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CLINICAL RESEARCH

Early mobilization after total hip or knee arthroplasty: a substudy of the POWER.2 study

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Local anesthesia

Abstract
Background: Early mobilization after surgery is a cornerstone of the Enhanced Recovery After Surgery (ERAS) programs in total hip arthroplasty (THA) or total knee arthroplasty (TKA). Our goal was to determine the time to mobilization after this surgery and the factors associated with early mobilization.
Methods: This was a predefined substudy of the POWER.2 study, a prospective cohort study conducted in patients undergoing THA and TKA at 131 Spanish hospitals. The primary outcome was the time until mobilization after surgery as well as determining those perioperative factors associated with early mobilization after surgery.

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Results: A total of 6093 patients were included. The median time to achieve mobilization after the end of the surgery was 24 hours [16–30]. 4,222 (69.3%) patients moved in $\leq$ 24 hours after surgery. Local anesthesia [OR = 0.80 (95% confidence interval [CI]: 0.72–0.90); p = 0.001], surgery performed in a self-declared ERAS center [OR = 0.57 (95% CI: 0.55–0.60); p < 0.001], mean adherence to ERAS items [OR = 0.93 (95% CI: 0.92–0.93); p < 0.001], and preoperative hemoglobin [OR = 0.97 (95% CI: 0.96–0.98); p < 0.001] were associated with shorter time to mobilization.

Conclusions: Most THA and TKA patients mobilize in the first postoperative day, early time to mobilization was associated with the compliance with ERAS protocols, preoperative hemoglobin, and local anesthesia, and with the absence of a urinary catheter, surgical drains, epidural analgesia, and postoperative complications. The perioperative elements that are associated with early mobilization are mostly modifiable, so there is room for improvement.

Introduction

Primary total hip arthroplasty (THA) is projected to grow 71%, to 635,000 procedures by 2030 and primary total knee arthroplasty (TKA) is projected to grow 85%, to 1.26 million procedures by 2030 in the USA.[1] As this implies an increase in health expenditure, in recent years the THA and TKA process has been focused as a short or ultra-short stay process, and has adhered to the principles of Enhanced Recovery After Surgery (ERAS), whose aim is to improve patient recovery in order to shorten length of stay (LOS) without increasing complications or readmissions.[2] Vendittoli et al. recently demonstrated that the implementation of a short-stay ERAS protocol was associated to a significant reduction in the complication rate by 50% when achieving ambulatory THA and < 24 hours LOS for TKA.[3] Early function and mobilization are key factors for success of a short stay program, and recent ERAS guidelines recommend that patients should be mobilized as soon as possible following surgery.[4] As perioperative care continues to become more expedited and health systems aim to implement programs to speed recovery and reduce costs, it is important to identify barriers to early mobilization. In addition to reducing LOS,[5] early mobilization programs integrated in ERAS protocols reduce postoperative complications. The POWER.2 study[6] showed that patients treated in self-declared ERAS centers, and who had multidisciplinary clinical pathways for THA/TKA had fewer postoperative complications and shorter LOS; in addition, postoperative complications were inversely related to adherence to the perioperative ERAS items. Importantly, patients who were mobilized early had significantly fewer complications.[6]

Although mobilization during the postoperative period is related to the center where the THA/TKA procedure is performed,[3] there are additional factors. Early mobilization can be considered both as an outcome and as a perioperative item within the ERAS program. The main goal of this substudy was to determine factors associated with an early mobilization after surgery.

Methods

Study design and participants

The POWER.2 study was a prospective 2-month multicenter cohort study. The study was approved by the Instituto Aragonés de Ciencias de la Salud Ethics Committee (Zaragoza, Spain) (C.P.–C.I. PI18/135; on 23 May 2018), and by the Spanish Medical Agency, and was registered prospectively in an international trial registry (NCT03570944). The study protocol[7] and the main results have been published.[6] Ethics committees or institutional review boards at each site reviewed and approved the protocol. Written informed consent was obtained from all participants. This Substudy is reported in accordance with the ''Strengthening the Reporting of Observational Studies in Epidemiology'' (STROBE).[8]

Participants

Inclusion and exclusion criteria were previously described. In brief, patients were eligible for inclusion if they were 18 years old or older and undergoing elective primary THA or TKA – regardless of whether they were treated in a self-declared ERAS center or not – and were recruited during a single period of two months between October and December 2018 in each participating center. Individual data on 16 ERAS items were collected prospectively for each patient. The definition of the individual ERAS components was based on the EM Soffin and JT YaDeau recommendations.[9]

Data included patient characteristics (American Society of Anesthesiologists – ASA physical status, age, sex, smoking status, body mass index, Rockwood clinical frailty score,[10] and comorbidities), procedure performed, surgical approach, perioperative interventions, ERAS items adherence and outcomes (including postoperative complications, time to achieve targeted mobility, LOS, and 30-day mortality). Complications were defined and graded as mild, moderate, or severe according to international recommendations, and were included if occurring within 30 days after surgery. Data validation was conducted by specific validators at each site.

Outcomes

The primary outcome for this substudy was the time until mobilization after surgery (i.e., time when patients walked, including any partial or full weight-bearing activities such as walking on the spot, bed-to-chair and bed-to-toilet) as well as determining those perioperative factors associated with early mobilization after surgery.

Statistical analysis

Simple descriptive statistics, including means, medians, quartiles, and proportions, were used to describe the overall and TKA-THA cohorts. The discrete and continuous variables were described as number and percentage and median (interquartile range [IQR]), and their differences analyzed using the Fisher exact or Pearson and Wilcoxon Rank sum tests. For exploratory purposes we split the cohort in patients who moved less than 24 hours after surgery and those who did it after this period.

Statistical methods that allowed simultaneous consideration of multiple factors with an outcome of interest were used to identify associations between covariates and mobilization outcomes. Quasi-Poisson regression was used as the primary outcome was count data. All patient and surgery related variables were included in regression analysis: age (divided into quartiles), body mass index (BMI) (according to categories used to grade obesity [< 25 kg.m^{-2}, 25−29.9 kg.m^{-2}, 30−34.9 kg.m^{-2} and > 35 kg.m^{-2}]), ASA physical status, frailty score, comorbidities, preoperative hemoglobin, preoperative creatinine, general anesthesia, spinal or epidural block, regional nerve block, local anesthesia, urinary drain, time of surgery, drains, red blood cell (RBC) transfusion, bleeding, tranexamic acid administration, compliance with the ERAS individual items, presence of ERAS protocol, postoperative hemoglobin, postoperative complications, postoperative level of care, postoperative red blood cell transfusion, and LOS. This analysis was performed for the THA and TKA subgroups. Age was categorized into quartiles to provide more clinically meaningful information, as statistical analysis calculated the risk ratio (RR) to determine the quantitative effects of each covariate. As age is normally a continuous variable, the RR would refer to an increment of one single year, which is less meaningful in a clinical setting. Similar reasons applied to categorizing other numerical variables, such as BMI, for statistical analysis.

Independent variables individually associated with the outcome with a p-value of < 0.05 on univariate analysis were selected for a multivariable regression model. A two-tailed p-value of < 0.05 was considered significant. OR was calculated in the multivariable regression with 95% confidence intervals (CI) to determine the quantitative effects of each covariate. THA and TKA patients were analyzed separately. We analyzed the variables associated with early mobilization (defined as equal or less than 24 hours) or delayed (greater than 24 hours) by means of a logistical univariate analysis including demographic characteristics, surgery, adherence to ERAS protocol, and postoperative journey.

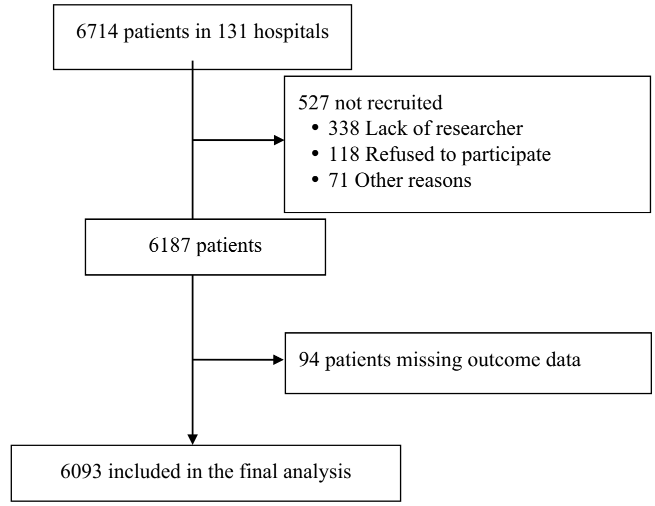

Figure 1 CONSORT flow diagram for included patients.

All analysis were performed using the R software packages. A p-value < 0.05 was considered as statistically significant.

Results

Participants

In POWER.2 study 6146 patients were recruited in 131 Spanish hospitals. Of these, there were complete data about their mobilization in 6093, which were analyzed in this substudy (Fig. 1).

Of the patients, 2280 (37.4%) underwent THA, while 3813 (62.6%) underwent TKA. According to the hospitals where the surgery was performed, 1558 patients (25.6%) were treated in self-proclaimed ERAS centers. The median compliance with the ERAS items was 8 (7−10 IQR), the majority of patients 4101 (67.3%) had ASA physical status II; the median frailty was 3 (2−3). The median preoperative hemoglobin was 14 g.dL^{-1} (13.1−15 IQR). Most patients received spinal anesthesia 5629 (92.4%). 673 (11%) patients had postoperative complications and the median hospital stay was 4 days (3−6) (Table 1).

Outcome data

The median time to achieve mobilization after the end of the surgery was 24 hours (16−30). 4222 (69.3%) patients moved in the first 24 hours after surgery, while 1871 (30.7%) moved after the first 24 hours. 1538 (67.5%) patients undergoing THA and 2684 (70.4%) undergoing TKA moved in the first 24 hours after surgery.

Factors associated with early mobilization

Patient characteristics, surgical and anesthetic factors, and compliance with ERAS items associated with time to mobilization on uni or multivariate analysis are shown in Table 2. For the entire cohort, local anesthesia [OR = 0.80 (95% confidence interval [CI]: 0.72−0.90); $p = 0.001$] and surgery

Table 1 Baseline characteristics of patients.

	[ALL] n = 6093	THA n = 2280	TKA n = 3813
Age n, %			
(18,63)	1535 (25.2%)	894 (39.2%)	641 (16.8%)
(63,71)	1762 (28.9%)	540 (23.7%)	1222 (32.0%)
(71,76)	1324 (21.7%)	377 (16.5%)	947 (24.8%)
(76,95)	1472 (24.2%)	469 (20.6%)	1003 (26.3%)
Sex n, %			
Female	3556 (58.4%)	1035 (45.4%)	2521 (66.1%)
Male	2537 (41.6%)	1245 (54.6%)	1292 (33.9%)
BMI $kg.m^{-2}$, n, %			
(15.9,25)	921 (15.5%)	517 (23.3%)	404 (10.9%)
(25,30)	2341 (39.5%)	955 (43.0%)	1386 (37.4%)
(30,35)	1787 (30.1%)	526 (23.7%)	1261 (34.0%)
(35,110)	883 (14.9%)	224 (10.1%)	659 (17.8%)
ASA Score n, %			
ASA I	388 (6.4%)	233 (10.2%)	155 (4.1%)
ASA II	4101 (67.3%)	1486 (65.2%)	2615 (68.6%)
ASA III	1561 (25.6%)	534 (23.4%)	1027 (26.9%)
ASA IV	42 (0.7%)	26 (1.1%)	16 (0.4%)
Ex-smoker n, %	996 (16.4%)	425 (18.7%)	571 (15.0%)
Smoker n, %	695 (11.4%)	375 (16.5%)	320 (8.4%)
Frailty median, IQR	3.0 [2.0;3.0]	3.0 [2.0;3.0]	3.0 [3.0;4.0]
Hypertension n, %	3614 (72.8%)	1126 (67.5%)	2488 (75.5%)
Ischemic heart disease n, %	356 (7.2%)	117 (7.0%)	239 (7.3%)
Heart failure n, %	156 (2.6%)	56 (2.5%)	100 (2.6%)
Cirrhosis n, %	52 (1.0%)	19 (1.1%)	33 (1.0%)
Stroke n, %	287 (5.8%)	106 (6.4%)	181 (5.5%)
Atrial fibrillation n, %	416 (6.8%)	147 (6.4%)	269 (7.1%)
COPD n, %	690 (13.9%)	261 (15.6%)	429 (13.0%)
Chronic kidney disease n, %	328 (6.6%)	102 (6.1%)	226 (6.9%)
Peripheral vasculopathy n, %	280 (4.6%)	103 (4.5%)	177 (4.6%)
Dementia n, %	66 (1.1%)	20 (0.9%)	46 (1.2%)
Preoperative hemoglobin $g.dL^{-1}$ (Median, IQR)	14.0 [13.1;15.0]	14.3 [13.3;15.2]	13.9 [13.0;14.8]
Preoperative creatinine $mg.dL^{-1}$ (Median, IQR)	0.8 [0.7;1.0]	0.8 [0.7;1.0]	0.8 [0.7;0.9]
Preoperative RBC transfusion n, %	7 (0.1%)	6 (0.3%)	1 (< 0.1%)
General anesthesia n, %	456 (7.5%)	258 (11.3%)	198 (5.2%)
Epidural anesthesia n, %	386 (6.3%)	60 (2.6%)	326 (8.5%)
Regional anesthesia n, %	925 (15.2%)	156 (6.8%)	769 (20.2%)
Local anesthesia n, %	233 (3.8%)	14 (0.6%)	219 (5.7%)
Spinal anesthesia n, %	5629 (92.4%)	2039 (89.4%)	3590 (94.2%)
Intrathecal morphine administration n, %	435 (7.7%)	158 (7.7%)	277 (7.7%)
Urinary drain n, %	1388 (22.8%)	533 (23.4%)	855 (22.4%)
Surgical drains n, %	4290 (70.4%)	1454 (63.8%)	2836 (74.4%)
Time of surgery, minutes (Median IQR)	90.0 [75.0;110.0]	90.0 [70.0;110.0]	90.0 [75.0;110.0]
Tourniquet time, minutes (Median, IQR)	80.0 [65.0;95.0]	. [.;.]	80.0 [65.0;95.0]
Intraoperative RBC transfusion n, %	60 (1.0%)	47 (2.1%)	13 (0.3%)
Bleeding, mL (Median IQR)	200.0 [100.0;350.0]	300.0 [200.0;500.0]	150.0 [50.0;300.0]
Tranexamic acid administration	4495 (74.1%)	1591 (70.2%)	2904 (76.4%)
ERAS center n, %	1558 (25.6%)	577 (25.3%)	981 (25.7%)
ERAS mean compliance (Medan, IQR)	8.0 [7.0;10.0]	8.0 [7.0;10.0]	9.0 [7.0;10.0]
Postoperative hemoglobin, $g.dL^{-1}$ (Median, IQR)	11.5 [10.5;12.5]	11.5 [10.4;12.6]	11.5 [10.6;12.5]
Postoperative complications n, %	673 (11.0%)	272 (11.9%)	401 (10.5%)
Moderate-severe postoperative complications n, %	347 (5.7%)	149 (6.5%)	198 (5.2%)
Level of care after surgery			
Ward/ Post-anesthetic care unit n, %	5692 (93.4%)	2160 (94.7%)	3532 (92.6%)

Table 1 (*Continued*)

	[ALL] n = 6093	THA n = 2280	TKA n = 3813
ICU level 1 n, %	373 (6.1%)	110 (4.8%)	263 (6.9%)
ICU level 2 n, %	28 (0.5%)	10 (0.4%)	18 (0.5%)
Postoperative RBC transfusion n, %	438 (7.2%)	209 (9.2%)	229 (6.0%)
LOS, days, (Median, IQR)	4.0 [3.0;6.0]	4.0 [3.0;6.0]	4.0 [3.0;6.0]

ASA, American Society of Anesthesiologists; BMI, Body mass index; COPD, Chronic obstructive pulmonary disease; RBC, Red blood cell; ERAS, Enhanced recovery after surgery; ICU, Intensive care unit; LOS, Length of stay; THA, total hip arthroplasty; TKA, total knee arthroplasty.

The Level of care after surgery was defined as: Surgical Ward/ Post-anesthetic care unit (Level 0): Normal ward care without Level 1 or 2 capabilities. Critical care Level 1: May include advanced cardiorespiratory monitoring (e.g., invasive arterial/central venous monitoring) and basic organ support (e.g., noninvasive ventilation and inotropic/vasoactive drug administration) Critical care Level 2: Includes advanced organ support, for example, invasive ventilation and renal replacement therapy.

performed in a self-declared ERAS center [OR = 0.57 (95% CI: 0.55−0.60); $p < 0.001$] were associated with shorter time to mobilization. In patients undergoing THA, male sex [OR = 0.94 (95% CI: 0.89−0.99); $p = 0.038$], and surgery performed in a self-declared ERAS center [OR = 0.60 (95% CI: 0.56−0.65); $p < 0.001$] were associated with shorter time to mobilization (Table 2). In the TKA subgroup, local anesthesia [OR = 0.83 (95% CI: 0.74−0.93); $p = 0.001$] and surgery performed in a self-declared ERAS center [OR = 0.55 (95% CI: 0.52−0.59); $p < 0.001$] were associated with shorter time to mobilization; on the contrary, ASA III patients, patients with vascular disease, epidural anesthesia, urinary drain, surgical drains, postoperative complications [OR = 1.28 (95% CI: 1.18−1.38); $p < 0.001$], postoperative stay at ICU level one or ICU level two, and LOS were associated with delayed mobilization (Table 2).

Stratification of the entire cohort among patients who moved before or after the first 24 hours after surgery showed that smoking, preoperative hemoglobin [OR = 0.94 (95% CI: 0.90−0.97); $p < 0.001$], local anesthesia [OR = 0.38 (95% CI: 0.26−0.54); $p < 0.001$], intraoperative tranexamic acid administration [OR = 0.70 (95% CI: 0.63−0.79); $p < 0.001$], being treated in an ERAS center [OR = 0.18 (95% CI: 0.15−0.21); $p < 0.001$], mean compliance with ERAS items [OR = 0.80 (95% CI: 0.78−0.82); $p < 0.001$], and postoperative hemoglobin [OR = 0.91 (95% CI: 0.88−0.94); $p < 0.001$] were significantly associated with early mobilization (< 24 hours) (Table 3). In the subgroup of patients who underwent THA, men [OR = 0.77 (95% CI: 0.65−0.92); $p < 0.001$], a BMI of 25−30 [OR = 0.76 (95% CI: 0.60−0.95); $p < 0.001$], preoperative hemoglobin, administration of tranexamic acid, belonging to a self-declared ERAS center [OR = 0.17 (95% CI: 0.13−0.23); $p < 0.001$], the median compliance with ERAS, and postoperative hemoglobin were the variables significantly associated with early mobilization (Table 3); while other variables detailed in Table 3 were associated with an increase in hours up to mobilization after surgery. In the TKA subgroup of patients, local anesthesia [OR = 0.39 (95% CI: 0.26−0.56); $p < 0.001$], preoperative hemoglobin, administration of tranexamic acid, belonging to a self-declared ERAS center, the median compliance with ERAS [OR = 0.79 (95% CI: 0.77−0.88); $p < 0.001$], were significantly associated with early mobilization (Table 3).

The distribution of the entire cohort and the time to mobilization according to whether or not they belonged to an ERAS center is shown in Figure 2. Figure 3 shows the distribution of patients and their mobilization according to the presence or not of postoperative complications.

Discussion

This study provides a snapshot of current practice in a large number of centers on how early mobilization is performed after THA or TKA and explores what factors may influence early or late mobilization. The median time to mobilization after the end of surgery was 24 hours, moving 69% of patients on the first 24 hours after the end of surgery.

Interestingly, being treated in an ERAS center was the factor most strongly associated with early mobilization, both in patients undergoing THA and TKA. This reflects the importance of hospital protocols, as it indicates that ERAS centers deliberately mobilized patients as soon as possible according to ERAS recommendations, while non-ERAS centers did not. In addition, with each ERAS implemented item, the time until mobilization was reduced by 7%. The median compliance with the ERAS items was 8 of the 16 items that made up the ERAS protocol evaluated in POWER.2 study. This indicates that there is room for improvement in these patients.

Contrary to previous studies in which it was found that age and ASA score were not associated with time until mobilization after THA or TKA,[3,11] our study found that there are patient related factors associated with mobilization time: in the multivariate analysis we found that a higher ASA score was associated with longer time until mobilization in all patients; in addition, patients older than 76 years, and patients with higher frailty score were unable to move on the first postoperative day. These patients, despite the improvements provided by ERAS programs, should be considered as at-risk patients, and expectations for the postoperative journey should be adjusted.

Since most patients undergoing THA/TKA can be optimized before surgery,[12] it is important to highlight the preoperative factors that influenced the time until postoperative mobilization. Although the median preoperative hemoglobin in our cohort was 14 $g.dL^{-1}$, for each increase in one gram of hemoglobin, the time to mobilization decreased by 8%. Preoperative anemia was associated with increased risk of receiving RBC transfusion during admission[13] and, similar to other studies, RBC transfusion[3,14] and anemia

Table 2 Univariate and multivariate analysis for mobilization.

Time to mobilization (hours)	ALL				THA				TKA			
		Median (IQR)	OR (uni-variable)	OR (multi-variable)		Median (IQR)	OR (uni-variable)	OR (multi-variable)		Median (IQR)	OR (uni-variable)	OR (multi-variable)
Age	[18,63]	24.00 (16.00 to 28.00)	•	•	[18,63]	24.00 (18.00 to 28.00)	•	•	[18,63]	24.00 (13.00 to 28.00)	•	•
	(63,71]	24.00 (15.00 to 30.00)	1.004 (0.962-1.048, *p* = 0.8441)	1.007 (0.962-1.055, *p* = 0.7581)	(63,71]	24.00 (18.00 to 30.00)	1.019 (0.955-1.086, *p* = 0.5764)	1.028 (0.959-1.101, *p* = 0.4435)	(63,71]	24.00 (13.00 to 30.00)	1.021 (0.960-1.086, *p* = 0.5143)	1.018 (0.956-1.083, *p* = 0.5820)
	(71,76]	24.00 (17.00 to 30.25)	1.047 (1.001-1.096, *p* = 0.0470)	1.031 (0.982-1.083, *p* = 0.2128)	(71,76]	24.00 (20.00 to 36.00)	1.103 (1.028-1.184, *p* = 0.0064)	**1.112 (1.029-1.200, *p* = 0.0069)**	(71,76]	24.00 (16.00 to 30.00)	1.049 (0.984-1.119, *p* = 0.1450)	1.016 (0.952-1.084, *p* = 0.6411)
	(76,95]	24.00 (16.00 to 32.00)	1.047 (1.001-1.094, *p* = 0.0448)	1.019 (0.971-1.071, *p* = 0.4432)	(76,95]	24.00 (20.00 to 30.00)	1.063 (0.994-1.136, *p* = 0.0726)	1.029 (0.953-1.110, *p* = 0.4708)	(76,95]	24.00 (15.00 to 34.50)	1.062 (0.997-1.132, *p* = 0.0636)	1.028 (0.963-1.098, *p* = 0.4088)
Sex	Female	24.00 (16.00 to 30.00)	•	•	Female	24.00 (20.00 to 35.50)	•	•	Female	24.00 (14.00 to 30.00)	•	•
	Male	24.00 (16.00 to 29.00)	0.971 (0.941-1.003, *p* = 0.0720)	0.973 (0.938-1.008, *p* = 0.1331)	Male	24.00 (18.00 to 28.00)	0.935 (0.890-0.982, *p* = 0.0071)	**0.941 (0.889-0.997, *p* = 0.0385)**	Male	24.00 (15.00 to 29.00)	0.976 (0.935-1.019, *p* = 0.2719)	0.970 (0.926-1.017, *p* = 0.2062)
BMI	[15.9,25)	24.00 (16.00 to 30.00)	•	•	[15.9,25)	24.00 (20.00 to 32.00)	•	•	[15.9,25)	24.00 (12.00 to 27.00)	•	•
	[25,30)	24.00 (16.00 to 30.00)	0.984 (0.939-1.032, *p* = 0.5038)	•	[25,30)	24.00 (18.00 to 28.50)	0.951 (0.893-1.014, *p* = 0.1212)	•	[25,30)	24.00 (15.00 to 30.00)	1.045 (0.973-1.123, *p* = 0.2260)	•
	[30,35)	24.00 (16.00 to 30.00)	0.980 (0.933-1.029, *p* = 0.4131)	•	[30,35)	24.00 (19.00 to 30.00)	0.958 (0.892-1.030, *p* = 0.2455)	•	[30,35)	24.00 (15.00 to 30.00)	1.041 (0.969-1.120, *p* = 0.2743)	•

Table 2 (*Continued*)

Time to mobilization (hours)	ALL				THA				TKA			
		Median (IQR)	OR (uni-variable)	OR (multi-variable)		Median (IQR)	OR (uni-variable)	OR (multi-variable)		Median (IQR)	OR (uni-variable)	OR (multi-variable)
	[35,110)	24.00 (18.00 to 36.00)	1.022 (0.966-1.082, *p* = 0.4425)	•	[35,110)	24.00 (20.00 to 36.00)	1.004 (0.916-1.100, *p* = 0.9264)	•	[35,110)	24.00 (16.00 to 36.00)	1.088 (1.005-1.178, *p* = 0.0370)	•
ASA	ASA I	24.00 (12.00 to 24.00)	•	•	ASA 1	24.00 (12.00 to 24.00)	•	•	ASA 1	22.00 (11.00 to 24.00)	•	•
	ASA II	24.00 (16.00 to 29.00)	1.135 (1.060-1.217, *p* = 0.0003)	**1.505 (1.171-1.978, *p* = 0.0022)**	ASA 2	24.00 (19.00 to 30.00)	1.149 (1.053-1.255, *p* = 0.0019)	**1.546 (1.110-2.240, *p* = 0.0148)**	ASA 2	24.00 (14.00 to 28.00)	1.161 (1.041-1.300, *p* = 0.0087)	1.442 (1.007-2.166, *p* = 0.0602)
	ASA III	24.00 (19.00 to 36.00)	1.248 (1.161-1.342, *p* < 0.0001)	**1.570 (1.219-2.068, *p* = 0.0008)**	ASA 3	24.00 (23.00 to 36.00)	1.261 (1.147-1.388, *p* < 0.0001)	**1.643 (1.174-2.389, *p* = 0.0061)**	ASA 3	24.00 (18.00 to 36.00)	1.280 (1.143-1.438, *p* < 0.0001)	**1.490 (1.038-2.242, *p* = 0.0417)**
	ASA IV	24.00 (24.00 to 48.00)	1.409 (1.170-1.684, *p* = 0.0002)	**1.587 (1.170-2.183, *p* = 0.0036)**	ASA 4	26.00 (24.00 to 48.00)	1.411 (1.122-1.753, *p* = 0.0025)	**1.606 (1.084-2.443, *p* = 0.0219)**	ASA 4	24.00 (24.00 to 36.00)	1.402 (1.020-1.882, *p* = 0.0303)	1.510 (0.945-2.466, *p* = 0.0908)
Ex-smoker	Exsmoker	24.00 (16.00 to 30.00)	0.987 (0.946-1.030, *p* = 0.5544)	•	Exsmoker	24.00 (18.00 to 30.00)	0.990 (0.928-1.055, *p* = 0.7527)	•	Exsmoker	24.00 (15.00 to 28.00)	0.975 (0.921-1.033, *p* = 0.3941)	•
Smoker		24.00 (16.00 to 26.00)	0.948 (0.901-0.997, *p* = 0.0387)	•		24.00 (18.00 to 28.00)	0.928 (0.865-0.994, *p* = 0.0343)	•		24.00 (15.00 to 26.00)	0.947 (0.878-1.020, *p* = 0.1518)	•
Frailty	[1,8]	24.00 (16.00 to 30.00)	1.017 (1.001-1.033, *p* = 0.0352)	0.998 (0.980-1.015, *p* = 0.7967)	[1,7]	24.00 (18.00 to 30.00)	1.040 (1.017-1.062, *p* = 0.0005)	1.010 (0.983-1.036, *p* = 0.4767)	[1,8]	24.00 (14.00 to 30.00)	1.000 (0.979-1.022, *p* = 0.9707)	0.985 (0.961-1.008, *p* = 0.1963)
Hypertension		24.00 (16.00 to 30.00)	1.027 (0.988-1.068, *p* = 0.1841)	•		24.00 (20.00 to 30.00)	0.983 (0.926-1.043, *p* = 0.5626)	•		24.00 (15.00 to 30.00)	1.066 (1.013-1.122, *p* = 0.0148)	•

Table 2 (*Continued*)

Time to mobilization (hours)	ALL			THA			TKA		
	Median (IQR)	OR (uni-variable)	OR (multi-variable)	Median (IQR)	OR (uni-variable)	OR (multi-variable)	Median (IQR)	OR (uni-variable)	OR (multi-variable)
Ischemic heart disease	24.00 (20.75 to 36.00)	1.086 (1.017-1.157, *p* = 0.0125)	1.011 (0.950-1.074, *p* = 0.7360)	24.00 (24.00 to 36.00)	1.113 (1.001-1.234, *p* = 0.0452)	1.018 (0.920-1.125, *p* = 0.7248)	24.00 (20.00 to 36.00)	1.072 (0.987-1.162, *p* = 0.0934)	1.018 (0.941-1.099, *p* = 0.6565)
Heart Failure	24.00 (18.00 to 31.25)	1.059 (0.960-1.164, *p* = 0.2444)	•	24.00 (18.00 to 28.25)	1.008 (0.857-1.176, *p* = 0.9221)	•	24.00 (17.50 to 36.00)	1.091 (0.964-1.228, *p* = 0.1614)	•
Cirrhosis	24.00 (19.75 to 28.00)	0.965 (0.809-1.141, *p* = 0.6880)	•	24.00 (20.00 to 28.00)	0.850 (0.630-1.117, *p* = 0.2652)	•	24.00 (19.00 to 36.00)	1.033 (0.827-1.271, *p* = 0.7656)	•
Stroke	24.00 (18.50 to 36.00)	1.044 (0.970-1.121, *p* = 0.2476)	•	24.00 (22.25 to 45.00)	1.070 (0.956-1.195, *p* = 0.2331)	•	24.00 (18.00 to 36.00)	1.024 (0.931-1.124, *p* = 0.6237)	•
Atrial Fibrillation	24.00 (18.00 to 36.00)	1.071 (1.008-1.137, *p* = 0.0253)	0.992 (0.936-1.052, *p* = 0.7969)	24.00 (21.00 to 42.00)	1.068 (0.968-1.176, *p* = 0.1822)	0.964 (0.877-1.058, *p* = 0.4398)	24.00 (17.00 to 36.00)	1.075 (0.995-1.159, *p* = 0.0647)	1.004 (0.932-1.080, *p* = 0.9154)
CPOD	24.00 (18.00 to 28.00)	1.012 (0.963-1.063, *p* = 0.6246)	•	24.00 (20.00 to 28.00)	1.007 (0.932-1.087, *p* = 0.8511)	•	24.00 (17.00 to 28.00)	1.011 (0.948-1.078, *p* = 0.7386)	•
Chronic kidney disease	24.00 (17.75 to 36.00)	1.047 (0.978-1.120, *p* = 0.1845)	1.054 (0.988-1.124, *p* = 0.1097)	24.00 (24.00 to 47.50)	1.173 (1.050-1.305, *p* = 0.0042)	1.105 (0.993-1.225, *p* = 0.0630)	24.00 (12.00 to 36.00)	0.990 (0.907-1.078, *p* = 0.8116)	1.044 (0.961-1.131, *p* = 0.3057)
Peripheral vascular disease	24.00 (19.75 to 37.00)	1.092 (1.016-1.173, *p* = 0.0155)	1.062 (0.994-1.134, *p* = 0.0713)	24.00 (24.00 to 29.50)	1.019 (0.905-1.144, *p* = 0.7496)	0.985 (0.885-1.094, *p* = 0.7864)	24.00 (18.00 to 48.00)	1.138 (1.039-1.245, *p* = 0.0050)	**1.097 (1.009-1.191, *p* = 0.0282)**
Dementia	24.00 (12.00 to 29.50)	0.947 (0.808-1.102, *p* = 0.4919)	•	25.50 (24.00 to 31.50)	1.112 (0.857-1.413, *p* = 0.4067)	•	24.00 (12.00 to 24.00)	0.877 (0.715-1.062, *p* = 0.1924)	•

Table 2 (*Continued*)

Time to mobilization (hours)	ALL				THA				TKA			
		Median (IQR)	OR (uni-variable)	OR (multi-variable)		Median (IQR)	OR (uni-variable)	OR (multi-variable)		Median (IQR)	OR (uni-variable)	OR (multi-variable)
Preoperative hemoglobin ($g.dL^{-1}$)	[8,18.7]	24.00 (16.00 to 30.00)	0.981 (0.970-0.992, *p* = 0.0006)	0.999 (0.986-1.012, *p* = 0.8374)	[8,18.7]	24.00 (19.00 to 30.00)	0.971 (0.956-0.987, *p* = 0.0004)	1.004 (0.984-1.024, *p* = 0.7258)	[8.7,18.7]	24.00 (15.00 to 30.00)	0.985 (0.971-1.000, *p* = 0.0528)	0.998 (0.981-1.014, *p* = 0.7811)
Preoperative Creatinine ($mg.dL^{-1}$)	[0.15,14.3]	24.00 (16.00 to 30.00)	1.035 (0.990-1.077, *p* = 0.1071)	•	[0.28,3.72]	24.00 (18.00 to 30.00)	1.065 (0.966-1.173, *p* = 0.2024)	•	[0.15,14.3]	24.00 (14.00 to 30.00)	1.028 (0.976-1.076, *p* = 0.2584)	•
Preoperative RBT transfusion		48.00 (48.00 to 48.50)	1.860 (1.300-2.561, *p* = 0.0003)	1.216 (0.870-1.654, *p* = 0.2329)		48.00 (48.00 to 48.75)	2.088 (1.471-2.859, *p* < 0.0001)	1.344 (0.961-1.837, *p* = 0.0736)		2.00 (2.00 to 2.00)	0.078 (NA-1.050, *p* = 0.2624)	0.070 (0.000-0.792, *p* = 0.1898)
General anesthesia		24.00 (18.00 to 30.00)	1.032 (0.973-1.093, *p* = 0.2953)	•		24.00 (19.00 to 29.50)	0.994 (0.919-1.074, *p* = 0.8813)	•		24.00 (17.00 to 36.00)	1.054 (0.963-1.151, *p* = 0.2467)	•
Epidural anesthesia		31.00 (24.00 to 48.00)	1.433 (1.357-1.512, *p* < 0.0001)	1.271 (1.203-1.343, *p* < 0.0001)		30.00 (24.00 to 48.00)	1.434 (1.258-1.627, *p* < 0.0001)	**1.362 (1.177-1.568, *p* < 0.0001)**		31.00 (24.00 to 48.00)	1.467 (1.380-1.559, *p* < 0.0001)	1.285 (1.207-1.366, *p* < 0.0001)
Regional anesthesia		24.00 (18.00 to 36.00)	1.016 (0.973-1.061, *p* = 0.4769)	0.981 (0.939-1.024, *p* = 0.3888)		24.00 (24.00 to 48.00)	1.168 (1.066-1.278, *p* = 0.0008)	**1.126 (1.020-1.240, *p* = 0.0171)**		24.00 (16.00 to 30.00)	0.997 (0.947-1.048, *p* = 0.8950)	0.974 (0.926-1.024, *p* = 0.3009)
Local anesthesia		7.00 (5.00 to 24.00)	0.543 (0.487-0.604, *p* < 0.0001)	**0.805 (0.722-0.894, *p* = 0.0001)**		7.00 (4.25 to 23.75)	0.547 (0.347-0.812, *p* = 0.0052)	0.862 (0.558-1.263, *p* = 0.4750)		8.00 (5.00 to 24.00)	0.549 (0.490-0.614, *p* < 0.0001)	**0.830 (0.739-0.929, *p* = 0.0014)**
Spinal anesthesia		24.00 (16.00 to 30.00)	0.933 (0.881-0.988, *p* = 0.0167)	0.976 (0.922-1.035, *p* = 0.4207)		24.00 (18.00 to 30.00)	0.959 (0.887-1.038, *p* = 0.2963)	1.062 (0.977-1.156, *p* = 0.1590)		24.00 (14.00 to 30.00)	0.921 (0.848-1.002, *p* = 0.0517)	0.952 (0.878-1.033, *p* = 0.2295)

Table 2 (*Continued*)

	ALL				THA				TKA			
Time to mobilization (hours)		Median (IQR)	OR (uni-variable)	OR (multi-variable)		Median (IQR)	OR (uni-variable)	OR (multi-variable)		Median (IQR)	OR (uni-variable)	OR (multi-variable)
Urinary drain		24.00 (22.00 to 48.00)	1.252 (1.209-1.296, *p* < 0.0001)	**1.068 (1.029-1.107, *p* = 0.0004)**		24.00 (24.00 to 48.00)	1.225 (1.160-1.293, *p* < 0.0001)	**1.070 (1.008-1.136, *p* = 0.0270)**		24.00 (20.00 to 48.00)	1.268 (1.213-1.327, *p* < 0.0001)	**1.069 (1.020-1.119, *p* = 0.0050)**
Surgical drains		24.00 (20.00 to 36.00)	1.372 (1.324-1.423, *p* < 0.0001)	**1.203 (1.158-1.249, *p* < 0.0001)**		24.00 (24.00 to 39.75)	1.377 (1.307-1.451, *p* < 0.0001)	**1.300 (1.228-1.377, *p* < 0.0001)**		24.00 (18.00 to 36.00)	1.395 (1.328-1.467, *p* < 0.0001)	**1.163 (1.105-1.224, *p* < 0.0001)**
Time of surgery (minutes)	[30,300]	24.00 (16.00 to 30.00)	1.002 (1.002-1.003, *p* < 0.0001)	**1.001 (1.000-1.001, *p* = 0.0415)**	[30,270]	24.00 (18.00 to 30.00)	1.002 (1.001-1.003, *p* < 0.0001)	1.001 (1.000-1.001, *p* = 0.1544)	[35,300]	24.00 (15.00 to 30.00)	1.002 (1.002-1.003, *p* < 0.0001)	1.001 (1.000-1.001, *p* = 0.0688)
RBC transfusion		24.00 (12.00 to 48.00)	1.242 (1.074-1.427, *p* = 0.0028)	1.089 (0.940-1.255, *p* = 0.2445)		24.00 (24.00 to 48.00)	1.351 (1.160-1.562, *p* = 0.0001)	1.068 (0.910-1.247, *p* = 0.4103)		6.00 (4.00 to 21.00)	0.717 (0.462-1.051, *p* = 0.1106)	0.930 (0.629-1.316, *p* = 0.6986)
Bleeding (mL)	[0,2640]	24.00 (17.00 to 32.00)	1.000 (1.000-1.000, *p* = 0.7483)	•	[0,2640]	24.00 (20.00 to 31.00)	1.000 (1.000-1.000, *p* = 0.5721)	•	[0,1800]	24.00 (15.00 to 36.00)	1.000 (1.000-1.000, *p* = 0.0938)	•
Tranexamic acid administration		24.00 (15.00 to 28.00)	0.898 (0.868-0.930, *p* < 0.0001)	1.015 (0.978-1.053, *p* = 0.4369)		24.00 (18.00 to 30.00)	0.896 (0.850-0.944, *p* < 0.0001)	1.030 (0.973-1.091, *p* = 0.3122)		24.00 (14.00 to 28.00)	0.906 (0.865-0.949, *p* < 0.0001)	1.014 (0.967-1.063, *p* = 0.5678)
ERAS center		12.00 (6.00 to 24.00)	0.540 (0.518-0.562, *p* < 0.0001)	**0.573 (0.547-0.601, *p* < 0.0001)**		16.00 (6.00 to 24.00)	0.566 (0.531-0.603, *p* < 0.0001)	**0.608 (0.564-0.654, *p* < 0.0001)**		12.00 (5.00 to 22.00)	0.524 (0.496-0.552, *p* < 0.0001)	**0.556 (0.523-0.590, *p* < 0.0001)**
ERAS adherence	[2,16]	24.00 (16.00 to 30.00)	0.927 (0.922-0.933, *p* < 0.0001)	•	[2,16]	24.00 (18.00 to 30.00)	0.945 (0.936-0.954, *p* < 0.0001)	•	[2,16]	24.00 (15.00 to 30.00)	0.916 (0.908-0.923, *p* < 0.0001)	•

Table 2 (*Continued*)

Time to mobilization (hours)	ALL				THA				TKA			
		Median (IQR)	OR (uni-variable)	OR (multi-variable)		Median (IQR)	OR (uni-variable)	OR (multi-variable)		Median (IQR)	OR (uni-variable)	OR (multi-variable)
Postoperative Hemoglobin	[1,17.3]	24.00 (16.00 to 30.00)	0.969 (0.959-0.978, *p* < 0.0001)	•	[1.4,17]	24.00 (19.00 to 30.00)	0.951 (0.937-0.966, *p* < 0.0001)	•	[1,17.3]	24.00 (14.75 to 30.00)	0.980 (0.968-0.993, *p* = 0.0019)	•
Postoperative complications		24.00 (24.00 to 48.00)	1.331 (1.254-1.411, *p* < 0.0001)	**1.213 (1.137-1.293, *p* < 0.0001)**		24.00 (24.00 to 48.00)	1.267 (1.158-1.383, *p* < 0.0001)	1.096 (0.985-1.217, *p* = 0.0895)		24.00 (24.00 to 48.00)	1.374 (1.269-1.484, *p* < 0.0001)	**1.281 (1.181-1.387, *p* < 0.0001)**
Level of care	Ward	24.00 (16.00 to 30.00)	•	•		24.00 (18.00 to 30.00)	•	•		24.00 (14.00 to 28.00)	•	•
	Level 1 Critical care	24.00 (24.00 to 40.00)	1.164 (1.095-1.237, *p* < 0.0001)	**1.091 (1.026-1.159, *p* = 0.0055)**		24.00 (24.00 to 36.00)	1.146 (1.028-1.274, *p* = 0.0130)	1.065 (0.952-1.188, *p* = 0.2624)		24.00 (20.00 to 40.00)	1.181 (1.096-1.271, *p* < 0.0001)	**1.113 (1.033-1.198, *p* = 0.0046)**
	Level 2 critical care	28.50 (23.75 to 48.00)	1.445 (1.184-1.743, *p* = 0.0002)	**1.274 (1.035-1.548, *p* = 0.0182)**		38.00 (24.00 to 48.00)	1.534 (1.118-2.044, *p* = 0.0053)	1.252 (0.898-1.693, *p* = 0.1633)		28.50 (22.25 to 48.00)	1.396 (1.074-1.776, *p* = 0.0092)	**1.304 (0.997-1.671, *p* = 0.0435)**
Postoperative RBC transfusion		24.00 (24.00 to 48.00)	1.272 (1.204-1.343, *p* < 0.0001)	1.074 (1.010-1.142, *p* = 0.0225)		24.00 (24.00 to 48.00)	1.269 (1.174-1.369, *p* < 0.0001)	1.072 (0.974-1.179, *p* = 0.1519)		24.00 (24.00 to 48.00)	1.262 (1.168-1.362, *p* < 0.0001)	1.078 (0.994-1.167, *p* = 0.0680)
LOS	[1,30]	24.00 (16.00 to 30.00)	1.014 (1.011-1.016, *p* < 0.0001)	•	[1,30]	24.00 (18.00 to 30.00)	1.014 (1.010-1.017, *p* < 0.0001)	•	[1,30]	24.00 (14.00 to 30.00)	1.014 (1.011-1.017, *p* < 0.0001)	•

ASA, American Society of Anesthesiologists; BMI, Body mass index; COPD, Chronic obstructive pulmonary disease; RBC, Red blood cell; ERAS, Enhanced recovery after surgery; ICU, Intensive care unit; LOS, Length of stay; THA, total hip arthroplasty; TKA, total knee arthroplasty.

The Level of care after surgery was defined as: Surgical Ward/ Post-anesthetic care unit (Level 0): Normal ward care without Level 1 or 2 capabilities. Critical care Level 1: May include advanced cardiorespiratory monitoring (e.g., invasive arterial/central venous monitoring) and basic organ support (e.g., noninvasive ventilation and inotropic/vasoactive drug administration) Critical care Level 2: Includes advanced organ support, for example, invasive ventilation and renal replacement therapy.

Table 3 Postoperative mobilization after surgery grouped by time after mobilization.

	All			THA				TKA				
	≤ 24 n = 4222	> 24 n = 1871	OR	p. ratio	≤ 24 n = 1538	> 24 n = 742	OR	p. ratio	≤ 24 n = 2684	> 24 n = 1129	OR	*p*. ratio
Age												
[18,63]	1090 (25.8%)	445 (23.8%)	Ref.	Ref.	630 (41.0%)	264 (35.6%)	Ref.	Ref.	460 (17.1%)	181 (16.0%)	Ref.	Ref.
(63,71]	1239 (29.3%)	523 (28.0%)	1.03 [0.89;1.20]	0.664	367 (23.9%)	173 (23.3%)	1.13 [0.89;1.42]	0.319	872 (32.5%)	350 (31.0%)	1.02 [0.83;1.26]	0.856
(71,76]	902 (21.4%)	422 (22.6%)	1.15 [0.98;1.34]	0.095	234 (15.2%)	143 (19.3%)	**1.46 [1.13;1.88]**	**0.004**	668 (24.9%)	279 (24.7%)	1.06 [0.85;1.33]	0.599
(76,95]	991 (23.5%)	481 (25.7%)	**1.19 [1.02;1.39]**	**0.029**	307 (20.0%)	162 (21.8%)	1.26 [0.99;1.60]	0.059	684 (25.5%)	319 (28.3%)	1.18 [0.95;1.47]	0.125
Sex												
Female	2435 (57.7%)	1121 (59.9%)	Ref.	Ref.	666 (43.3%)	369 (49.7%)	Ref.	Ref.	1769 (65.9%)	752 (66.6%)	Ref.	Ref.
Male	1787 (42.3%)	750 (40.1%)	0.91 [0.82;1.02]	0.102	872 (56.7%)	373 (50.3%)	**0.77 [0.65;0.92]**	**0.004**	915 (34.1%)	377 (33.4%)	0.97 [0.84;1.12]	0.679
BMI												
[15.9,25)	620 (15.2%)	301 (16.4%)	Ref.	Ref.	328 (21.9%)	189 (26.0%)	Ref.	Ref.	292 (11.2%)	112 (10.1%)	Ref.	Ref.
[25,30)	1640 (40.1%)	701 (38.1%)	0.88 [0.75;1.04]	0.128	665 (44.5%)	290 (39.9%)	**0.76 [0.60;0.95]**	**0.016**	975 (37.6%)	411 (36.9%)	1.10 [0.86;1.41]	0.455
[30,35)	1251 (30.6%)	536 (29.1%)	0.88 [0.74;1.05]	0.153	361 (24.1%)	165 (22.7%)	0.79 [0.61;1.03]	0.077	890 (34.3%)	371 (33.3%)	1.09 [0.85;1.40]	0.515
[35,110)	581 (14.2%)	302 (16.4%)	1.07 [0.88;1.30]	0.494	142 (9.5%)	82 (11.3%)	1.00 [0.72;1.39]	0.987	439 (16.9%)	220 (19.7%)	1.31 [1.00;1.72]	0.053
ASA Score												
ASA 1	293 (6.9%)	95 (5.1%)	Ref.	Ref.	176 (11.5%)	57 (7.7%)	Ref.	Ref.	117 (4.4%)	38 (3.4%)	Ref.	Ref.
ASA 2	2882 (68.3%)	1219 (65.2%)	**1.30 [1.03;1.67]**	**0.028**	1019 (66.3%)	467 (62.9%)	**1.41 [1.03;1.96]**	**0.030**	1863 (69.4%)	752 (66.6%)	1.24 [0.86;1.83]	0.256
ASA 3	1023 (24.2%)	538 (28.8%)	**1.62 [1.26;2.10]**	**< 0.001**	329 (21.4%)	205 (27.6%)	**1.92 [1.36;2.73]**	**< 0.001**	694 (25.9%)	333 (29.5%)	**1.47 [1.01;2.20]**	**0.046**
ASA 4	23 (0.5%)	19 (1.0%)	**2.54 [1.31;4.89]**	**0.006**	13 (0.8%)	13 (1.8%)	**3.07 [1.33;7.13]**	**0.009**	10 (0.4%)	6 (0.5%)	1.86 [0.59;5.43]	0.280
Ex-smoker	706 (16.7%)	290 (15.5%)	0.89 [0.77;1.04]	0.137	290 (18.9%)	135 (18.2%)	0.91 [0.72;1.15]	0.443	416 (15.5%)	155 (13.7%)	0.85 [0.70;1.04]	0.119
Smoker	503 (11.9%)	192 (10.3%)	**0.83 [0.69;0.99]**	**0.038**	268 (17.5%)	107 (14.5%)	0.78 [0.61;1.00]	0.053	235 (8.8%)	85 (7.5%)	0.83 [0.64;1.07]	0.154

Table 3 (*Continued*)

	All			THA				TKA				
	≤ 24 n = 4222	> 24 n = 1871	OR	p. ratio	≤ 24 n = 1538	> 24 n = 742	OR	p. ratio	≤ 24 n = 2684	> 24 n = 1129	OR	*p.* ratio
Frailty	3.0 [2.0;3.0]	3.0 [2.0;4.0]	**1.06 [1.01;1.12]**	**0.031**	3.0 [2.0;3.0]	3.0 [2.0;4.0]	**1.15 [1.06;1.24]**	**0.001**	3.0 [2.0;4.0]	3.0 [3.0;4.0]	1.00 [0.93;1.08]	0.963
Hypertension	2483 (72.6%)	1131 (73.3%)	1.04 [0.91;1.19]	0.566	755 (68.1%)	371 (66.4%)	0.93 [0.75;1.15]	0.481	1728 (74.7%)	760 (77.3%)	1.15 [0.97;1.38]	0.111
Ischemic heart disease	229 (6.7%)	127 (8.2%)	1.25 [1.00;1.57]	0.053	69 (6.2%)	48 (8.6%)	1.42 [0.96;2.07]	0.079	160 (6.9%)	79 (8.0%)	1.18 [0.89;1.55]	0.259
Heart failure	109 (2.6%)	47 (2.5%)	0.97 [0.68;1.37]	0.883	39 (2.5%)	17 (2.3%)	0.91 [0.50;1.59]	0.737	70 (2.6%)	30 (2.7%)	1.02 [0.65;1.56]	0.920
Cirrhosis	35 (1.0%)	17 (1.1%)	1.08 [0.59;1.92]	0.788	13 (1.2%)	6 (1.1%)	0.93 [0.32;2.39]	0.881	22 (1.0%)	11 (1.1%)	1.19 [0.55;2.42]	0.650
Stroke	196 (5.7%)	91 (5.9%)	1.03 [0.80;1.33]	0.803	67 (6.0%)	39 (7.0%)	1.17 [0.77;1.75]	0.460	129 (5.6%)	52 (5.3%)	0.95 [0.67;1.31]	0.748
Atrial fibrillation	281 (6.7%)	135 (7.2%)	1.09 [0.88;1.35]	0.424	92 (6.0%)	55 (7.4%)	1.26 [0.89;1.78]	0.196	189 (7.0%)	80 (7.1%)	1.01 [0.76;1.32]	0.955
COPD	488 (14.3%)	202 (13.1%)	0.91 [0.76;1.08]	0.274	183 (16.5%)	78 (14.0%)	0.82 [0.61;1.09]	0.176	305 (13.2%)	124 (12.6%)	0.95 [0.76;1.19]	0.659
Chronic kidney disease	219 (6.4%)	109 (7.1%)	1.11 [0.87;1.41]	0.380	59 (5.3%)	43 (7.7%)	1.48 [0.98;2.23]	0.061	160 (6.9%)	66 (6.7%)	0.97 [0.72;1.30]	0.840
Peripheral vascular disease	181 (4.3%)	99 (5.3%)	1.25 [0.97;1.60]	0.087	70 (4.6%)	33 (4.4%)	0.98 [0.63;1.48]	0.920	111 (4.1%)	66 (5.8%)	**1.44 [1.05;1.96]**	**0.025**
Dementia	45 (1.1%)	21 (1.1%)	1.06 [0.62;1.76]	0.833	9 (0.6%)	11 (1.5%)	**2.55 [1.04;6.42]**	**0.041**	36 (1.3%)	10 (0.9%)	0.67 [0.31;1.30]	0.242
Preoperative Hemoglobin	14.1 [13.2;15.0]	14.0 [13.0;14.9]	**0.94 [0.90;0.97]**	**0.001**	14.4 [13.4;15.3]	14.1 [13.0;15.0]	**0.89 [0.84;0.94]**	**<0.001**	14.0 [13.1;14.9]	13.9 [13.0;14.8]	0.97 [0.92;1.02]	0.187
Preoperative creatinine	0.8 [0.7;1.0]	0.8 [0.7;1.0]	1.06 [0.91;1.24]	0.466	0.8 [0.7;1.0]	0.8 [0.7;1.0]	1.02 [0.72;1.45]	0.924	0.8 [0.7;0.9]	0.8 [0.7;1.0]	1.07 [0.90;1.28]	0.451
Preoperative RBC	1 (< 0.1%)	6 (0.3%)	**12.15 [2.00;314.42]**	**0.005**	0 (0.0%)	6 (0.8%)	. [.;.]	.	1 (< 0.1%)	0 (0.0%)	. [.;.]	.

Table 3 (*Continued*)

	All				THA				TKA			
	≤ 24 n = 4222	> 24 n = 1871	OR	p. ratio	≤ 24 n = 1538	> 24 n = 742	OR	p. ratio	≤ 24 n = 2684	> 24 n = 1129	OR	*p.* ratio
General anesthesia	310 (7.3%)	146 (7.8%)	1.07 [0.87;1.31]	0.527	177 (11.5%)	81 (10.9%)	0.94 [0.71;1.24]	0.681	133 (5.0%)	65 (5.8%)	1.17 [0.86;1.59]	0.310
Epidural anesthesia	184 (4.4%)	202 (10.8%)	**2.66 [2.16;3.27]**	**0.000**	30 (2.0%)	30 (4.0%)	**2.12 [1.26;3.56]**	**0.005**	154 (5.7%)	172 (15.2%)	2.95 [2.35;3.72]	0.000
Regional anesthesia	614 (14.5%)	311 (16.6%)	**1.17 [1.01;1.36]**	**0.038**	93 (6.0%)	63 (8.5%)	**1.44 [1.03;2.01]**	**0.033**	521 (19.4%)	248 (22.0%)	1.17 [0.98;1.38]	0.074
Local anesthesia	199 (4.7%)	34 (1.8%)	**0.38 [0.26;0.54]**	**< 0.001**	12 (0.8%)	2 (0.3%)	0.37 [0.05;1.36]	0.147	187 (7.0%)	32 (2.8%)	**0.39 [0.26;0.56]**	**< 0.001**
Spinal anesthesia	3911 (92.6%)	1718 (91.8%)	0.89 [0.73;1.09]	0.272	1371 (89.1%)	668 (90.0%)	1.10 [0.83;1.47]	0.523	2540 (94.6%)	1050 (93.0%)	0.75 [0.57;1.00]	0.053
Intrathecal morphine	258 (6.6%)	177 (10.3%)	**1.63 [1.33;1.99]**	**< 0.001**	98 (7.1%)	60 (9.0%)	1.28 [0.91;1.79]	0.150	160 (6.3%)	117 (11.1%)	**1.86 [1.45;2.39]**	**< 0.001**
Urinary drain	827 (19.6%)	561 (30.0%)	**1.76 [1.55;1.99]**	**0.000**	311 (20.2%)	222 (29.9%)	**1.68 [1.38;2.06]**	**< 0.001**	516 (19.2%)	339 (30.0%)	**1.80 [1.54;2.11]**	**< 0.001**
Surgical drains	2802 (66.4%)	1488 (79.5%)	**1.97 [1.73;2.24]**	**0.000**	896 (58.3%)	558 (75.2%)	**2.17 [1.79;2.64]**	**< 0.001**	1906 (71.0%)	930 (82.4%)	**1.91 [1.60;2.27]**	**< 0.001**
Time of surgery	90.0 [72.0;110.0]	90.0 [75.0;120.0]	**1.01 [1.00;1.01]**	**< 0.001**	90.0 [70.0;110.0]	90.0 [75.0;118.0]	**1.01 [1.00;1.01]**	**< 0.001**	90.0 [75.0;110.0]	95.0 [80.0;120.0]	**1.01 [1.00;1.01]**	**< 0.001**
Tourniquet time	78.0 [63.0;92.0]	80.0 [68.0;99.0]	**1.01 [1.01;1.01]**	**< 0.001**	.	.	.	.	78.0 [63.0;92.0]	80.0 [68.0;99.0]	**1.01 [1.01;1.01]**	**< 0.001**
Intra-operative RBC	35 (0.8%)	25 (1.3%)	1.62 [0.96;2.71]	0.072	25 (1.6%)	22 (3.0%)	**1.85 [1.02;3.31]**	**0.041**	10 (0.4%)	3 (0.3%)	0.74 [0.16;2.46]	0.643
Bleeding	200.0 [100.0;350.0]	200.0 [100.0;350.0]	1.00 [1.00;1.00]	0.789	300.0 [200.0;500.0]	300.0 [200.0;500.0]	1.00 [1.00;1.00]	0.963	150.0 [50.0;300.0]	120.0 [50.0;300.0]	1.00 [1.00;1.00]	0.088

Table 3 (*Continued*)

	All				THA				TKA			
	≤ 24	> 24	OR	p. ratio	≤ 24	> 24	OR	p. ratio	≤ 24	> 24	OR	*p*. ratio
	n = 4222	n = 1871			n = 1538	n = 742			n = 2684	n = 1129		
Tranexamic acid administration	3203 (76.3%)	1292 (69.2%)	**0.70 [0.62;0.79]**	**< 0.001**	1108 (72.8%)	483 (65.1%)	**0.70 [0.58;0.84]**	**< 0.001**	2095 (78.4%)	809 (71.8%)	**0.70 [0.60;0.83]**	**< 0.001**
ERAS center	1406 (33.3%)	152 (8.1%)	**0.18 [0.15;0.21]**	**0.000**	517 (33.6%)	60 (8.1%)	**0.17 [0.13;0.23]**	**0.000**	889 (33.1%)	92 (8.1%)	**0.18 [0.14;0.22]**	**0.000**
ERAS mean compliance	9.0 [7.0;11.0]	8.0 [6.0;9.0]	**0.80 [0.78;0.82]**	**< 0.001**	9.0 [7.0;11.0]	7.0 [6.0;9.0]	**0.82 [0.79;0.85]**	**< 0.001**	9.0 [8.0;11.0]	8.0 [6.0;9.0]	**0.79 [0.77;0.82]**	**< 0.001**
Postoperative hemoglobin, $g.dL^{-1}$ (mean, IQR)	11.6 [10.6;12.6]	11.3 [10.3;12.4]	**0.91 [0.88;0.94]**	**< 0.001**	11.6 [10.5;12.7]	11.2 [10.0;12.3]	**0.85 [0.80;0.90]**	**< 0.001**	11.6 [10.6;12.5]	11.4 [10.4;12.4]	**0.95 [0.91;0.99]**	**0.027**
Postoperative complications	403 (9.5%)	270 (14.4%)	**1.60 [1.35;1.88]**	**< 0.001**	150 (9.8%)	122 (16.4%)	**1.82 [1.41;2.35]**	**< 0.001**	253 (9.4%)	148 (13.1%)	**1.45 [1.17;1.80]**	**0.001**
Moderate to severe postoperative complications	193 (4.6%)	154 (8.2%)	**1.87 [1.50;2.33]**	**< 0.001**	85 (5.5%)	64 (8.6%)	**1.61 [1.15;2.26]**	**0.006**	108 (4.0%)	90 (8.0%)	**2.07 [1.54;2.76]**	**< 0.001**
Postoperative care:												
Ward	3984 (94.4%)	1708 (91.3%)	Ref.	Ref.	1468 (95.4%)	692 (93.3%)	Ref.	Ref.	2516 (93.7%)	1016 (90.0%)	Ref.	Ref.
ICU level 1	227 (5.4%)	146 (7.8%)	**1.50 [1.21;1.86]**	**< 0.001**	66 (4.3%)	44 (5.9%)	1.42 [0.95;2.09]	0.087	161 (6.0%)	102 (9.0%)	**1.57 [1.21;2.03]**	**0.001**
ICU level 2	11 (0.3%)	17 (0.9%)	**3.59 [1.68;7.97]**	**0.001**	4 (0.3%)	6 (0.8%)	**3.14 [0.87;12.82]**	**0.081**	7 (0.3%)	11 (1.0%)	**3.86 [1.50;10.68]**	**0.005**
Postoperative RBC	240 (5.7%)	198 (10.6%)	**1.96 [1.61;2.39]**	**< 0.001**	106 (6.9%)	103 (13.9%)	**2.18 [1.63;2.90]**	**< 0.001**	134 (5.0%)	95 (8.4%)	**1.75 [1.33;2.29]**	**< 0.001**
LOS	4.0 [3.0;6.0]	5.0 [4.0;7.0]	**1.03 [1.02;1.04]**	**< 0.001**	4.0 [3.0;6.0]	5.0 [4.0;7.0]	**1.03 [1.01;1.04]**	**< 0.001**	4.0 [3.0;6.0]	5.0 [4.0;7.0]	**1.02 [1.01;1.04]**	**< 0.001**

ASA, American Society of Anesthesiologists; BMI, Body mass index; COPD, Chronic obstructive pulmonary disease; RBC, Red blood cell; ERAS, Enhanced recovery after surgery; ICU, Intensive care unit; LOS, Length of stay; THA, total hip arthroplasty; TKA, total knee arthroplasty.
The Level of care after surgery was defined as: Surgical Ward/ Post-anesthetic care unit (Level 0): Normal ward care without Level 1 or 2 capabilities. Critical care Level 1: May include advanced cardiorespiratory monitoring (e.g., invasive arterial/central venous monitoring) and basic organ support (e.g., noninvasive ventilation and inotropic/vasoactive drug administration) Critical care Level 2: Includes advanced organ support, for example, invasive ventilation and renal replacement therapy.

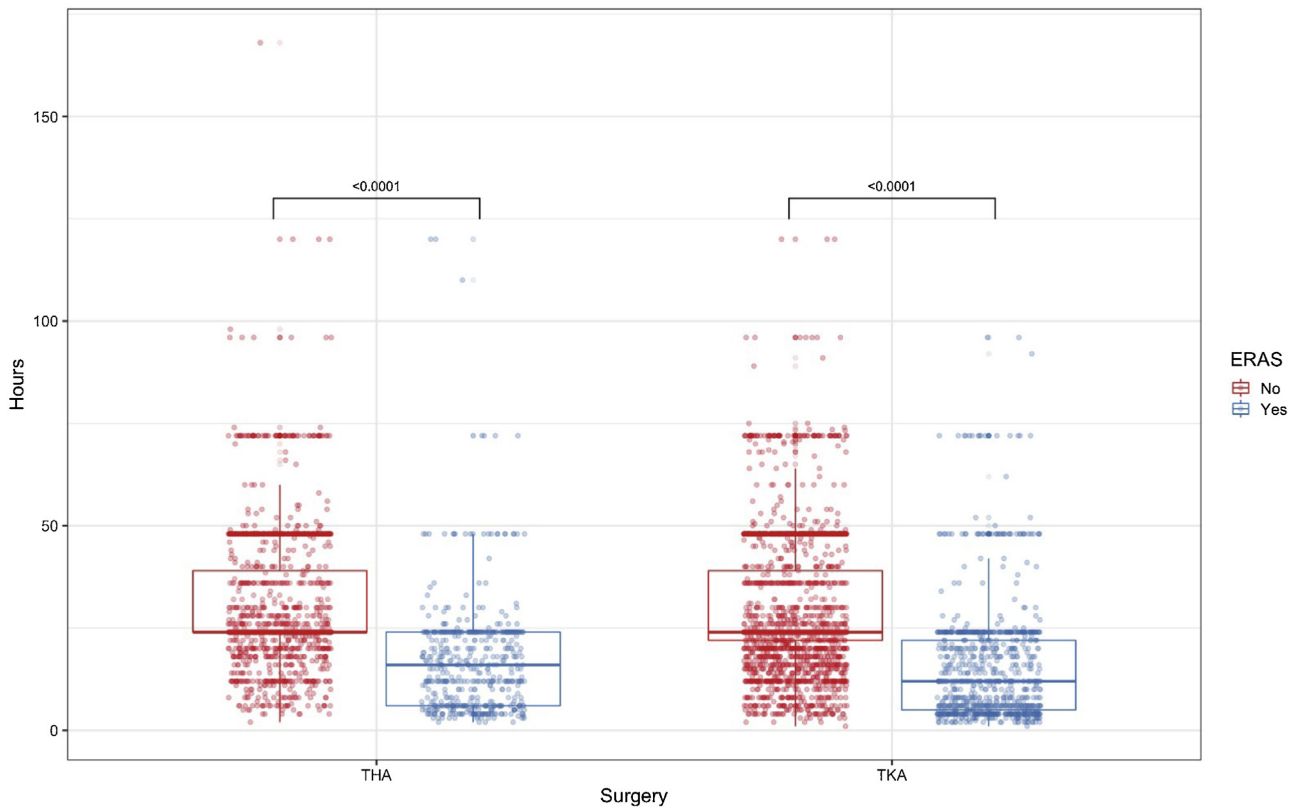

Figure 2 Distribution of hours of mobilization. ERAS, Enhanced recovery after surgery; IQR, Interquartile range; THA, total hip arthroplasty; TKA, total knee arthroplasty.
Dots represent number of hours of mobilization according to ERAS and surgery. Box lines represent median and IQR. By using quasi-poison regression, *p*-values were obtained between the ERAS and non-ERAS groups for THA and TKA.

have been associated with both delayed mobilization and postoperative complications.[6,13] Most patients undergoing THA/TKA have iron deficiency anemia[15]; however, despite international recommendations,[16] not all centers have an established Patient Blood Management program for these patients[17] in order to treat anemia before surgery.

Epidural analgesia is not frequent in THA/TKA, and it was performed in 2.6% and 8.5% of patients, respectively; however, its use was associated with an increase in time until mobilization after surgery. Nonetheless, the administration of local infiltration analgesia (LIA) was significantly associated with a decrease in hours until mobilization, both in THA and in TKA. A recent meta-analysis showed that LIA was associated with a reduction of LOS compared to epidural anesthesia finding no differences in postoperative pain in patients undergoing TKA.[18] On the contrary, the effectiveness of the LIA in patients undergoing THA is not clear, and LIA may have limited additional analgesic efficacy in THA when combined with a multimodal analgesic regimen.[19] Similarly, we found that it was the patients undergoing TKA who presented an early mobilization associated with LIA, while not those undergoing THA. LIA with administration of local anesthetic in various combinations with epinephrine, nonsteroidal anti-inflammatory drugs, opioids, steroids, or all to the wound is a simple and safe technique for the treatment of postoperative pain; despite that, its use in patients included in POWER.2 was less than 4%, mainly patients undergoing TKA, while only 14 (0.6%) patients undergoing THA received LIA, so this substudy cannot provide new evidence in these patients.

Both the use of surgical drains and urinary drains were discouraged in the ERAS guidelines,[4] and both of them were associated with an increase in hours until mobilization in POWER2. A 2019 meta-analysis showed that urinary catheterization during THA/TKA can increase postoperative urinary tract infection without reducing the incidence of postoperative urinary retention risk ratio.[20] The results of this substudy reinforce the ERAS recommendations,[21] it is logical that unselected urinary catheterization does not provide benefits and delays mobilization. Similarly, postoperative treatment in intensive care units delayed mobilization in patients in our study.

Our study has certain limitations: although LOS in several countries has been reported to be short,[22] the aim is to improve recovery to be able to go directly home and not via another institution.[23]

Our study shows that although mobilization was early in most cases, it was not related to reduced LOS, even in patients without complications (Fig. 3). Nor have we evaluated whether early mobility was associated with the participation of physiotherapists or rehabilitation physicians in the process. Finally, this study was not specifically designed to assess the causes of delayed mobilization, so there are certain circumstances such as orthostatic hypoten-

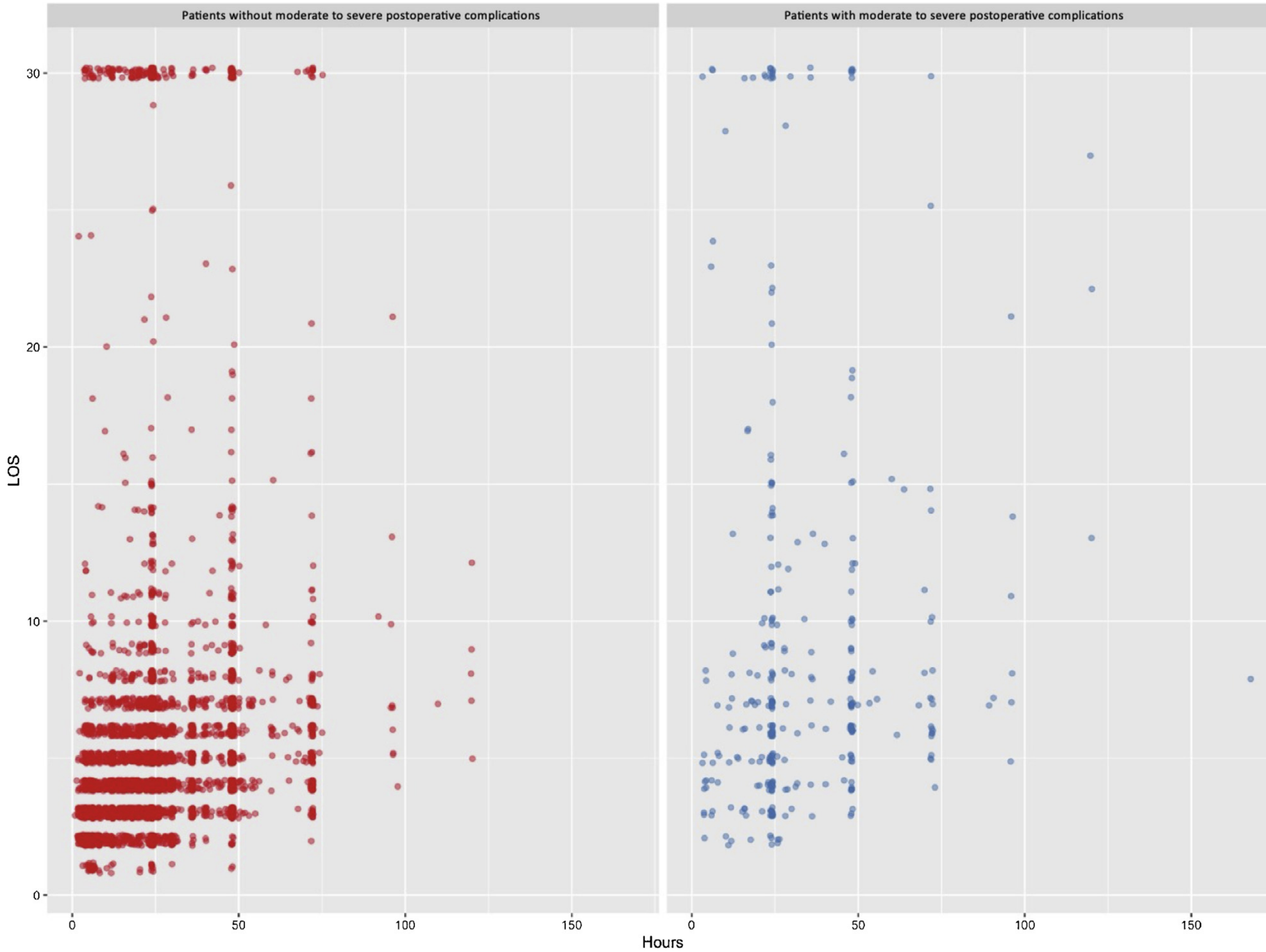

Figure 3 Scatter plot. Relation between hours of mobilization and length of stay (LOS) stratified by postoperative complications.

sion, postoperative pain or urinary retention that were not evaluated and are nonetheless important.[24]

Conclusions

The majority of patients with THA and TKA are mobilized early in Spanish hospitals. Early time to mobilization was associated with the compliance with ERAS protocols, preoperative hemoglobin and LIA, and with the absence of a urinary catheter, surgical drains, epidural analgesia and postoperative complications. The perioperative elements that are associated with early mobilization are mostly modifiable, so there is room for improvement in patients undergoing THA/TKA.

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This article is not based on a previous communication to a society or meeting.

Conflicts of interest

JRM reports personal fees from Edwards Lifesciences, Fresenius Kabi, MSD and Dextera Medical outside the submitted work; CA reports personal fees from Fresenius Kabi and Octapharma outside the submitted work; MVD reports personal fees from MSD, Pfizzer, Astellas, Ferrer y Fresenius Kabi outside the submitted work; JVL reports personal fees Edwards Lifesciences, Fresenius Kabi and Biomerieux outside the submitted work. RGF, NAE, DGR, LCM, LHB, BNA, JMRR and AAM nothing to disclose.

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We are willing to make the data, analytical methods, and study materials available to other researchers. Such material will be available upon request to the author of correspondence.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi: https://doi.org/10.1016/j.bjane.2021.05.008.

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