Activity Level and Patient Outcome After Liver Surgery – A Prospective Study

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Activity level and patient outcome after liver surgery – a prospective study

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Abstract

Background: Perioperative measurement to enhance recovery after surgery has been introduced as a prognostic factor. The effect of surgery on activity level during and after hospital discharge has been relatively under-explored. The present study aims to measure

perioperative activity for patients undergoing liver surgery as a benchmark for further interventional studies on the relationship between postoperative mobilization and outcome.

Methods: In this prospective cohort study we measured activity levels for patients selected for liver surgery at a single liver surgical center. The activity level was measured before, during hospital admission, and after discharge with patients wearing pedometers. Clinical parameters and outcomes were documented.

Results: Thirty-three patients were included. Median activity level was 4303 (2381- 6912), 293 (170-665), and 1250 (613-3300) steps per day preoperatively, perioperatively, and postoperatively after discharge, respectively. The activity level decreased to 38 (22-62) % after discharge compared to preoperative levels.

Conclusion: This study quantified the decrease in activity level after liver surgery. Future studies could further evaluate the intervention effect of perioperative care on postoperative outcome measures.

Keywords

Activity, mobility, pedometer, liver resection, postoperative care, steps, biometry.

Background

An active lifestyle increases muscle mass and cardiopulmonary function, as well as overall physical wellbeing. Regular activity is an important factor to reduce the risk of many lifestyle-related diseases and premature death[1].

It is known that active patients fare better after surgery and patient with better physical performance status have better postoperative outcome[2, 3]. For the last couple of decades, standardized postoperative programs have been developed for various surgical procedures that decrease complications and shorten the length of hospital stay. These programs include, e.g. early mobilization and food intake[4].

During the last decade, the use of biometric products that measure activity has increased drastically[5]. Biometrics is an easy and inexpensive way to measure activity level and will probably guide future clinical decision making in the future[5, 6].

Few studies are available that measure activity level with pedometers. A recent study observed a correlation between poor activity and complications, and the study found a drop to 19% steps postoperatively compared to preoperatively[5]. This study had few participants and the effect of surgery on the activity level after hospital discharge needs further investigation.

The present study aims to measure pre-, peri- and postoperative mobility levels using pedometers for patients undergoing liver surgery with a special investigation on the relationship between postoperative mobility and outcome.

Methods

All patients over the age of eighteen scheduled for liver resection at the Skåne University hospital during a six months' period, were asked to participate. Only patients that could reliable give informed consent were offered participation. Forty-eight patients were offered to participate in the study and 38 underwent liver resection. Four patients denied participation and one hade unreliable data, making the final cohort of patients, 33.

Data on perioperative mobility was recorded using a validated pedometer, Yamax SW 200[7]. The patients wore the pedometer on their waist during all waking hours. Pre- and postoperative mobility was recorded at the patients' home before admission and after discharge from the hospital for seven consecutive days. Perioperative mobility was recorded during admission starting the first postoperative day until discharge or for a maximum seven consecutive days.

An enhanced recovery program was used, and liver resection was performed as previously described[8].

Clinical data were recorded continuously. Complications were registered using the Clavien-Dindo classification of surgical complications during the postoperative period until discharge[9]. The pain severity score was obtained during admission using the validated pain numeric rating scale (NRS)[10]. A novel nausea score was recorded during admission with three categorical values as reported by the patients: none, some, or severe nausea. All methods were performed in accordance with the relevant guidelines and regulations.

Statistics

Summary statistics are presented as whole numbers and/or percentages for categorical variables, or as medians with interquartile ranges (IQRs) for continuous variables. A Mann-Whitney U-test was used to compare continuous data and Fischer´s exact test was used for categorical data. Friedman-test when comparing three continuous variable groups. An Odd ratio was calculated with a 95% confidence interval using a logistic regression model. A P-value of less than 0.05 was considered statistically significant. Statistical analysis was performed using R (R Core Team (2016). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/).

Results

Thirty-three patients underwent liver surgery during the study period. All but two patients underwent open liver resection and eight patients underwent major liver resection. The patients' characteristics are shown in Table 1.

Table 1. Clinical features of patients

n	33
Age	70 (58-74)
Gender (male)	18 (54.5)
BMI	25.1 (23.9-28.0)
ASA > 2	13 (39.4)
Previously cancer diagnosis	19 (57.6)
Chronic pain	2 (6.1)
Smokers	
Never	17 (51.5)

Previously	12 (36.4)
Current	4 (12.1)
Diabetes	4 (12.1)
Neoadjuvant therapy within 3 months	19 (57.6)
Type of liver disease	
Synchronous CRLM	12 (36.4)
Metachronous CRLM	13 (39.4)
HCC	3 (9.1)
Cholangiocarcinoma	1 (3.0)
Other	4 (12.1)
Tumor size	3.0 (1.9-4.2)
Number of liver tumors	2 (1- 3)
Open liver surgery	31 (93.9)
Major resection	8 (24.2)
Operation time (min)	219 (175-287)
Operative bleeding (ml)	300 (150-1000)
Total intravenous opiate analgesic (mg)	51.8 (27.5-62.5)
Average pain during admission (NRS)	4.40 (3.30, 4.86)
Median nausea score per day during admission	0 (0-1)
Perioperative intravenous analgesic (days)	2 (2-2)
Number of days with IDUC	2 (1-3)
Number of days with CVC	1 (0-3)
Preoperative steps/day	4303 (2381-6912)
Perioperative steps/day	293 (170-665)
Postoperarive steps/day	1250 (613-3300)
Ratio steps 1 (perioperative/preoperative) (%)	8.86 (4.39-15.15)
Ratio steps 2 (postoperative/preoperative) (%)	37.88 (22.14-62.13)
Discharge other than home	3 (9.1)
Length of stay (days)	6 (4-7)
Complications (Clavian Dindo ≥ 3)	5 (16.1)

Table 1. Percentages are in parentheses unless otherwise indicated: Continuous data shown with median and interquartile range in parentheses. BMI. Body mass index. ASA. American Society of Anesthesiologists. CRLM. Colorectal liver metastases. NRS. Numeric rating scale. IDUC. Indwelling Urinary Catheter. CVC. Central Venous Catheter.

The median length-of-stay was 6 (4-7) days. Median steps per day were 4303 (2381 - 6911) preoperatively, 293 (170 - 665) during admission, and 1250 (612 - 3300) after discharge, as shown in Fig. 1.

Steps per day for different periods

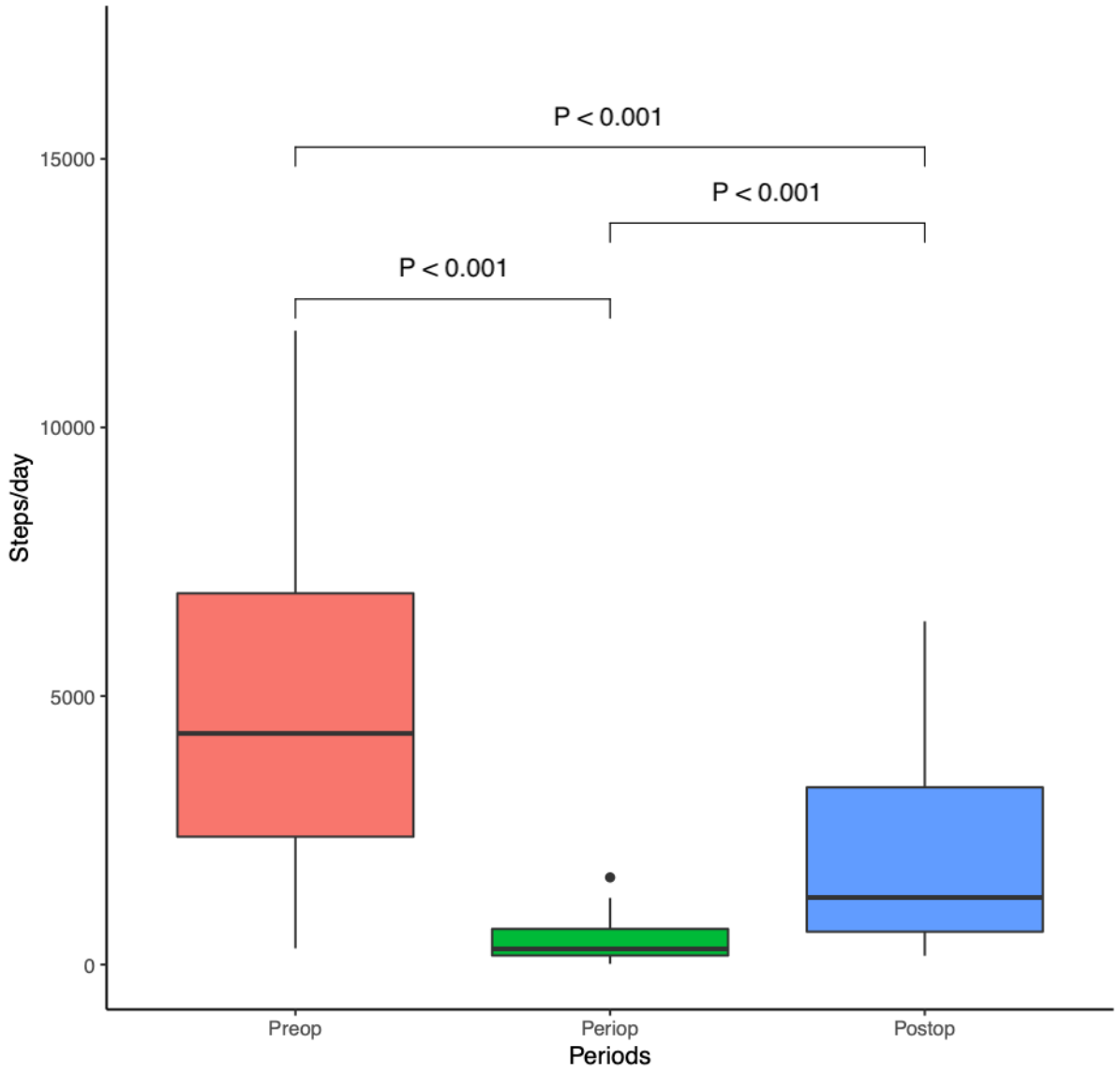

Figure 1. Steps per day preoperatively, perioperatively during hospital admission, and postoperatively, after discharge from hospital.

The ratio of perioperative and preoperative steps and the ratio of postoperative and preoperative steps are shown in Fig. 2.

Steps ratio for different periods.

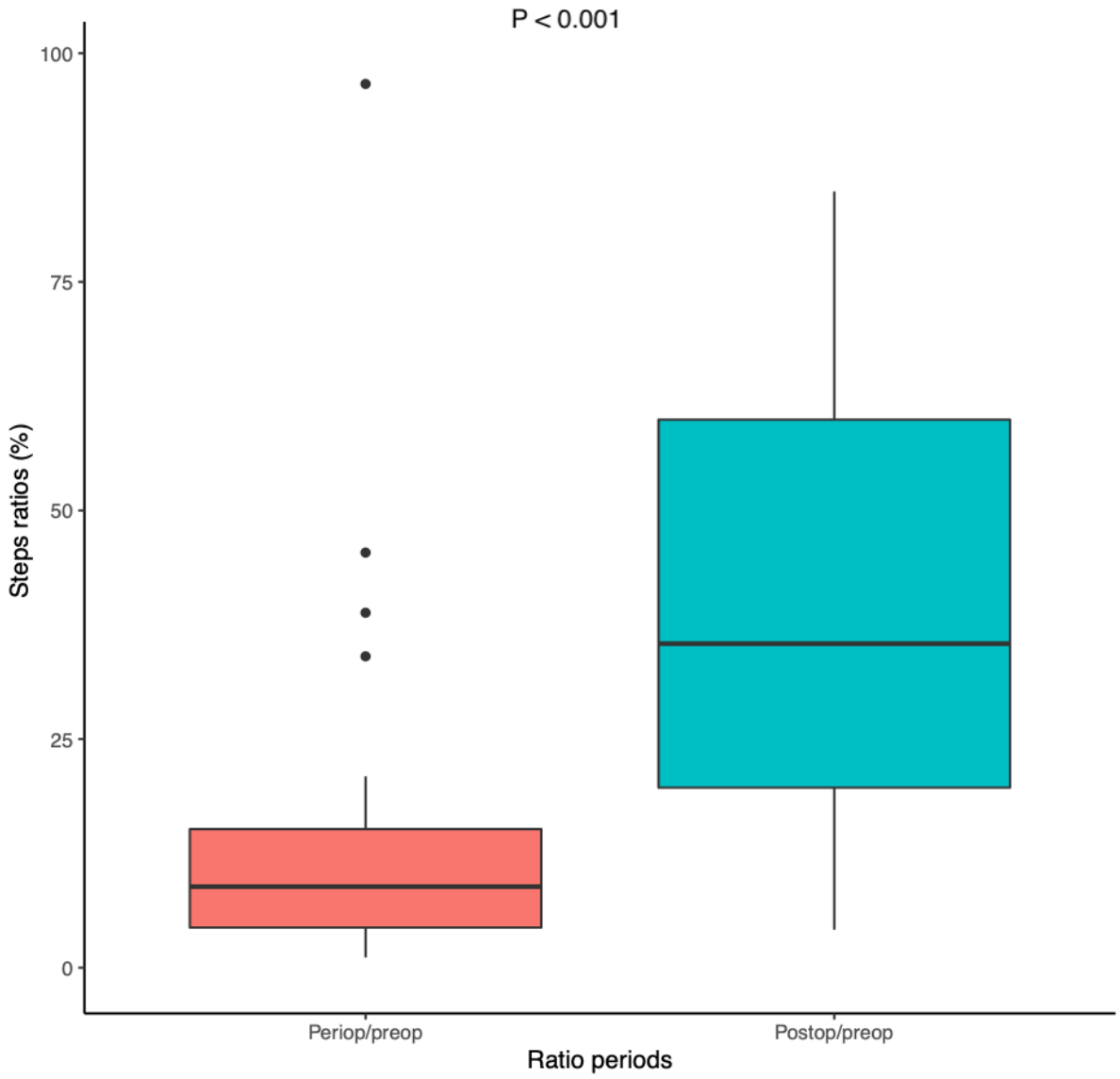

Figure 2. The ratio of perioperative divided by preoperative steps, and postoperative divided by preoperative steps

Nineteen patients (58 %) were physically inactive (as defined by an activity level of less than 5000 steps/day) preoperatively. This group had significantly higher ASA scores, more often metachronous colorectal liver metastases (CRLM), larger liver tumors, more operative bleeding, longer operation time, longer Central Venous Catheter (CVC) usage, and had less postoperative oral fluid intake. The patients' characteristics are shown in Table 2.

Table 2. Comparison between preoperatively physically inactive and active patients

	Inactive	Active	p
n	19	14	
Age	73 (63-77)	63 (56-72)	0.155
Gender (male)	11 (57.9)	7 (50.0)	0.733
BMI	25.9 (24.1-28.2)	24.2 (23.4-26.0)	0.105

ASA > 2	11 (57.9)	2 (14.3)	0.015*
Previous cancer diagnoses	13 (68.4)	6 (42.9)	0.173
Chronic pain	2 (10.5)	0 (0.0)	0.496
Smoke (%)			0.257
Never	12 (63.2)	5 (35.7)	
Previously	6 (31.6)	6 (42.9)	
Current	1 (5.3)	3 (21.4)	
Diabetes	2 (10.5)	2 (14.3)	1.000
Neoadjuvant therapy within 3 m	13 (68.4)	6 (42.9)	0.173
Type of liver disease			0.008*
Synchronous CRLM	7 (36.8)	5 (35.7)	
Metachronous CRLM	11 (57.9)	2 (14.3)	
HCC	1 (5.3)	2 (14.3)	
Cholangiocarcinoma	0 (0.0)	1 (7.1)	
Other	0 (0.0)	4 (28.6)	
Tumor size (cm)	3.5 (2.8-4.9)	2.2 (1.2-3.0)	0.020*
Number of liver tumors	2 (1-2)	2 (1-3)	0.954
Open liver surgery	19 (100.0)	12 (85.7)	0.172
Major liver resection	6 (31.6)	2 (14.3)	0.416
Operation time (min)	279 (202-344)	199 (130-250)	0.035*
Operative bleeding (ml)	700 (275-1050)	250 (56-288)	0.036*
Total intravenous opiate analgesic (mg)	51.0 (32.9-60.0)	53.2 (25.9-63.3)	0.950
Average pain during admission (NRS)	4.4 (3.2-5.4)	4.4 (3.5-4.7)	0.954
Median nausea score per day during admission	0 (0-0)	0.5 (0-1)	0.303
Perioperative intravenous analgesic (days)	2 (2-2)	2 (2-2)	0.161
Number of days with IDUC	2 (2-3)	2 (2-3)	0.097
Number of days with CVC	2 (1-5)	0.50 (0-2.50)	0.037
Preoperative steps/day	2706 (1162-3894)	7116 (6143-8023)	<0.001*
Perioperative steps/day	184 (158-482)	457 (255-692)	0.223
Postoperative steps/day	940 (532-2292)	2118 (873-4136)	0.160
Ratio steps 1 (perioperative/preoperative) (%)	12.0 (4.5-27.5)	6.3 (4.4-10.3)	0.126
Ratio steps 2 (postoperative/preoperative) (%)	49.8 (26.4-69.6)	36.2 (13.7-60.0)	0.380
Discharge other than to home	3 (15.8)	0 (0.0)	0.244
Hospital length of stay (days)	6 (5-7)	5 (4-7)	0.544
Major morbidity (Clavian Dindo ≥ 3)	3 (17.6)	2 (14.3)	1.000

Table 2. Percentages are in parentheses unless otherwise indicated: Continuous data shown with median and interquartile range in parentheses. BMI. Body mass index. ASA. American Society of Anesthesiologists. CRLM. Colorectal liver metastases. NRS. Numeric rating scale. IDUC. Indwelling Urinary Catheter. CVC. Central Venous Catheter.

The patients that were perioperatively more active (more than 300 steps/day, n=13) had significantly lower Body Mass Index (BMI) (23.9 (23.3 - 25.1) - 25.9 (24.2-27.1), p=0.042), had shorter length of CVC usage (1 (0 – 3) vs. 3 (1-6) days, p =0.043).

Five patients (16%) had major complications, three or more on the Clavian-Dindo scale. The complication group included only males, had significantly higher BMI, more operative bleeding, and longer operation time, as shown in Table 3. When calculating the odds ratio for complication in the preoperative active group we found no significant difference when unadjusted (OR 0.778 (95% CI 0.907-5.465) or adjusted (OR 2.049 (95% CI 0.127-62.930) for major resection, gender, age, bleeding, and ASA score.

Table 3. Comparison between patients without and with serious complications (Clavien Dindo ≥ 3)

	Without serious complications	Serious complications (CD ≥ 3)	p
n	26	5	
Age	71 (61-74)	62(55-72)	0.518
Gender (male)	12 (46.2)	5 (100.0)	0.048*
BMI	24.2 (23.7-26.7)	28.37 (25.5-32.0)	0.034
ASA > 2	10 (38.5)	3 (60.0)	0.625
Previous cancer diagnoses	16 (61.5)	1 (20.0)	0.148
Chronic pain	2 (7.7)	0 (0.0)	1.000
Smoke (%)			1.000
Never	13 (50.0)	3 (60.0)	
Previously	10 (38.5)	2 (40.0)	
Current	3 (11.5)	0 (0.0)	
Diabetes (%)	2 (7.7)	2 (40.0)	0.112
Neoadjuvant therapy < 3 m	15 (57.7)	3 (60.0)	1.000
Type of liver disease			0.059
Synchronous CRLM	9 (34.6)	3 (60.0)	
Metachronous CRLM	11 (42.3)	0 (0.0)	
HCC	1 (3.8)	2 (40.0)	
Cholangiocarcinoma	1 (3.8)	0 (0.0)	
Other	4 (15.4)	0 (0.0)	
Tumor size (cm)	3.0 (1.4-3.6)	3.3 (3.0-4.7)	0.388
Number of liver tumors	2 (1-3)	1 (1-2)	0.572
Open liver surgery (%)	24 (92.3)	5 (100.0)	1.000
Major resection (%)	6 (23.1)	1 (20.0)	1.000
Operation time (min)	212 (162-277)	347 (287-462)	0.021*
Operative bleeding (ml)	250 (150-700)	1200 (1200-1400)	0.007*
Total intravenous opiate analgesic (mg)	51.6 (26.8-60)	62.7 (51.2-82.0)	0.166
Average pain during admission (NRS)	4.4 (3.4-4.8)	3.5 (3.0-5.3)	0.831
Median nausea score per day during admission	0 (0- 1)	0 (0-0)	0.573
Perioperative intravenous analgesic (days)	2 (2-2)	2 (2-4)	0.011*
Number of days with IDUC	2 (2- 3)	5 (3-7)	0.018*
Number of days with CVC	1 (0-3)	5 (2-7)	0.147
Preoperative steps/day	4380 (2860-7116)	4733 (610-5930)	0.303
Perioperative steps/day	251 (161- 632)	726 (510-746)	0.190
Postoperative steps/day	1250 (629-3300)	623 (402-1349)	0.247
Ratio steps 1 (perioperative/preoperative) (%)	7.11 (4.28-13.30)	15.34 (14.04-56.00)	0.059
Ratio steps 2 (postoperative/preoperative) (%)	46.30 (22.14-62.13)	29.61 (20.06-32.07)	0.214
Discharge other than home	2 (7.7)	1 (20.0)	0.422
Length of stay (days)	5 (4-6)	5 (4-7)	0.947

Table 3. Percentages are in parentheses unless otherwise indicated: Continuous data shown with median and interquartile range in parentheses. *. P-value below 0.05. BMI. Body mass index. ASA. American Society of Anesthesiologists. CRLM. Colorectal liver metastases. NRS. Numeric rating scale. IDUC. Indwelling Urinary Catheter. CVC. Central Venous Catheter.

Discussion

The present study aimed to measure the perioperative level of mobility with a pedometer for patients undergoing liver surgery with a special investigation on the relationship between postoperative mobilization and outcome.

Previous studies that have investigated the impact of a better preoperative physical mobility subjectively with questionnairs have showed a decreased length of hospital stay and decreased

postoperative complications[2, 11]. With the increased use of wearable biometric devices such as pedometers, more research has been done to objectively observe mobility after surgical procedures[5, 12].

Interestingly we found that physical mobility during admission decreased to merely 9% of the preoperative mobility and increased to 38% after discharge which is well in line with the previous article by Sun et al[5], which however included only 6 patients subjected to liver resection. Patients in the present study were much older (median 70 year) as compared to the median age of 55 years of patients included in the study by Sun et al.[5] The level of reduction in physical activity then seems to be a general phenomenon after surgery without real association to age. It is still to be decided if active mobility intervention pre-, peri- and postoperatively could promote patient outcomes.

Patients who were less active preoperatively had higher ASA scores, more operative bleeding, and longer operation times representing more frailty, co-morbidity, and more complex tumor disease. Interestingly, patients with larger tumors and metachronous CRLM tumors had less preoperative mobility probably because of the effect of tumor burden and previous cancer therapies.

During hospital admission mobility decreased to only about nine percent and patients with fewer days with a central venous catheter and lower BMI were more active. It is easy to imagine how lower BMI and fewer central venous catheter days could help with early mobility and central venous catheter usage termination should perhaps be encouraged when possible.

The group that had major complications included only males. The group also had higher BMI, longer operation time, and intraoperative bleeding as compared to the group without major complications. It is unknown why only males got major complications but a male gender has previously been linked to more surgical complications[13, 14].

The strength of this study is the use of objective measurement to measure physical mobility before, during, and after surgery. The use of pedometers as a biomarker is a simple and easy objective and could be used to measure objective well-being. The prospective design of this study and the well-defined patient group represents additional strengths of the study. The use of pedometers to measure the activity level also gives some limitations, with the main being the patients reactivity and inaccurate low-speed measurements. Patients could also be subjected to the Hawthorne effect where they could increase their activity level because of a positive feedback loop and the awareness of activity measurements. Other limitations are a modest number of included patients.

Conclusions

In conclusion, the activity level markedly decreases postoperatively for patients undergoing liver resections, both during the perioperative period at hospital admission and postoperatively after discharge. Future studies could further evaluate the intervention effect of perioperative care on postoperative outcome measures.

List of abbreviations

ASA. American Society of Anesthesiologists.

BMI. Body mass index.

CRLM. Colorectal liver metastases.

CVC. Central Venous Catheter.

IDUC. Indwelling Urinary Catheter.

IQRs. Interquartile ranges

OR. Odds ratio.

NRS. Numeric rating scale.

Declarations

Ethics approval and consent to participate. Informed consent was obtained from all the participants. The study was approved by the regional ethics committee, Lund, Sweden.

Consent for publication. Not applicable.

Availability of data and materials. The datasets generated during and analysed during the current study are not publicly available due to information that could compromise the privacy of research participants but are available from the corresponding author on reasonable request.

Competing interests. The authors declare that there is no competing interest.

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Authors' contributions. CS conceived of the presented idea. PSH, JR and JM carried out the experiment. VTV and CS developed the theory. VTV wrote the manuscript and performed the computations with support from CS.

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Figure titles and legends.

Figure 1 - title.

Figure 1 – legend. Steps per day preoperatively, perioperatively during hospital admission, and postoperatively, after discharge from hospital.

Figure 2 - title.

Figure 2 – legend.

Figures

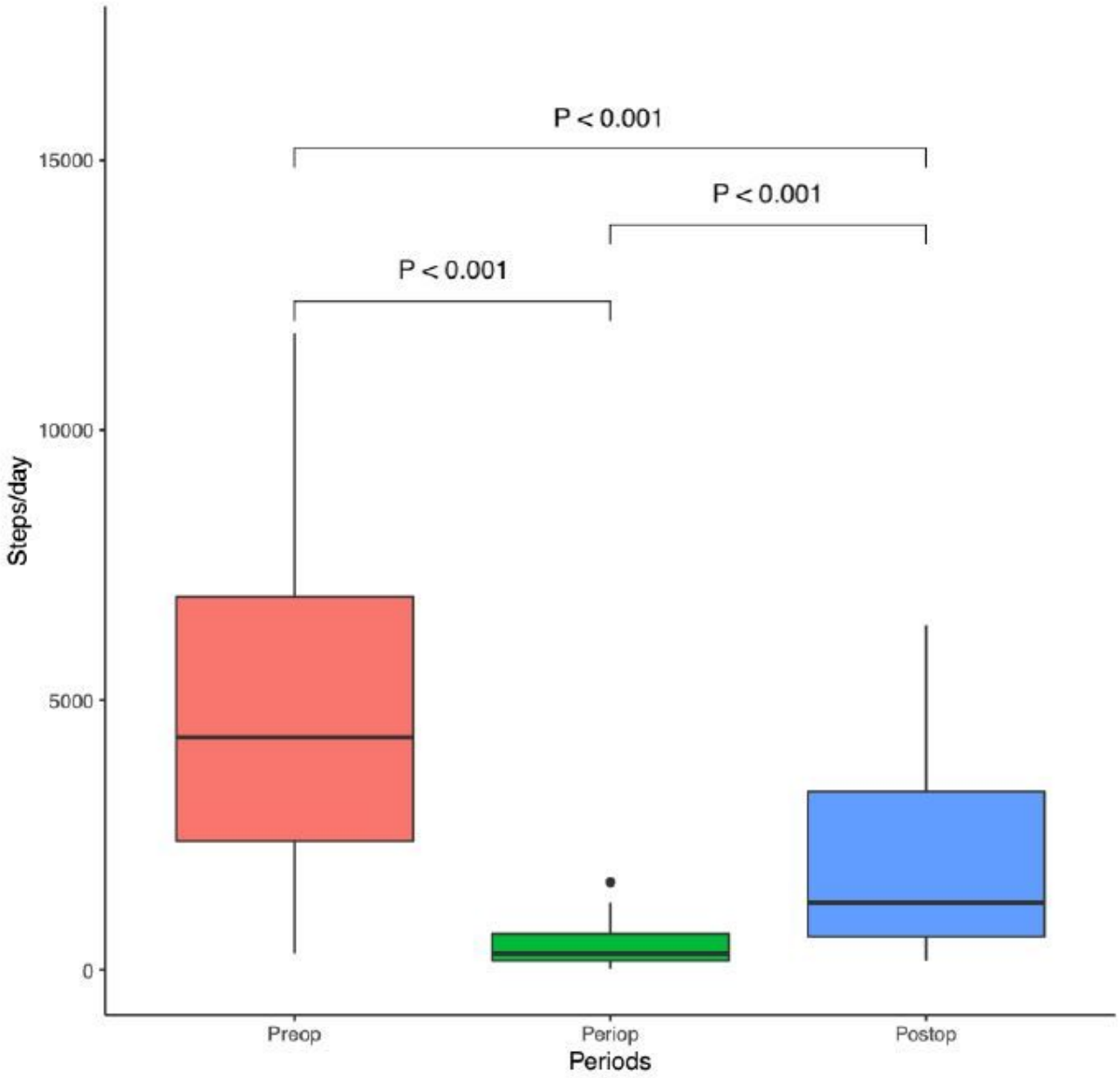

Figure 1

Steps per day preoperatively, perioperatively during hospital admission, and postoperatively, after discharge 99 from hospital.

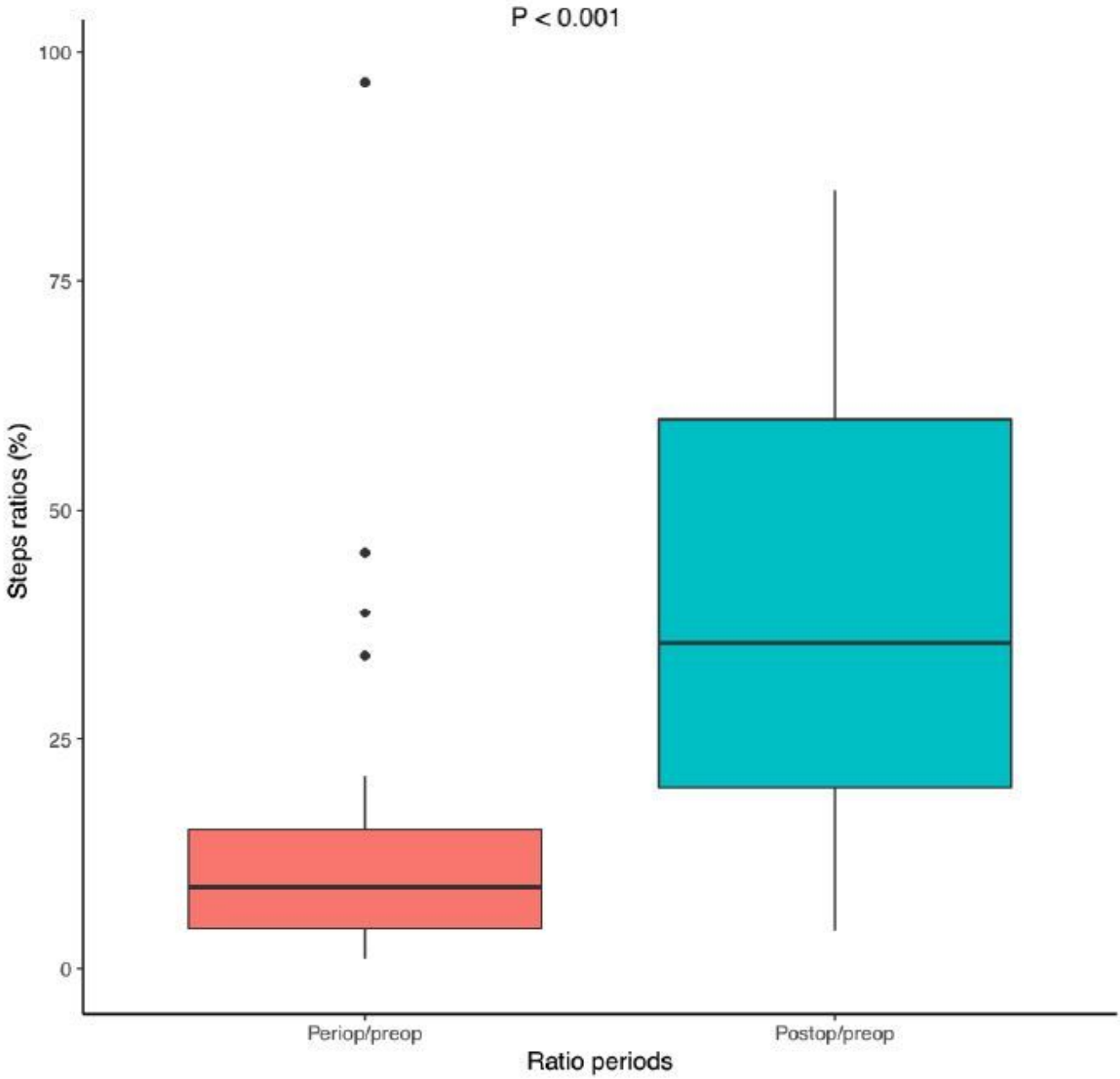

Figure 2

The ratio of perioperative divided by preoperative steps, and postoperative divided by preoperative steps