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RESEARCH ARTICLE

The impact of orthostatic intolerance on early ambulation following abdominal surgery in an enhanced recovery programme

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Abstract

Background: The prevalence of orthostatic intolerance on the day of surgery is more than 50% after abdominal surgery. The impact of orthostatic intolerance on ambulation on the day of surgery has been little studied. We investigated orthostatic intolerance and walking ability after colorectal and bariatric surgery in an enhanced recovery programme.

Methods: Eighty-two patients (colorectal: $n = 46$, bariatric $n = 36$) were included and analysed in this prospective study. Walk tests for 2 min (2-MWT) and 6 min (6-MWT) were performed before and 24 h after surgery, and 3 h after surgery for 2-MWT. Orthostatic intolerance characterised by presyncopal symptoms when rising was recorded at the same time points. Multivariate binary logistic regressions modelling the probability of orthostatic intolerance and walking inability were performed taking into account potential risk factors.

Results: Prevalence of orthostatic intolerance and walking inability was, respectively, 65% and 18% 3-hour after surgery. The day after surgery, patients' performance had greatly improved: approximately 20% of the patients experienced orthostatic intolerance, whilst only 5% of the patients were unable to walk. Adjusted binary logistic regressions demonstrated that age ($p = .37$), sex ($p = .39$), BMI ($p = .74$), duration of anaesthesia ($p = .71$) and type of surgery ($p = .71$) did not significantly influence walking ability.

Conclusion: Our study confirms that orthostatic intolerance was frequent (~ 60%) 3-hour after abdominal surgery but prevented a 2-MWT only in ~20% of patients. No risk factors for orthostatic intolerance and walking inability were evidenced.

KEYWORDS
enhanced recovery programme, orthostatic intolerance, postoperative ambulation, surgery: bariatric, colorectal.

The work was carried out at CHU Liège, Domaine du Sart Tilman, B-4000 Liège, Belgium.

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Editorial Comment

In this assessment of a abdominal surgery the interaction of orthostatic intolerance on walking ability 3 and 24 h postoperatively is presented. Some methodological limitations include no assessment of pathophysiological mechanisms a relatively small sample size no data on opioid use or arterial blood pressure during the orthostatic assessment. Still the study identifies the clinical impact of orthostasis. Despite an enhanced recovery protocol many cases had orthostatic intolerance at the 3-hour assessment but most were still able to perform the walk-tests albeit at a reduced distance. The following day only a few cases were unable to walk due to orthostasis but those with 3-hour impairment had reduced 24 h walking distance and longer lengths of stay. These findings suggest an interpretation that orthostatic intolerance should not be a contraindication to early ambulation including physiotherapy but that early reduced ambulation is a predictor of subsequent reduced recovery. Future pathophysiological studies are needed with stratification of cases into those with no orthostasis orthostatic intolerance with ambulation and persisting intolerance affecting ambulation.

1 | INTRODUCTION

As far back as 1944, early postoperative activity and walking were reported to improve postoperative recovery and reduce postoperative complications.[1] Early mobilisation, advocated from the first enhanced recovery programmes (ERP) after colorectal surgery,[2,3] is now considered as a key item of these programmes[4,5] and is highly recommended in all ERPs, whatever the surgical procedure. Unfortunately, postoperative orthostatic intolerance (OI) can occur the day of surgery with a prevalence of 40–50% after major surgery and prevent early rising and ambulation.[6] OI is defined by subjective presyncopal symptoms of dizziness, nausea, vomiting, feeling of heat or blurred vision whilst sitting or standing.[6] Although postoperative autonomic dysregulation and decreased vasopressor response with reduced cerebral perfusion are the main mechanisms for OI symptoms,[7] OI and orthostatic hypotension are not always associated.[8,9] Its precise mechanisms and risk factors remain unclear: further research is, therefore, needed to improve our understanding of its pathogenesis and so develop preventive strategies.[6,10]

The nature of the surgical procedure seems to directly influence the prevalence of postoperative OI.[6] ERP which improves and accelerates postoperative patient recovery provides conditions to reduce the development of OI. A few studies using a well-defined mobilisation protocol have prospectively investigated OI after abdominal surgery in an ERP.[8,9] But the ability to walk the day of surgery has never been studied after abdominal surgery. However early walking becomes mandatory for patients undergoing ambulatory abdominal surgery. We, therefore, assessed early ambulation using standardised walk tests in patients scheduled for colorectal and bariatric surgery with an ERP and hypothesised that 50% of orthostatic intolerant patients would be unable to walk the day of surgery. Second, we prospectively investigated the prevalence and risk factors of OI in these patients. We selected colorectal and bariatric surgery for two reasons. First, ambulatory colonic and bariatric surgery are now proposed as safe procedures.[11,12] Second, the selection of these two procedures increases the range of different variables potentially affecting OI, such as age, sex, weight, duration of surgery and allowed their potential impact to be more fully investigated.

2 | METHODS

This monocentric prospective observational study was approved by the Institutional Ethics Committee of the Centre Hospitalier Universitaire de Liège (Liège, Belgium, Chair: Prof. V. Seutin, No 2019–218) on 3 October 2019 and registered with Clinical Trials (ref: NCT04040647). This study was reported according to the STROBE checklist. After obtaining written informed consent, 53 consecutive patients scheduled for colorectal surgery in an ERP and 39 consecutive patients scheduled for bariatric surgery in an ERP were included in the study between 15 October 2019 and 15 March 2020 (Figure 1).

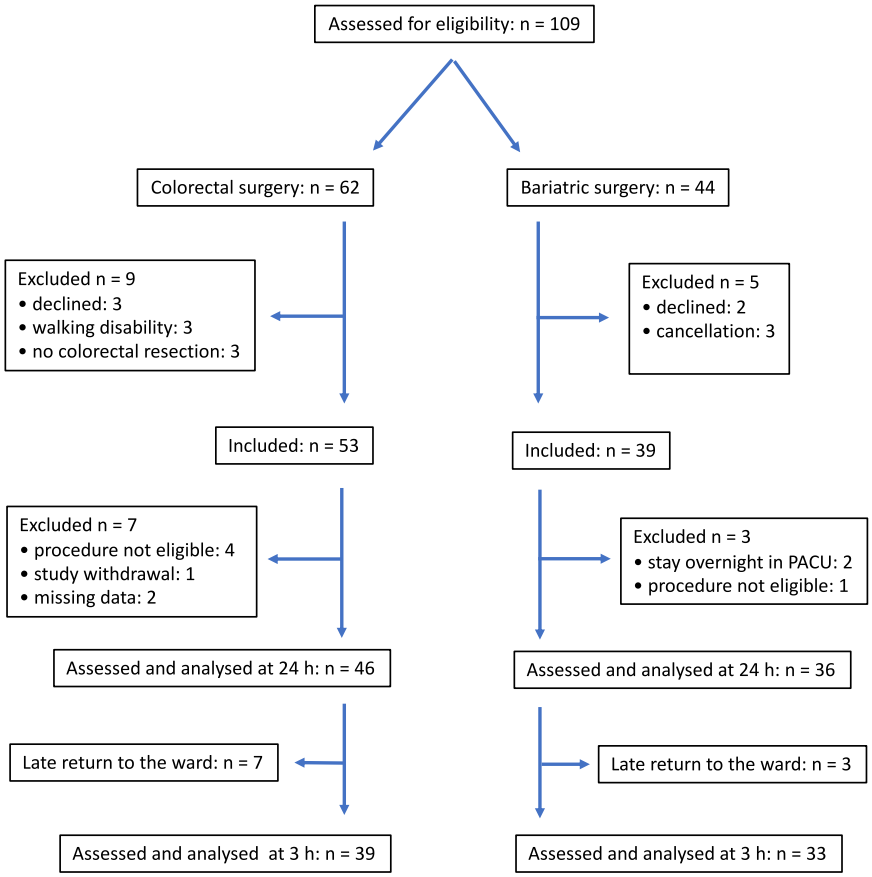
2.1 | Patients

Patients scheduled for elective colorectal surgery at Centre Hospitalier Universitaire de Liège were recruited in the study regardless of the surgical approach (laparoscopy, laparotomy), the site of surgery (colon, rectum), and the indication of surgery. Morbidly obese patients included in the study were to undergo scheduled laparoscopic Roux-en-Y gastric bypass or sleeve gastrectomy. Exclusion criteria were age less than 18 years and inability to walk without assistance.

2.2 | Perioperative care

All the patients scheduled for colorectal surgery were managed with the same ERP protocol.[13] The protocols were optimised to allow early mobilisation minimising the impact of potential factors predisposing to OI: hypovolaemia, pain, nausea, fatigue, opioid use, and surgical inflammation.[6] Patients were informed of the importance

FIGURE 1 CONSORT flow diagram



of early mobilisation and exercises. Bowel preparation was prescribed only for patients undergoing rectal surgery. All the patients received 400 mL of carbohydrate beverage 2–3 h before surgery. Patients received no premedication. General anaesthesia consisted of inhalational anaesthesia with sevoflurane. Sevoflurane was adjusted to keep mean arterial pressure within 15% of preinduction value and to maintain Response Entropy as well as State Entropy (GE Entropy™, GE Healthcare, Machelen, Belgium) below 60. No epidural analgesia was performed. Patients were given sufentanil 0.1–0.15 μg kg^{-1} for the induction of anaesthesia. Dexamethasone 10 mg was administered before surgery except in patients with insulin-requiring diabetes. Intraoperative fluid was managed with Plasmalyte® (Baxter SA, Lessines, Belgium) 500 mL at induction of anaesthesia followed by an intraoperative continuous infusion of 2–3 mL kg^{-1}. If mean arterial pressure dropped below 15% of preinduction value of below 60 mmHg, patients were administered 9 mg ephedrine intravenously and a fluid challenge of 250 mL Plasmalyte® in 10 min. Postoperatively, the crystalloid infusion was prolonged at a rate of 40 mL h^{-1} until tolerance of food. Venous thrombosis prophylaxis included intraoperative intermittent compression of legs and postoperative low molecular-weight heparin. No patients wore stockings. The urinary catheter and the nasogastric tube placed before surgery were removed before leaving the operating room. No abdominal drain was used except in cases of rectal surgery. Dehydrobenzperidol 0.625 mg was administered iv to prevent postoperative nausea and vomiting. Multimodal analgesia consisted of a combination of at least three non-opioid analgesic drugs and/or techniques to reduce postoperative opioid needs.[13] It combined a bilateral transversus abdominis plane (TAP) block, intravenous lidocaine (bolus [1.5 mg kg^{-1}] followed by an intraoperative infusion [2 mg kg^{-1} h^{-1}]), paracetamol and non-steroidal anti-inflammatory drug. Residual pain was treated with tramadol slow release 100 mg BID and oxycodone 5 mg as rescue medication on demand. No iv PCA was used. Patients were allowed to drink water 2 h after surgery and eat a light meal 3 h after surgery in the absence of nausea. PONV was treated with iv ondansetron.

For bariatric patients, the ERP protocol was similar. The differences were minor: sufentanil was replaced by an intravenous infusion of low dose remifentanil (0.1 μg kg^{-1} h^{-1}), no TAP block was performed. Ideal body weight was used to calculate the dosage of lidocaine, remifentanil and Plasmalyte®. Urinary catheters were not indwelling.

Rising from sitting to standing and walking in the ward was allowed from 3 h after surgery. Patients were asked to stay 1 h out of bed on the day of surgery, and 4 h out of bed on the days after surgery.

2.3 | Measurements

The primary endpoint was the prevalence of inability to walk 3 h and 24 h after the end of surgery. Regardless of the occurrence of OI

all patients subjected to the same protocol sat on the edge of their bed and were mobilised to the upright position after two minutes. After two more minutes, the ability to walk without assistance was assessed in a standardised 2-min walk test (2-MWT).[14] The 2-MWT, found suitable to measure patient recovery in the early postoperative period, was selected for testing patients 3 h after surgery.[14,15] Inability to walk was defined as the inability to complete the required walking test whatever the reason.

Secondary endpoints were the prevalence of OI 3 h and 24 h after the end of surgery and the distances covered during the standardised postoperative walk tests. OI was defined by the occurrence of subjective presyncopal symptoms of dizziness, nausea, vomiting, feeling of heat or blurred vision during rising from sitting to standing before the walking tests.[6] Standardised 2-MWT were performed at the time of the pre-anaesthetic visit, 3 h and 24 h after the end of surgery and 6-min walk test (6-MWT) were performed before surgery and 24 h after surgery following the guidelines of the American Thoracic Society.[16] After surgery, the tests took place in the hallway directly outside the patient's room. The distance walked by the patient was measured using a wheel odometer. All these tests were supervised by the same two physiotherapists (SVJ and MHLB) to minimise variability in test performance.

Potential risk factors for orthostatic and walking intolerance were also recorded: age, body mass index (BMI), sex, type of surgery, duration of surgery, anti-hypertensive treatment (all anti-hypertensive treatments were given up to and including the morning of the operation except for angiotensin-converting enzyme inhibitors and angiotensin II-receptor antagonists, which were paused on the day of surgery), together with pain and fatigue scores during the walk tests measured on a 0 – 10 verbal scale. Postoperative complications and length of hospital stay (LOS) were also recorded. Postoperative complications defined following the European Perioperative Clinical Outcome (EPCO) definitions [17] were considered only when requiring medical or surgical treatment.

2.4 | Statistical analysis

The normality of the distribution of quantitative variables was investigated graphically using histograms and quantile-quantile plots and tested using the Shapiro-Wilk test. Quantitative variables were expressed as mean ±SD or median [IQR] when appropriate. Qualitative data were expressed as count (per cent). Quantitative variables were compared between groups using Student's *t* test when normally distributed and using the Mann–Whitney *U* test for non-parametric data. The chi-square test or Fisher test were used to compare qualitative variables when appropriate.

A univariate binary logistic regression modelling the presence of OI was applied for each potential risk factor, adjusting for the type of intervention. A multivariate binary logistic regression was then applied taking into account all the factors, adjusting for the type of intervention. The same analytical procedure was applied to analyse the inability to walk.

No data were available regarding the incidence of inability to walk 3 h after abdominal surgery. We, therefore, hypothesised that 50% of the orthostatic intolerant patients would not complete the 2-MWT the day of surgery. Considering a reported prevalence of OI of 50–60%, the appropriate sample size for estimating the proportion of our population unable to walk with a confidence limit of 10% and a confidence level of 95% was 70 patients. We, therefore, decided to recruit patients until we had included 72 patients tested 3 h after the end of the surgery.

A *p*-value less than .05 was considered statistically significant. Only observed data were analysed. Data were analysed using SAS (version 9.4 for Windows).

3 | RESULTS

Among the 53 colorectal patients and 39 bariatric patients included in the study, 46 and 36 patients, respectively, in the colorectal and bariatric group were finally analysed (Figure 1). Exclusions were for changes in the surgical strategy, missing data, and need for overnight stay in the PACU in two bariatric patients with obstructive sleep apnoea syndrome (Figure 1). A late return to the ward after surgery planned in the afternoon prevented the assessment of some patients 3 h after the surgery. Orthostatic and walking tolerance were investigated in 39 colorectal patients and 33 bariatric patients at 3 h after surgery.

3.1 | Patients' descriptive data

Patients' data in the colorectal and bariatric groups are presented in Table 1. Bariatric patients were significantly younger ($p < .0001$) and had higher BMI ($p < .0001$) than colorectal patients. Duration of anaesthesia and length of hospital stay (1 [1–1.5] *vs.* 3 [2–6.5] days, respectively, in the bariatric and colorectal groups) were shorter ($p < .0001$) in the bariatric group. Finally, the distances covered during the preoperative 2-MWT and 6-MWT were similar in both groups: 2-MWT (137 [120–155] *vs.* 144 [117–162] m, $p = .51$) and 6-MWT (419 [361–469] *vs.* 423 [350–464] m, $p = .74$), respectively, in the bariatric group and the colorectal group.

3.2 | Assessments 3 h after surgery

OI was reported in 47 (65%) patients. Dizziness, nausea, vomiting, feeling of heat and blurred vision were, respectively, reported in 40 (56%), 16 (22%), 4 (6%), 6 (8%) and 3 (4%) patients. Characteristics of patients who experienced OI and of patients who did not are compared in Table 2. No significant differences were observed between the two groups. However, patients with OI covered a distance in the 2-MWT

TABLE 1 Patients' characteristics; preoperative 2-MWT and 6-MWT

	Global population	Bariatric surgery	Colorectal surgery
Tested at 24 h	82	36	46
Tested at 3h	72	33	39
Age (years)	53.6 (18–89)	46.3 (18–67)	59.6 (22–89)
Sex: M/F (%)	39/43 (47.6/52.4)	13/23 (36.1/63.9)	26/20 (56.5/43.5)
Weight (kg)	89.5 ± 23.0	108.0 ± 16.2	74.3 ± 15.2
Height (cm)	169.0 ± 9.2	168.6 ± 10.1	169.3 ± 8.5
BMI (kg m^{-2})	31.4 ± 7.7	38.1 ± 4.8	25.8 ± 4.6
Anaesth (min)	163 [120–220]	120 [90–160]	210 [155–258]
Colon / rectum			35/11
Scopy / Tomy		39/0	42/4

Note: Data are mean (range) for age, mean ±SD; median [IQR] or count (%).

Abbreviations: Anaesth, duration of anaesthesia; BMI, body mass index; Scopy / Tomy, laparoscopy/laparotomy.

TABLE 2 Comparison of the characteristics of patients who developed orthostatic intolerance at 3 h after surgery and of patients without orthostatic intolerance

	All	Orthostatic intolerance	No orthostatic intolerance	*p*
N	72	47 (65)	25 (35)	
Age (years)	52.7 (18–89)	54.0 (22–80)	50.1 (18–89)	.37
Weight (kg)	90.4 ± 22.9	90.8 ± 21.8	89.6 ± 25.6	.86
Height (cm)	169.2 ± 9.1	168.5 ± 9.2)	170.6 ± 9.0	.38
BMI (kg m^{-2})	31.6 ± 7.9	32.0 ± 7.7	30.8 ± 8.4	.56
Male/Female	35/37	22/25	13/12	.67
2-MWT Preop (m)	144 [122–157]	138 [120–154]	146 [130–149]	.27
6-MWT Preop (m)	425 [364–470]	419 [360–464]	443 [381–471]	.52
2-MWT 3 h (m)[a]	58 ± 22 *n* = 59	42 ± 16 *n* =35	63 ± 23 *n* = 24	<.001
2-MWT 24 h (m)[a]	94 [70–109] *n* = 68	87 [60–109] *n* = 43	101 [89–108] *n* = 25	.11
6-MWT 24 h (m)[a]	287 [208–336]	265 [171–333]	313 [285–336]	.057
Type of surgery: CR *vs*. BAR	39/33	23/24	16/9	.47
Anaesth (min)	150 [110–210]	170 [112–210]	150 [115–187]	.39
Preop arterial hypertension	28 (39)	22 (47)	6 (24)	.09
Intraop anti-HT drug	33 (46)	22 (47)	11 (44)	.82
Pain score	5 [3–7]	5 [3–7]	6 [3–7]	.67
Fatigue score	7 [5–9]	7 [5–9]	7 [5–8]	.80
Postop compl	7 (10)	5 (11)	2 (8)	1
Complications grade >2[b]	4 (6)	3 (6)	1 (4)	1
LOS (day)	2 [1–3.5]	2 [1–3.75]	2 [1–3]	.64

Note: Data are count (%), mean ±SD, or median [IQR], except for age: mean (range).

Abbreviations: 2-MWT, 2 min walk test; 6-MWT, 6 min walk test; Anaesth, duration of anaesthesia; BMI, body mass index; Intraop anti-HT drug, intraoperative administration of anti-hypertensive drug; LOS, length of hospital stay; Postop compl, postoperative complication; Type of surgery: CR, colorectal, BAR, bariatric.

[a]Only the distances covered by the patients able to walk were considered.

[b]Complications grade >2 following Clavien Dindo classification.

one-third shorter (~ 20 m) than patients without OI ($p < .001$), a difference considered as clinically relevant for the 2-MWT.[14]

Walking inability was reported in 13 (18%) patients. The reasons for not completing the 2-MWT were OI in 12 patients and insufficient pain relief in one patient. Characteristics of patients able and unable to walk are presented in Table 3. There were no significant differences between the two groups except for the duration of anaesthesia, which was one-third shorter in the group of patients able to walk ($p = .02$). Interestingly, during the 2-MWT 24 h after surgery patients unable to walk 3 h after surgery walked a distance 25% shorter (~ 20 m) than patients able to walk ($p = .04$). For the 6-MWT, a difference of 150 m was observed ($p = .02$). Longer LOS ($p = .05$) was observed in the group of patients unable to walk 3 h after surgery.

3.3 | Risk factors for orthostatic intolerance and inability to walk 3 h after surgery

Applying an adjusted binary logistic regression demonstrated that age, sex, BMI, duration of anaesthesia, type of surgery (colorectal *vs*. bariatric surgery), preoperative anti-hypertensive treatment, preoperative 6-MWT, postoperative pain score, and fatigue score did not significantly influence the prevalence of OI (Table 4) and of the inability to walk (Table 5).

3.4 | Assessments 24 h after surgery

OI and inability to walk were reported, respectively, in 18 (22%) and 4 (5%) patients. In the 11 patients experiencing OI 24 h after surgery and tested 3 h after surgery, 9 already experienced symptoms 3 h after surgery. The four patients unable to walk at 24 h were already not walking at 3 h.

4 | DISCUSSION

Our study confirms that the prevalence of OI in the early postoperative period after intermediate abdominal surgery in an ERP is high. More than 60% of the patients scheduled for laparoscopic bariatric surgery and colorectal surgery experienced presyncopal symptoms during rising from sitting to standing 3 h after surgery. However, these symptoms did not prevent many of these orthostatic-intolerant patients from walking. Only 18% of the patients were unable to walk 3 h after surgery, i.e. 25% of the orthostatic intolerant patients. Twenty-four hours after surgery, patients' performance had greatly improved: approximately 20% of the patients experienced symptoms of orthostatic intolerance, whilst only 5% of the patients were unable to walk. Age, obesity, sex, duration of anaesthesia, distance covered during the preoperative walk test, type of surgery (bariatric *vs*. colorectal surgery), preoperative arterial hypertension, postoperative pain and fatigue were not predictive risk factors for orthostatic intolerance and inability to walk in our study.

The originality of our study was that a standardised walk test was already programmed 3 h after surgery to further investigate the phenomenon of OI. Walk tests were usually not scheduled before the day after surgery.[14,16] As reported by others,[8,9] we observed symptoms of OI in more than 50% of patients undergoing abdominal surgery, even with an ERP.[9] Our study found that these symptoms did not prevent most of these patients from walking. A 2-MWT promptly after surgery is, therefore, feasible for most patients. The demonstration of the ability to walk for at least 2 min a few hours only after bariatric and colorectal surgery is new and important, given the importance of early mobilisation in the ERPs.[4,18] These findings are new and emphasise the role of the physiotherapist to facilitate early mobilisation in the ERP.

In some patients, orthostatic disabilities detected 3 h after surgery lasted up to 24 h after surgery. More than 80% of the patients tested at the two time points and complaining of OI at 24 h had already experienced presyncopal symptoms when rising at 3 h after surgery. The four patients unable to walk on the day after surgery did not succeed either in walking 3 h after surgery. Furthermore, the distances covered during the 2-MWT and the 6-MWT 24 h after surgery by patients unable to walk on the day of surgery were significantly shorter compared to those who walked. The prolongation of the orthostatic dysfunction on the day after surgery precluded a potential role of anaesthesia as residual effects of short-acting anaesthetics is unlikely at that time. Finally, early postoperative orthostatic disorders might be associated with later consequences. Like others reporting longer LOS in cases of early postoperative OI,[9,19] we similarly observed longer LOS in our patients unable to walk on the day of surgery. These observations suggest that the inability to walk on the day of the operation could predict a more difficult postoperative course, as has also been shown in cases of intolerance of early oral feeding.[20]

The magnitude of the surgical procedure and the resulting inflammatory responses could contribute to early postoperative impaired autonomic dysfunction.[6] In our study, we selected patients scheduled for bariatric and colorectal surgery, two different abdominal surgical procedures, but with similar surgical invasiveness. Accordingly, the type of surgery (colorectal *vs*. bariatric) was not a predictive risk factor for orthostatic intolerance and inability to walk in our study. The selection of these two procedures increased the range of different variables potentially affecting OI, such as age, sex, weight, duration of surgery and allowed their potential impact to be more fully investigated. Conflicting results have been reported concerning age, sex, BMI, duration of surgery, pain score and preoperative arterial hypertension as potential risk factors.[8,9,19,21] In our study, multivariate analyses suggested that these variables were not associated with orthostatic intolerance or inability to walk.

The strengths of the present study include the standardisation of the patient management, of the definition of OI,[6] and of the performance of the walk test. Our ERP aimed at minimising the impact of potential factors predisposing to OI. Accordingly, the distances covered the day after surgery by our patients were almost twice as

TABLE 3 Comparison of the characteristics of patients unable to walk and patients able to walk at 3 h after surgery

	All	Unable to walk	Able to walk	*p*
N	72	13 (18)	59 (82)	
Age (years)	52.7 (18–89)	59.2 (27–80)	51.2 (18–89)	.14
Weight (kg)	90.4 ± 22.9	83.0 ± 19.7	92.1 ± 23.4	.16
Height (cm)	169.2 ± 9.1	168.3 ± 11.8	169.4 ± 8.5	.76
BMI (kg m^{-2})	31.6 ± 7.9	29.4 ± 6.8	32.1 ± 8.1	.22
Male/Female	35/37	6/7	29/30	.84
Preop 2-MWT (m)	144 [122–157]	145 [112–161]	144 [123–156]	.27
Preop 6-MWT (m)	425 [364–470]	437 [335–479]	423 [368–467]	.52
2-MWT 3 h (m)	50.7 (22.1)	0	50.7 (22.1)	
2-MWT 24 h (m)	94 [70–109]	71 [43–92]	99 [73–112]	.04
6-MWT 24 h (m)	287 [208–336]	169 [129–275]	300 [220–337]	.02
Type of surgery: CR *vs.* BAR	39/33	9/4	30/29	.23
Anaesth (min)	150 [110–210]	210 [175–226]	140 [105–200]	.02
Preop arterial hypertension	28 (39)	6 (46)	22 (37)	.55
Intraop anti-hypertensive drug	33 (46)	4 (31)	29 (50)	.32
Pain score	5 [3–7]	5 [2.25–6.75]	5 [3–7]	.52
Fatigue score	7 [5–9]	8 [6.25–9.75]	7 [5–8]	.14
Postop compl	7 (10)	3 (25)	4 (6.8)	.09
Compl grade >2[a]	4 (6)	1 (8)	3 (5)	.53
LOS (days)	2[1–3.5]	3 [2–5]	2 [1–3.5]	.05

Note: Data are count (%), mean ±SD, or median [IQR], and except for age: mean (range).

Abbreviations: 2-MWT, 2 min walk test; 6-MWT, 6 min walk test; Anaesth, duration of anaesthesia; BMI, body mass index; Intraop anti-hypertensive drugs, intraoperative administration of anti-hypertensive drug; Pain and fatigue scores were measured during the walk test on a 0 – 10 verbal scale. LOS, length of stay; Postop compl, postoperative complications; Type of surgery: CR, colorectal, BAR, bariatric.

[a]Postoperative complication grade >2 following Clavien Dindo classification.

TABLE 4 Risk factors for orthostatic intolerance at 3 h after surgery: univariate and multivariate binary logistic regressions adjusted for the type of surgery

Variables	OR (95% CI) Orthostatic intolerance	*p*	aOR (95% CI) Orthostatic intolerance	*p*
Sex (F *vs.* M)	1.124 (0.399–3.163)	.82	1.188 (0.344–4.100)	.79
Age (year)	1.022 (0.986–1.059)	.24	1.001 (0.959–1.044)	.97
BMI (kg m^{-2})	0.997 (0.895–1.110)	.96	1.004 (0.888–1.136)	.95
Preop HBP (yes *vs.* no)	2.501 (0.823–7.596)	.12	3.32 (0.861–12.834)	.08
Preop 6-MWT (m)	1.000 (0.995–1.005)	.99	1.001 (0.995–1.006)	.80
Pain score	0.969 (0.788–1.192)	.77	0.976 (0.749–1.270)	.85
Fatigue score	1.004 (0.818–1.232)	.97	1.000 (0.768–1.302)	.99
Duration of anaesthesia (min)	1.007 (0.997–1.1016)	.17	1.006 (0.995–1.017)	.30
Type of surgery (BAR *vs.* CR)			0.474 (0.051– 4.390)	.51

Note: Pain and fatigue scores were measured during the walk test on a 0 – 10 verbal scale.

Abbreviations: 6-MWT, 6 min walk test; aOR, adjusted odds ratio; Pain and fatigue scores were measured during the walk test on a 0 – 10 verbal scale. BAR, bariatric surgery; BMI, body mass index; CI, confidence interval; CR, colorectal surgery; HBP, high blood pressure.

TABLE 5 Risk factors for inability to walk at 3 h after surgery: univariate and multivariate binary logistic regressions adjusted for the type of surgery

Variables	OR (95% CI) Inability to walk	*p*	aOR (95% CI) Inability to walk	*p*
Sex (F *vs.* M)	1.117 (0.306–4.080)	.87	0.439 (0.068–2.827)	.39
Age (year)	1.020 (0.974–1.069)	.40	1.030 (0.966–1.099)	.37
BMI (kg m^{-2})	0.962 (0.837–1.105)	.58	0.966 (0.784–1.189)	.74
Preop HBP (yes *vs.* no)	1.109 (0.0306–4.012)	.87	0.768 (0.149–3.962)	.75
Preop 6-MWT (m)	1.002 (0.996–1.008)	.51	1.002 (0.993–1.011)	.64
Pain score	0.936 (0.705–1.243)	.64	0.752 (0.502–1.126)	.17
Fatigue score	1.303 (0.925–1.836)	.13	1.502 (0.956–2.360)	.08
Duration of anaesthesia (min)	1.005 (0.995–1.016)	0.30	0.997 (0.983–1.012)	.72
Type of surgery (BAR *vs.* CR)			1.832 (0.069–48.721)	.72

Note: Pain and fatigue scores were measured during the walk test on a 0 – 10 verbal scale.
Abbreviations: 6-MWT, 6 min walk test; aOR, adjusted odds ratio; BAR, bariatric surgery; CI, confidence interval. BMI, body mass index; CR, colorectal surgery; HBP, high blood pressure.

much as those reported in other colorectal studies without ERP.[22,23] Finally, our walk tests were standardised[16] and supervised by only two physiotherapists to reduce variability in test performance.

Our study had several limitations. First, we did not monitor arterial blood pressure during rising and the walk tests. Although the pathophysiology of OI frequently includes postoperative autonomic dysregulation and decreased vasopressor response with reduced cerebral perfusion,[7] postoperative orthostatic hypotension and OI are not always associated.[9,24,25] Consequently, Eriksen et al. considered OI may be the most clinically relevant parameter for investigating postoperative orthostatism.[9] Second, we did not record postoperative opioid consumption, considered a potential predisposing factor for postoperative OI.[6,19] Pain scores during the walk tests were, however, assessed and were similar in orthostatic-tolerant and -intolerant patients, and in patients able and unable to walk. Finally, we did not measure perioperative intravenous fluid to eliminate possible hypovolaemia. Intravenous fluid was administered following the same protocol in all the patients. However, even goal-directed fluid therapy in patients undergoing open prostatectomy did not affect postoperative OI. Due to the small sample size, the number of events per covariate could be too small to obtain strong results for multivariate statistical analyses. However, we considered the conclusions as reliable since the multivariate analyses provide the same results as the univariate analyses.

In conclusion, this study confirms that OI is frequent after abdominal surgery despite optimisation of the ERP to minimise the impact of potential contributing factors. However, OI does not prevent most of these patients from walking, but reduces by one-third the distance covered the day of surgery. A physiotherapist to encourage and coach patients during ambulation plays probably a major role in facilitating early walking. Our findings suggest that orthostatic disabilities can last up to the day after surgery and result in a more difficult postoperative course, and so might prolong LOS. We were unable to isolate a single risk factor for OI and the inability to walk.

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CONFLICTS OF INTEREST

The authors declare they have no competing interests.

AUTHOR CONTRIBUTIONS

PYH and AT contributed equally to study design, patient recruitment, data collection and data analysis. SJ and MHB: study design, patient recruitment, data collection, data analysis. JM: statistical analysis and data analysis. LK and AH: patient recruitment and data analysis. JJ: study design, patient recruitment, data collection, statistical analysis, data analysis and the first draft of the paper. All the authors revised critically the draft, gave final approval of the version to be published and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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