

Postoperative Footsteps and Outcomes - A Pilot Study

Benoit Romain^{1*}, Martin Hübner², Cécile Brigand¹, Jean-Philippe Steinmetz¹ and Serge Rohr¹

¹Department of Digestive Surgery, Strasbourg University, 1 Avenue Moliere, Strasbourg, France

²Department of Visceral Surgery, University Hospital CHUV, Lausanne, Switzerland

Abstract

Background: Early physical activity is one of the key components of enhanced recovery programs. Recovery after surgery remains difficult to quantify. In this pilot study, we assessed feasibility of connected bracelets measuring number of footsteps each day during the postoperative course. Then, early postoperative physical activity was compared by age and correlated to postoperative complications.

Materials and Methods: Daily physical activity (No. of footsteps) was recorded from postoperative day (POD) 1 until discharge in a prospective cohort of consecutive colorectal patients by use of an attached strap. Physical activity was compared between old (> 65y) and young patients and correlated to postoperative complications.

Results: A total of 30 patients were included in this prospective pilot study. Physical activity increased steadily in the early postoperative course from 545 ± 489 steps on POD1 up to 1177 ± 1385 steps on POD3. No significant difference was found comparing younger with older patients ($p = 0.47$). Patients without complications trended to have higher activity levels throughout the early postoperative period (POD 5: 1154 ± 368 vs. 739 ± 219; $p = 0.03$). Increased physical activity (POD1+2+3) correlated with shorter length of stay ($R^2 = 0.28$, $p = 0.0031$).

Conclusions: Physical activity increased steadily in the postoperative course regardless of age. Increased number of footsteps was associated with no complications and reduced hospital length of stay. Connected bracelets deliver an objective measure reflecting recovery and predicting outcomes.

Keywords: Connected bracelet; Rehabilitation; Physical activity; Colorectal surgery

Introduction

Major abdominal surgery, particularly colorectal surgery, provokes a physiologic stress response and is associated with a period of disability. One key dimension of recovery is physical activity, as it affects the ability to perform activities of daily living, return to work, resume social leisure life and it helps to prevent potentially life-threatening complications like pneumonia, pulmonary embolism, and myocardial infarction. Even in the absence of complications, the postsurgical period is associated with 20 to 40% reduction in physiological and functional activity that, particularly in the elderly with comorbidities, may not return to preoperative function for several months [1,2].

Application of enhanced recovery after surgery (ERAS) pathways have been associated with the improved clinical outcomes after colorectal surgery. The most challenging and arguably the most important part of the protocol is the early postoperative phase. Postoperative physical activity is one of the most important factors in the rehabilitation programme. However, physical activity and recovery are rarely reported and are difficult to quantify [3].

In this pilot study, we have studied the use of connected bracelets as an original tool measuring postoperative physical activity by the number of footsteps. The second aim was to assess physical activity by age and to correlate number of footsteps with the occurrence of complications and the hospital length of stay.

Methods

This prospective cohort study included a consecutive cohort of non-selected elective colorectal patients operated from March 2015 to August 2015. All patients included were operated on colorectal surgery except stoma closure. All patients were treated according to the ERAS protocol. The ERAS program was systematically introduced for colorectal surgery in our academic centre in January 2015. The Institutional Review Board approved the study and all patients provided

written consent before surgery. All patients have given their informed consent. The study was conducted in accordance with the STROBE criteria and registered under www.researchregistry.com (No. 712).

Connected device measuring footsteps

Connected bracelets are connected with sensors, memory and a transceiver and record various informations and communicate across networks (smartphone, tablet, computer, etc.). For the purpose of this study, we have used an attached strap (Misfit Werables[®], Misfit 839 Mitten Road, Suite 100, Burlingame, CA 94010, United States) measuring footsteps of patients in order to quantify daily physical activity. The bracelet was carried on patients from postoperative day 1 (POD 1) until discharge. Number of daily footsteps was collected via the manufacturer software on a smartphone and reported to a coded database.

Data collection

A dedicated and specially trained enhanced recovery nurse was in charge of completing the prospective database (ERAS Interactive Audit System) and collecting demographic and surgical details of all patients in the enhanced recovery pathway with detailed information of clinical outcomes until a minimum of 30 days after surgery. Our institutional enhanced recovery pathway adhered closely to the recently updated ERAS guidelines [4,5]. Compliance with the ERAS protocol

***Corresponding author:** Benoit Romain, Department of Digestive Surgery, Strasbourg University, 1 Avenue Moliere, 67000 Strasbourg, France, Tel: +33 388 127 237; Fax: +33 388 127 238; E-mail: ben.romain@hotmail.fr

Received March 15, 2016; **Accepted** April 28, 2016; **Published** April 30, 2016

Citation: Romain B, Hübner M, Brigand C, Steinmetz JP, Rohr S (2016) Postoperative Footsteps and Outcomes - A Pilot Study. Gen Med (Los Angel) 4: 239. doi:10.4172/2327-5146.1000239

Copyright: © 2016 Romain B, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

was prospectively assessed for the different phases of peri-operative care (pre-, intra- and post-operative; total). Enhanced recovery items were handled as dichotomous variables. Compliance with individual items was calculated as percentage of compliant patients/total patients. Postoperative complications were graded according to the Clavien classification system [6]. Length of stay was counted from day of surgery until discharge. Discharge was decided according to Fiore criteria [7].

Statistical analysis

Descriptive statistics for categorical variables were reported as frequency (%), while continuous variables were reported as means (standard deviation). Chi-square was used for comparison of categorical variables. We used parametric t-test to compare continuous variables according to a normal distribution with a Kolmogorov Smirnov test. All statistical tests were two-sided and a level of 0.05 was used to indicate statistical significance. Statistical correlation was measured by use of the Pearson correlation coefficient. Data analyses were performed using SPSS 10 (SPSS Inc., Chicago, IL).

Results

A total of 30 colorectal patients were included in this prospective pilot study. Demographics and surgical details are displayed in Table 1. Postoperative physical activity increased steadily from 545 ± 489 footsteps on POD1 to 1177 ± 1385 steps on POD3. No significant difference in physical activity was found between older and younger patients ($p = 0.47$) (Figure 1A). Nine out of 30 patients experienced a postoperative complication. Those were classified according to Clavien et al. [4] as grade I ($n = 2$), II ($n = 5$), IIIa ($n = 1$) and IVb ($n = 1$).

The number of footsteps realized increased progressively each day after surgery in the group with no complication (Figure 1B). In the group with complications, the number of footsteps per day had a tendency to be stable during the postoperative days and was lower than those with no complications. The mean number of footsteps during the fifth postoperative days was 1154 ± 368 in the group with no complications compared to 739 ± 219 in the group with complications, this difference was significant ($p = 0.03$). Cumulative physical activity for patients with and without complications during the fifth postoperative days is depicted in (Figure 2).

Then we have compared the mean number of footsteps during the fifth postoperative days between patients who underwent laparoscopy ($n = 17$) and laparotomy ($n = 13$; patients who are converted were counted as laparotomy). The mean number of footsteps during the fifth postoperative days was 1412 ± 465 in the laparoscopic group compared to 532 ± 190 in the laparotomy group, this difference was significant ($p = 0.002$).

Overall median length of stay was 9 days [4]. Early postoperative physical activity (No. of footsteps on POD 1+2+3) was significantly inversely correlated with hospital length of stay ($R^2 = 0.28$, $p = 0.0031$) (Figure 3).

Discussion

Connected bracelets permitted to quantify physical activity in the postoperative course. Physical activity increased steadily but was independent of age. A significant correlation was found between the number of footsteps and clinical outcomes.

Length of stay (LOS) has been extensively used or even abused to measure recovery. Medical recovery is not the same [8]. Discharge from hospital requires fulfillment of minimal requirements such as good

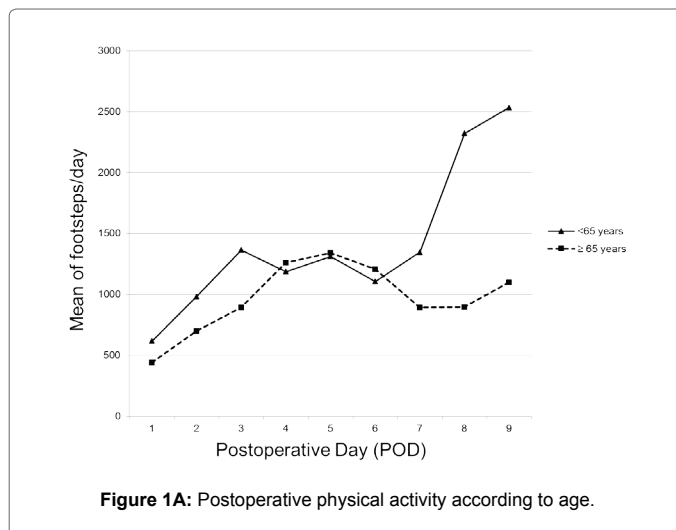


Figure 1A: Postoperative physical activity according to age.

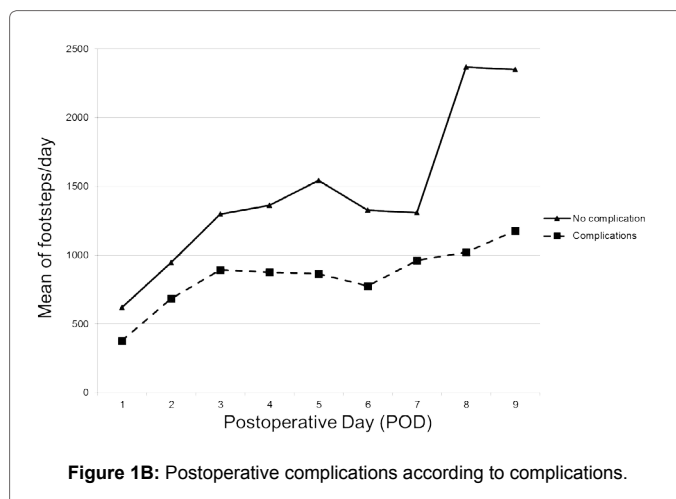


Figure 1B: Postoperative physical activity according to complications.

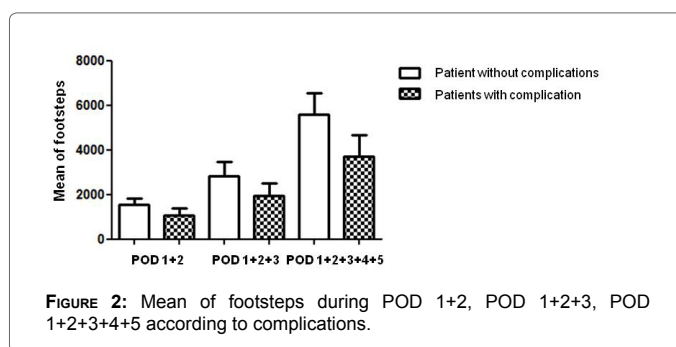


FIGURE 2: Mean of footsteps during POD 1+2, POD 1+2+3, POD 1+2+3+4+5 according to complications.

pain control, ability to self-care, as well as tolerance of oral nutrition [9]. However, actual discharge occurs frequently several days later; many factors play a role such as surgeon's preference, hospital tradition or a place in a postoperative structure care. Furthermore we have shown that there was a negative correlation between LOS and physical activity during POD 1+2+3. Early postoperative activity is probably not only a predictor but also a causative factor for the risk of complications and the length of hospital stay. Our findings are in line with the results from Montreal showing that postoperative exercise training helped to enhance recovery [10]. The same group suggested preoperative physical training and their preliminary findings were promising. While the

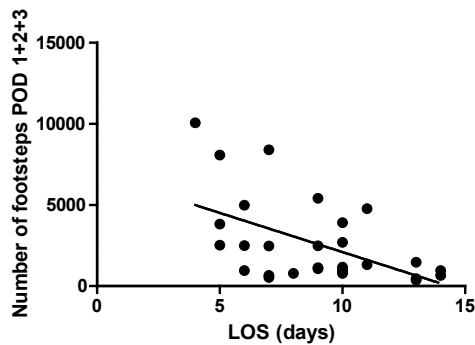


Figure 3: Correlation between mean of footsteps for each patient during POD 1+2+3 and length of stay (LOS).

concept is intriguing, prospective data are needed to proof the concept. This is primary aim of a planned randomized trial of our unit. We could hypothesize that stimulation in order to motivate patients to have a postoperative physical activity could reduce LOS.

Postoperative functional walking capacity is one of the mean to quantify recovery and some test are used to quantify postoperative physical activity as for example the six-minute walk test (6MWT) [11] and the Timed Up and Go test [12]. However these tests don't quantify the total patient's physical activity achieving during a day. Measurement of footsteps during the postoperative phase could be an objective tool to study the postoperative recovery. In our study, we have shown that the mean number of postoperative footsteps is significantly different between patients who are going to develop or not complications. Since postoperative blood tests like CRP level on POD 3 predict complications [13] in colorectal surgery, we could hypothesize that number of postoperative footsteps could predict the development of postoperative complications. Physical activity might potentially predict risk of complications already prior to surgery.

Cancer is one of the major indications of colorectal surgery. In this case, fatigue and anxiety could disturb the healing process and the physical activity [14,15]. Gillis et al. [2] have studied in a randomized controlled trial the effect of prehabilitation on pre- and postoperative functional walking capacity thanks to a training program initiated 4 weeks before surgery (prehabilitation) to an identical program (rehabilitation) initiated after surgery and to be maintained, in both groups, for 8 weeks postoperatively. In this study, complication rates and duration of hospital stay were similar. The difference between baseline and 8-week physical activity test was significantly higher in the prehabilitation compared with the rehabilitation group. Furthermore, there was a higher proportion of patients in the prehabilitation group who were also recovered to or above baseline exercise capacity at 8 weeks compared with the rehabilitation group. Connected bracelet could be a good tool to measure preoperative physical activity during the prehabilitation thanks to its low price, easiness to use and objective measurements.

Poor adherence to physical exercise program could contribute to its lack of benefit. Carli et al. [16] have shown that only 16% of subjects were fully adherent to the prehabilitation protocol particularly in people with poor physical reserve at baseline. Using connected bracelet could permit to control continuously the patient's physical activity, and they could be informed as a feedback each day on their number of footsteps achieved. It could be a major factor to motivate patients for increased

their preoperative and postoperative physical activity.

Our pilot study presents several limitations due to a low number of patients. These are a non homogeneous cohort in terms of age, type of colorectal pathology and surgery performed (laparoscopy vs laparotomy). Physical activity is also influenced by surgery technique as we have shown with a significant difference of mean number of footsteps during the fifth postoperative days between laparoscopic and laparotomy resections. Complications are associated with lower footsteps and higher LOS so there is likely to be confounding. However it is the first study to our knowledge using an original tool with a connected bracelet to study postoperative physical activity after colorectal surgery.

In conclusion, connected bracelets have provided robust measurements of postoperative physical activity. Quantification of physical activity is a potential tool to predict complications and length of hospital stay. A large-scale prospective study is underway (BRAVE study (Bracelet and physical activity Evaluation; clinicaltrials.gov # NCT02610790) to test the hypothesis that early postoperative physical activity (assessed by the No. of footsteps) could predict postoperative outcomes.

References

- Christensen T, Bendix T, Kehlet H (1982) Fatigue and cardiorespiratory function following abdominal surgery. *Br J Surg* 69: 417-419.
- Gillis C, Li C, Lee L, Awasthi R, Augustin B, et al. (2014) Prehabilitation versus rehabilitation: a randomized control trial in patients. *Anesthesiology* 121: 937-947.
- Li C, Carli F, Lee L, Charlebois P, Stein B, et al. (2013) Impact of a trimodal prehabilitation program on functional recovery after colorectal cancer surgery: a pilot study. *Surg Endosc* 27: 1072-1082.
- Gustafsson UO, Scott MJ, Schwenk W (2013) Guidelines for perioperative care in elective colonic surgery: Enhanced Recovery After Surgery (ERAS^(®)) Society recommendations. *World J Surg* 37: 259-284.
- Nygren J, Thacker J, Carli F (2013) Guidelines for perioperative care in elective rectal/pelvic surgery: Enhanced Recovery After Surgery (ERAS^(®)) Society recommendations. *World J Surg* 37: 285-305.
- Dindo D, Demartines N, Clavien PA (2004) Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg* 240: 205-213.
- Fiore JF Jr, Bialocerkowski A, Browning L, Faragher IG, Denehy L (2012) Criteria to determine readiness for hospital discharge following colorectal surgery: an international consensus using the Delphi technique. *Dis Colon Rectum* 55: 416-423.
- Maessen J, Dejong CH, Hausel J, Nygren J, Lassen K, et al. (2007) A protocol is not enough to implement an enhanced recovery programme for colorectal resection. *Br J Surg* 94: 224-231.
- Neville A, Lee L, Antonescu I, Mayo NE, Vassiliou MC (2014) Systematic review of outcomes used to evaluate enhanced recovery after surgery. *Br J Surg* 101: 159-170.
- Santa Mina D, Scheede-Bergdahl C, Gillis C, Carli F (2015) Optimization of surgical outcomes with prehabilitation. *Appl Physiol Nutr Metab* 40: 966-969.
- Pecorelli N, Fiore JF Jr, Gillis C, Awasthi R, Mappin-Kasirer B, et al. (2015) The six-minute walk test as a measure of postoperative recovery after colorectal resection: further examination of its measurement properties. *Surg Endosc* pp: 1-8.
- Podsiadlo D, Richardson S (1991) The timed "up&go": a test of basic functional mobility for frail elder persons. *J Am Geriatr Soc* 39: 142-148.
- Platt JJ, Ramanathan ML, Crosbie RA, Anderson JH, McKee RF, et al. (2012) C-reactive protein as a predictor of postoperative infective complications after curative resection in patients with colorectal cancer. *Ann Surg Oncol* 19: 4168-4177.
- Cheema FN, Abraham NS, Berger DH, Albo D, Taffet GE, et al. (2011) Novel

-
- approaches to perioperative assessment and intervention may improve long-term outcomes after colorectal cancer resection in older adults. *Ann Surg* 253: 867-749.
15. Silver JK, Baima J (2013) Cancer prehabilitation: An opportunity to decrease treatment-related morbidity, increase cancer treatment options, and improve physical and psychological health outcomes. *Am J Phys Med Rehabil* 92: 715-727.
16. Carli F, Charlebois P, Stein B, Feldman L, Zavorsky G, et al. (2010) Randomized clinical trial of prehabilitation in colorectal surgery. *Br J Surg* 97: 1187-1197.