented as mean (SD), frequency (%) or a score out of 18 for the MILES (a score of 18 denotes excellent recovery, 16 = very good recovery and a score that is less than 15 represents poor quality). POD = post-operative day; ERAS = enhanced recovery after surgery.

Table 6
Patient characteristics by length of hospital stay.

	≤2 days (n = 13)	3–4 days (n = 10)	≥5 days (n = 7)
Average baseline 6MWD, m	499.2 (92.6)	455.9 (87.1)	509.4 (89.4)
Average 4-week postop 6MWD, m**	508.8 (92.3)	473.9 (80.3)	469.8 (85.3)
Mean change 6MWD, m	9.6 (40.8)	18 (46.2)	−18.9 (83.7)
Exercise modality on POD1			
Standing	12 (92.3%)	4 (40%)	1 (14.3%)
Seated	0	3 (30%)	0
In-bed	1 (7.7%)	2 (20%)	4 (57.1%)
Refusal	0	1 (10%)	2 (28.6%)
In-hospital complications	0	0	5 (71.4%)
30-day complications	2 (14.3%)	1 (10%)	4 (57.1%)

Data are presented as mean (SD) or frequency (%). POD = post-operative day; 6MWD = 6-min walking distance. **data from 29 subjects. 1 subject lost to follow up.

energy expenditure and body composition, and promoting participation in spontaneous physical activity [17]. Resistance training has also been shown to be a safe and important strategy for mitigating hospital-associated decline, even in frail, elderly patients [18]. In addition to its beneficial effects on muscle, resistance training does not require the same amount of space as is required for performing endurance-based exercise. This is important given that patients may not feel comfortable or able to maneuver in a space-limited hospital environment. Also, as in our study, mobility limitations, either due to physical status or medical devices, can be compensated for without compromising the opportunity to perform exercise. The intensity of the resistance training stimulus can be maintained by adapting the exercise to suit the abilities of the patient. For example, if a patient cannot stand or leave their room, the target intensity of arm and leg resistance exercises can still be maintained. This is well demonstrated in Table 4 where a total of 10 patients could not stand to perform exercises on POD1, 3 could not stand on POD2 and 3 could not stand on POD3. If mobility consisted of walking exercises, these patients might have been excluded and remained sedentary instead.

Recently, a study that investigated the effects of a staff facilitated mobilization program (transfers and walking in hospital hallways) versus usual care in an enhanced recovery program reported that, despite a greater adherence from POD 0 and step count from POD 1, there was no between group difference in recovery walking capacity at 4 weeks post-surgery [8]. It was concluded that, although there was an increase in out-of-bed activities during hospital stay, a staff-directed facilitation of early mobility in an enhanced recovery program does not warrant the additional resources due to the lack of improvement on recovery outcomes. It could be argued, however, that the intensity of exercise performed by the patients during periods of ambulation was not sufficient to elicit physical improvements that could be detected by the evaluation methods employed in this study. It must be emphasized that, in order to achieve a training response, the exercise stimulus must be sufficient to challenge, or overload, the system [19]. Given that the intensity of work was not reported in this study, it is possible that step counts alone was not a sufficient stimulus to achieve the targeted outcomes.

By prescribing resistance training in the immediate post-surgical time frame, we propose a means of encouraging physical activity in patients in order to achieve the early mobilization goals of enhanced recovery programs and mitigate the deterioration of functional capacity that is associated with prolonged bed rest in the in-hospital period. Resistance training can be easily and safely performed, taking into consideration the patient's physical status on each post-operative day.

Limitations to the study

Firstly, it must be emphasized that this work was a feasibility study in order to establish adherence to a stratified resistance training based intervention in the immediate post-operative time frame. Given the high patient compliance and lack of adverse events associated with the program, we will now conduct a randomized control trial with sufficient power to compare patients receiving an in-hospital resistance training program with a control group receiving standard ERAS care.

Secondly, this study represents a single centre experience and, thus, might not reflect the needs and situation in a broader context. This also requires addressing in future large scale studies.

Lastly, it is well understood that not all hospitals have the obvious resources to provide a trained multidisciplinary team that is able to effectively stratify, prescribe, monitor and progress a resistance training program. It is important that further work be conducted in order to understand the barriers to increasing patient mobility using a multidisciplinary perspective in order to translate evidence into practice and improve patient outcomes [20].

Conclusions

In summary, the implementation of an individualized and stratified resistance training program is feasible, safe and provides clinicians with an alternate means of encouraging in-hospital resistance training with the goal of mitigating post-surgical functional decline associated with prolonged bed rest. This type of approach, in conjunction with an effective enhanced recovery program will lead to a paradigm shift in best preparing and recovering the patient from surgery, as well as promoting patient involvement and quality of life.

Funding

Financial support was provided by the Perioperative Programme (POP) Charitable Foundation, Montreal, Quebec, Canada.

Conflict of interest

The authors report no conflict of interest.

Acknowledgement

The authors thank Mary Guay for invaluable administrative support and the McGill University Health Center (Montreal, Quebec, Canada) colorectal surgeons and nursing staff for their assistance with the study.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ejso.2019.04.015.

List of exercises performed in each stage. Exercises were encouraged to be 10 to 12 repetitions, with the option of performing multiple sets, either at the same time or multiple sessions spaced throughout the day. Compliance and progression of the program was recorded.

References

[1] Carli F. Physiologic considerations of Enhanced Recovery after Surgery (ERAS) programs: implications of the stress response. Can J Anesth Can d'anesthésie. 2015;62(2):110–9.
[2] Havey R, Herriman E, O'Brien D. Guarding the gut. Crit Care Nurs Q 2013;36(1):63–72.
[3] Horstman AM, Sheffield-Moore M. Nutritional/metabolic response in older cancer patients. Nutrition 2015;31(4):605–7.
[4] Højbjerre L, Sonne MP, Alibegovic AC, Nielsen NB, Dela F, Vaag A, et al. Impact of physical inactivity on adipose tissue low-grade inflammation in first-degree relatives of type 2, diabetic patients. Diabetes Care 2011;34(10):2265–72.
[5] Scott MJ, Baldini G, Fearon KCH, Feldheiser A, Feldman LS, Gan TJ, et al. Enhanced Recovery after Surgery (ERAS) for gastrointestinal surgery, part 1: pathophysiological considerations. Acta Anaesthesiol Scand 2015;59(10):1212–31.
[6] Gustafsson UO, Scott MJ, Hubner M, Nygren J, Demartines N, Francis N, et al. (ERAS®) society recommendations: 2018. World J Surg 2019;43(3):659–95.
[7] Castelino T, Fiore Jr JF, Niculiseanu P, Landry T, Augustin B, Feldman LS. The effect of early mobilization protocols on postoperative outcomes following abdominal and thoracic surgery: a systematic review. Surgery 2016;159(4):991–1003.
[8] Fiore JF, Castelino T, Pecorelli N, Niculiseanu P, Balvardi S, Hershorn O, et al. Ensuring early mobilization within an enhanced recovery program for colorectal surgery: a randomized controlled trial. Ann Surg 2017;266(2):223–31.
[9] Killewich LA. Strategies to minimize postoperative deconditioning in elderly surgical patients. J Am Coll Surg 2006;203(5):735–45.
[10] Westcott WL. Resistance training is medicine: effects of strength training on health. Curr Sports Med Rep 2012;11(4):209–16.

[11] Bousquet-Dion G, Awasthi R, Loiselle SÈ, Minnella EM, Agnihotram RV, Bergdahl A, et al. Evaluation of supervised multimodal prehabilitation program in cancer patients undergoing colorectal resection: a randomized control trial. Acta Oncol 2018;57(6):849–59.
[12] Varadhan KK, Lobo DN, Ljungqvist O. Enhanced recovery after surgery: the future of improving surgical care. Crit Care Clin 2010;26(3):527–47.
[13] Stark PA, Myles PS, Burke JA. Development and psychometric evaluation of a postoperative quality of recovery score: the qor-15. Anesthesiology 2013;118(6):1332–40.
[14] MUHC Patient Education. A guide to bowel surgery. http://www.muhcpatienteducation.ca/DATA/GUIDE/210_en~v~bowel-surgery-glen-site.pdf.
[15] Ahn K-Y, Hur H, Kim D-H, Min J, Jeong DH, Chu SH, et al. The effects of inpatient exercise therapy on the length of hospital stay in stages i-iii colon cancer patients: randomized controlled trial. Int J Colorectal Dis Clin Mol Gastroenterol Surg 2013;28(5):643–51.
[16] Carmichael JC, Keller DS, Baldini G, Bordeianou L, Weiss E, Lee L, et al. Clinical practice guidelines for enhanced recovery after colon and rectal surgery from the American society of colon and rectal surgeons and society of American gastrointestinal and endoscopic surgeons. Dis Colon Rectum 2017 Aug;60(8):761–84.
[17] Hunter GR, McCarthy JP, Bamman MM. Effects of resistance training on older adults. Sports Med 2004;34(5):329–48.
[18] Falvey JR, Mangione KK, Stevens-Lapsley JE. Rethinking hospital-associated deconditioning: proposed paradigm shift. Phys Ther 2015;95(9):1307–15.
[19] Per-Olof Astrand. Textbook of work physiology : physiological bases of exercise. fourth ed. Champaign, IL: Human Kinetics; 2003.
[20] Hoyer EH, Brotman DJ, Chan KS, Needham DM. Barriers to early mobility of hospitalized general medicine patients: survey development and results. Am J Phys Med Rehab 2015;94(4):304–12.