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ORIGINAL ARTICLE

The effects of frailty on opioid consumption after total knee arthroplasty

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Abstract

Purpose This study evaluated the effects of frailty on postoperative opioid consumption in elderly patients.

Methods Patients aged 65 and older scheduled for unilateral primary total knee arthroplasty under spinal anesthesia were included. A blinded anesthesiologist assessed patients using the FRAIL scale during the preoperative visit, classifying them into robust (Group I), pre-frail (Group II), and frail (Group III) categories. The main outcome measure was total opioid consumption over 24 h. Opioid consumption was recorded at 6 (T1), 12 (T2) and 24 (T3) hours postoperatively. Secondary outcomes included visual analog pain scores (VAS) at rest (VAS-R) and during 45° knee flexion (VAS-F), as well as postoperative nausea and vomiting.

Results Seventy-five patients were included in the study, with seventy-three completing it and two being excluded. Total opioid consumption was significantly higher in Groups II and III compared to Group I ($p < 0.001$ for both). There were no significant differences in VAS-R scores between groups at T0, T1, T2, and T3 ($p = 0.659$, $p = 0.425$, $p = 0.994$, and $p = 0.689$, respectively), and no significant differences in VAS-F scores at the same time points ($p = 0.580$, $p = 0.739$, $p = 0.322$, and $p = 0.679$, respectively).

Conclusion Our study results indicate that frailty, easily assessed preoperatively in elderly surgical patients, is a significant predictor of postoperative opioid consumption.

Keywords Acute post-surgical pain · Total knee arthroplasty · Frailty

Introduction

Aging is associated with a progressive loss of functional reserve across all physiological systems, which can lead to frailty. Frailty is a complex clinical syndrome characterized by diminished physiological reserve and increased vulnerability to stressors [1]. This condition is accompanied by a multidimensional decline in areas such as physical performance, reduced gait speed and mobility, impaired nutritional status, and cognitive dysfunctions [2]. Frailty has been identified as a significant risk factor for adverse postoperative outcomes in elderly patients, including prolonged hospital stays, neurocognitive disorders, and mortality [3–5]. Several previous studies have demonstrated a strong association between frailty and pain in older individuals [6, 7].

Total knee arthroplasty (TKA) is the primary treatment for severe pain and functional impairment caused by degenerative diseases of the knee joints and is widely performed [8]. Previous data indicate that the number of TKA procedures is steadily increasing, with nearly half of these cases involving patients over the age of 65 [9]. Postoperative pain is a significant issue in patients undergoing TKA. It is well known that postoperative pain tends to be more severe in elderly patients, making recovery more challenging [10].

While the impact of frailty on postoperative pain and other complications has been evaluated, studies assessing its relationship with postoperative opioid consumption are limited [11]. The aim of this study is to evaluate the effect of frailty on postoperative opioid consumption in geriatric patients undergoing surgeries, such as TKA, which are associated with significant postoperative pain.

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Methods

The present study was a prospective, cohort trial conducted at Selçuk University Medical Faculty Hospital. The study was approved by the institutional ethics committee of Selçuk University Medical Faculty (2019/307), and written informed consent was obtained from all patients.It has been registered with the ClinicalTrials.gov (NCT05445700).

Patients aged 65 and over who were to undergo unilateral, primary total knee arthroplasty under spinal anesthesia were included in the study. Exclusion criteria were: ASA IV and above physical status, inability to co-operate; non-Turkish speakers; and routine intake of strong opioids during the last 4 weeks.

During the preoperative visit, patients were assessed using the FRAIL scale [12] by a blinded anesthesiologist and categorized into three groups: robust (Group I), pre-frail (Group II), and frail (Group III). The FRAIL scale, consisting of 5 items (fatigue, resistance, ambulation, unintentional weight loss, and comorbidities), scores 0–1 for each item. A total score of 0 indicates robustness, 1–2 indicates pre-frailty, and > 2 indicates frailty. The FRAIL Scale has been validated in various languages, including Turkish, and proven to be an effective tool for identifying frailty [13–18].

All patients were expected to fast 6–8 h before surgery, and no one was pre-medicated. After routine monitoring (consisting of a pulse oximeter, 3-lead ECG, and a noninvasive blood pressure cuff) baseline measurements were obtained while patients were supine position. Following pre-hydration with Ringer's lactate solution 500 mL, spinal anesthesia was induced with hyperbaric bupivacaine 10–15 mg via a 25 G Quincke-tip spinal needle in the sitting position at the L3–L4 or L4–L5 vertebral level using median approach. Patients were brought into a supine position when they reached block-level T6 sensory dermatome. Oxygen (4 l/min) was administered through a facemask. Surgery was initiated when the sensory block level reached T4 sensory dermatome. Patients' demographic data (age, weight, height, BMI, comorbidities, and ASA physical status), duration of surgery, operated knee side, and intraoperative blood loss were also noted.

Following surgery, patients were attended to in the post-anesthesia care unit (PACU). All patients discharged from the PACU according to the customary guidelines practiced in the institution.

All patients received iv paracetamol 1 g every 12 h, and a patient-controlled analgesia (PCA) pump with intravenous (i.v.) morphine (bolus dose 1 mg, lockout 10 min, no background infusion). Additional morphine could be administered upon request in case of inadequate analgesia.

The primary outcome measure was 24-h total opioid consumption. Secondary outcomes of the present study were visual analog pain scores (VAS) [at rest (VAS-R) and during 45° active knee flexion (VAS-F)], and postoperative nausea and vomiting. Total opioid consumption was calculated as the sum at the end of 24 h of iv morphine doses administered with the PCA pump and administered when inadequate analgesia occurred. Opioid consumption was recorded at 6 (T1), 12 (T2) and 24 (T3) hours postoperatively. Visual analog pain scores (0–100 mm) were recorded pre-operatively (T0), and postoperative 6. (T1),12. (T2) and 24 (T3) hours.

Sample size calculation

Our study was designed with a minimum of 22 patients in each group to have a 90% power at the 95% significance level to detect a 20% change in cumulative 24-h morphine consumption as reported in the previous study [19]. Considering the possible excluded cases, 25 patients were included in each group.

Statistical analysis

The statistical analyses were performed using the Statistical Package for the Social Sciences 21.0 software (SPSS Institute, Chicago, IL, USA). Continuous data were tested for normality. Skewed data were summarized using the median and interquartile range (IQR) and were compared using Kruskal–Wallis H test. Categorical data were summarized using the number and percentage (%) and were compared using the chi-square test or Fisher's exact test. P-values below 0.05 were considered statistically significant.

Results

A total of seventy-five patients were included in the present study, seventy-three of whom completed the study, while 2 were excluded. Data analysis was performed on the three groups.

Patients' demographics and clinical characteristics are summarized in Table 1, indicating no significant differences among the three groups regarding age, gender, BMI, ASA physical status, surgery duration, intraoperative blood loss, and postoperative nausea and vomiting. ($p = 0.056$, $p = 0.217$, $p = 0.874$, $p = 0.196$, $p = 0.212$, $p = 0.755$, and $p = 0.385$, respectively).

Total opioid consumption is presented in Fig. 1. Opioid consumption at the 6th postoperative hour (T1), presented as median (IQR) [range], was as follows: in Group I; 10 (7–15) [1–20], in Group II; 13 (8–19) [4–37], and in Group III; 12 (9–17) [5–31]. In the T1 period, opioid consumption was

Table 1 Demographic and clinical characteristics of the patients

	Group I (n = 25)	Group II (n = 24)	Group III (n = 24)	p
Age, years	68.00 (66.00–70.50)	72.50 (67.25–75.00)	70.00 (67.00–75.00)	0.056
Gender, male / female	5 (20%) / 20 (80%)	6 (25%) / 18 (75%)	10 (41.7%) / 14 (58.3%)	0.217
BMI, kg/m^2	30.45 (27.34–34.56)	29.93 (27.22–33.01)	30.48 (27.34–32.60)	0.874
ASA PS, II/III	23 (92%) / 2 (8%)	19 (79.2%) / 5 (20.8%)	17 (70.8%) / 7 (29.2%)	0.196
Co-morbidity				
-Hypertension	10 (40%)	17 (70.8%)	16 (60.6%)	0.099
-Diabetes mellitus	2 (8%)	8 (33.3%)	8 (33.3%)	0.077
-COPD/Asthma	8 (32%)	8 (33.3%)	6 (25%)	0.712
-Other	11 (44%)	12 (50%)	12 (50%)	0.888
Preoperative analgesic use				NA
- NSAIDs	25 (100%)	24 (100%)	24 (100%)	
-Opiods	0	0	0	
Amount of bupivacaine used in spinal anesthesia, mg	12.5 (11.25–12.50)	12.5 (12.25–12.50)	12.5 (12.25–12.50)	0.690
Duration of surgery, min	115.00 (80.00–128.75)	122.50 (79.25–150.00)	105.00 (64.50–138.75)	0.212
Operated knee, right/left	22 (88) / 3 (12)	11 (47.8) / 12 (52.2)	9 (37.5) / 15 (62.5)	0.001
Intraoperative blood loss, ml	200 (150–240)	200 (150–200)	200 (100–250)	0.755
Postoperative nausea and vomiting	3 (12%)	3 (12.5%)	6 (25%)	0.385

ASA PS American Society of Anesthesiologists Physical Status Classification System, *COPD* Chronic obstructive pulmonary disease. Data are presented median (IQR) or n (%)

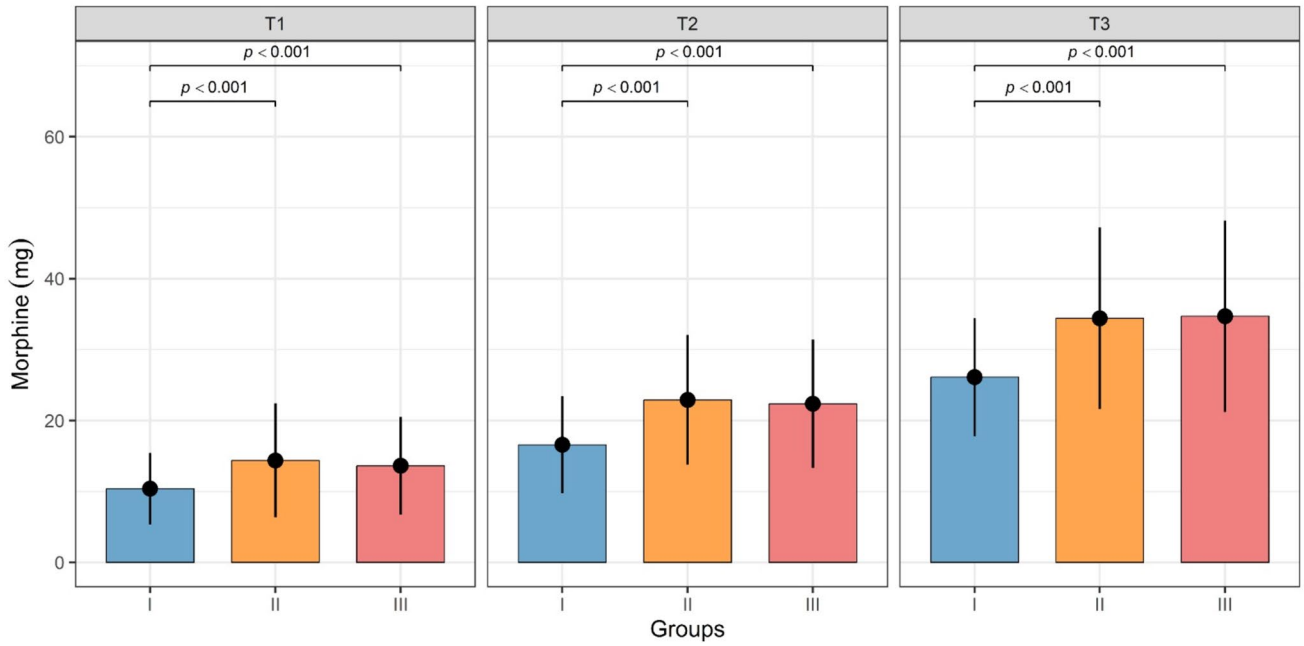

Fig. 1 The total opioid consumption at postoperative 6 (T1), 12 (T2), and 24 (T3) hours. Values are mean and 95% confidence interval

found to be significantly higher in Group II and Group III compared to Group I in the intergroup assessment (p < 0.001 and p < 0.001, respectively). Opioid consumption at the 12th postoperative hour (T2), presented as median (IQR) [range], was as follows: in Group I; 18 (10–22) [8–32], in Group II; 23 (16–28) [6–50], and in Group III; 21 (16–27) [10–50], (p = 0.018). In the T2 period, opioid consumption was found to be significantly higher in Group II and Group III compared to Group I in the intergroup assessment (p < 0.001 and p < 0.001, respectively). Total opioid consumption

(24th postoperative hour/T3/), presented as median (IQR) [range], was as follows: in Group I; 26 (18–33) [13–39], in Group II; 35 (23–43) [14–70], and in Group III; 34 (25–44) [13–65], ($p = 0.018$). Total opioid consumption was found to be significantly higher in Group II and Group III compared to Group I in the intergroup assessment ($p < 0.001$ and $p < 0.001$, respectively).

VAS-R scores are presented in Fig. 2. There was no significant difference in VAS-R scores between groups at T0, T1, T2 and T3 ($p = 0.659$, $p = 0.425$, $p = 0.994$, and $p = 0.689$, respectively). Preoperative VAS-R scores (T0), presented as median (IQR) [range], was as follows: in Group I; 40 (20–60) [0–80], in Group II; 30 (20–50) [0–70], and in Group III; 30 (20–50) [0–80]. VAS-R scores at the 6th postoperative hour (T1), presented as median (IQR) [range], was as follows: in Group I; 60 (50–75) [10–100], in Group II; 60 (50–80) [10–100], and in Group III; 50 (40–70) [10–100]. VAS-R scores at the 12th postoperative hour (T2), presented as median (IQR) [range], was as follows: in Group I; 50 (40–70) [10–90], in Group II; 55 (40–70) [0–100], and in Group III; 55 (35–70) [10–100]. VAS-R scores at the 24th postoperative hour (T3), presented as median (IQR) [range], was as follows: in Group I; 30 (20–45) [0–80], in Group II; 35 (10–50) [0–60], and in Group III; 30 (20–50) [0–100].

VAS-F scores are presented in Fig. 3. There was no significant difference in VAS-F scores between groups at T0, T1, T2 and T3 ($p = 0.580$, $p = 0.739$, $p = 0.322$, and $p = 0.679$, respectively). Preoperative VAS-F scores (T0), presented as median (IQR) [range], was as follows: in Group I; 60 (40–70) [0–90], in Group II; 60 (40–80) [0–70], and in Group III; 50 (40–60) [20–100]. VAS-F scores at the 6th postoperative hour (T1), presented as median (IQR) [range], was as follows: in Group I; 80 (60–80) [40–100], in Group II; 80 (60–100) [20–100], and in Group III; 80 (60–80) [40–100]. VAS-F scores at the 12th postoperative hour (T2), presented as median (IQR) [range], was as follows: in Group I; 70 (60–80) [20–100], in Group II; 80 (70–90) [20–100], and in Group III; 80 (60–80) [40–100]. VAS-F scores at the 24th postoperative hour (T3), presented as median (IQR) [range], was as follows: in Group I; 60 (40–70) [20–100], in Group II; 60 (40–70) [20–80], and in Group III; 60 (40–80) [20–100].

Discussion

In this study, the effects of frailty on opioid consumption following total knee arthroplasty in geriatric patients were evaluated. It was found that frail and pre-frail geriatric patients required higher postoperative opioid consumption to achieve similar pain scores compared to robust patients.

It is recommended that frailty be assessed preoperatively to improve perioperative outcomes in geriatric patients [20, 21]. Additionally, assessing frailty provides valuable insight into the likelihood of adverse events in the postoperative period [22]. However, despite these recommendations, there is limited evidence showing that frailty is routinely assessed in the preoperative period [22, 23].

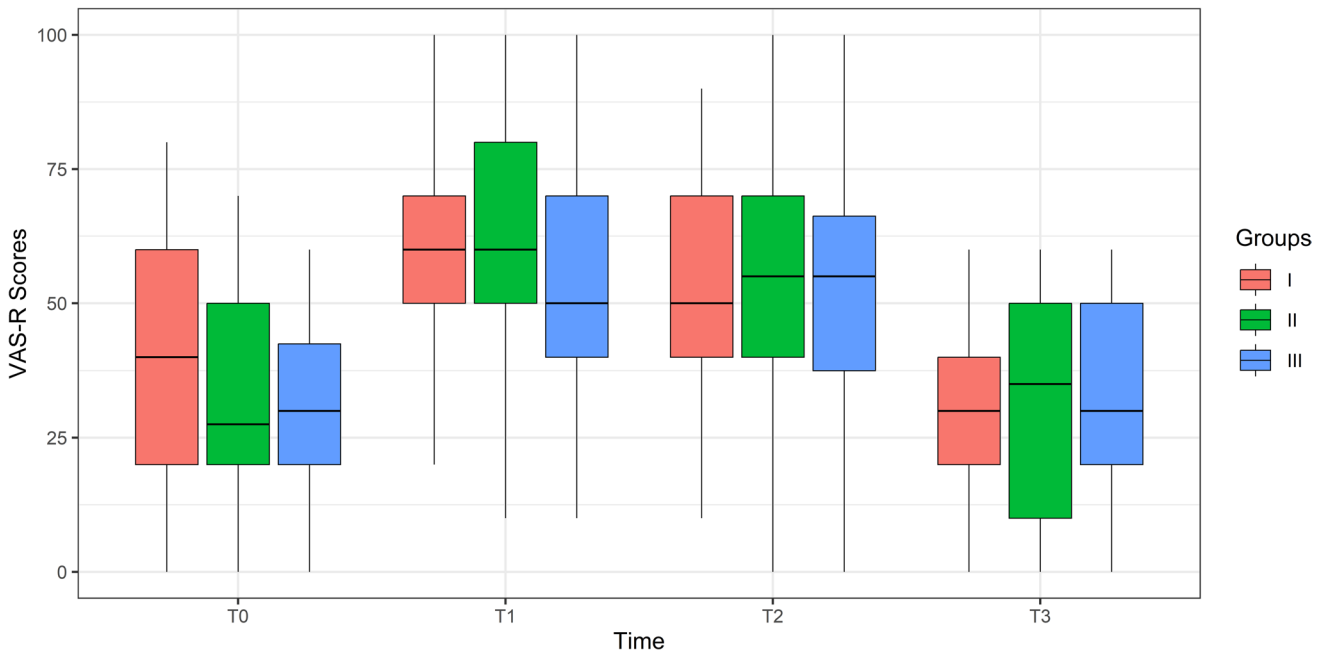

Fig. 2 VAS-R scores at pre-operatively (T0), and postoperative 6. (T1),12. (T2) and 24 (T3) hours. Values are median (horizontal bars), IQR (box) and range (whiskers)

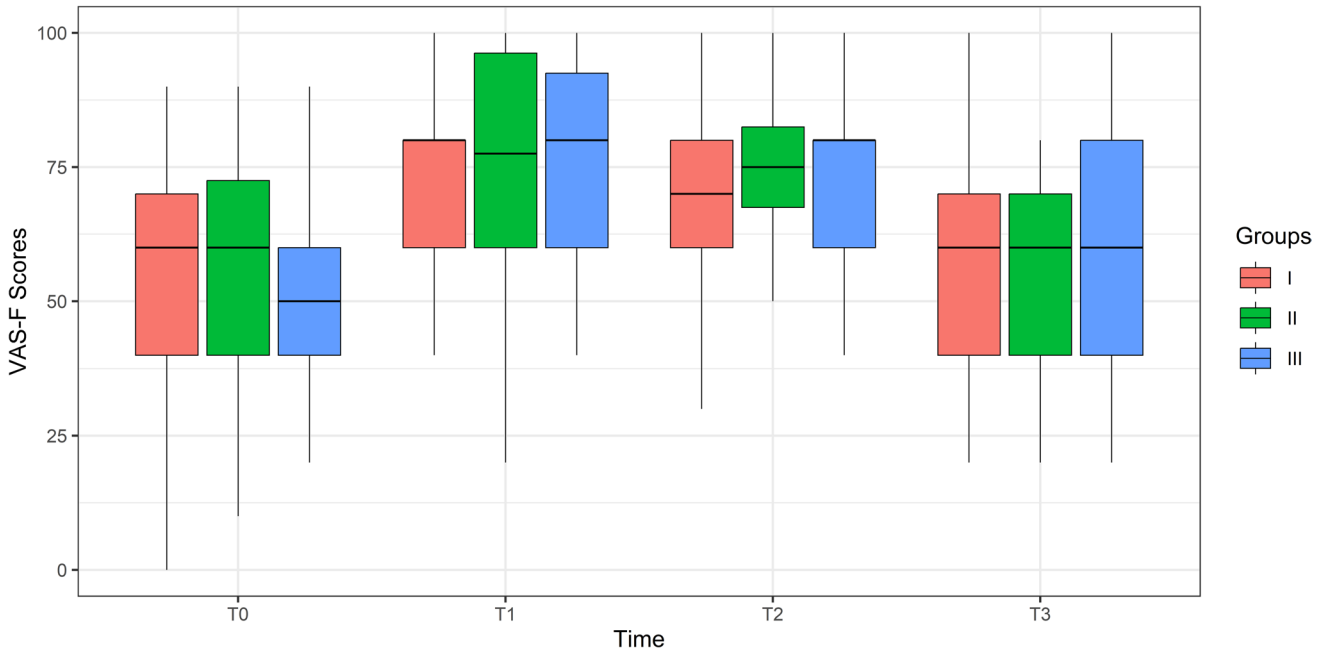

Fig. 3 VAS-F scores at pre-operatively (T0), and postoperative 6. (T1),12. (T2) and 24 (T3) hours. Values are median (horizontal bars), IQR (box) and range (whiskers)

A review of frailty-related studies in anesthesia practice reveals a predominant focus on mortality and postoperative complications [24]. Other evaluated outcomes include length of stay, quality of life, delirium, and functional decline. Despite these assessed parameters, the effects of frailty in anesthesia practice have yet to be fully understood.

Pain is one of the most common medical complaints among elderly patients, and its treatment is often inadequate. Additionally, pain management in geriatric patients is challenging due to various factors. Opioids, frequently used to alleviate severe postoperative pain, must be administered with caution in elderly patients who may have compromised renal, respiratory, and cognitive functions, and who are likely frail [25]. However, despite these concerns regarding opioid use in geriatric patients, there is a lack of sufficient studies focusing on frail individuals.

It has been shown that frail patients are more likely to experience pain at a higher frequency and intensity compared to non-frail elderly individuals [26, 27]. In our study, preoperative VAS scores (VAS-R; at rest and VAS-F; during 45° active knee flexion) were evaluated, and no significant differences were found between groups. A prospective observational study conducted by Jin et al. identified frailty as a risk factor for both acute and chronic postsurgical pain [28].

A prospective cohort study demonstrated that frail patients are inclined to use nearly all of the opioids prescribed to them during the postoperative period, whereas non-frail patients use a significantly smaller portion of their prescribed opioids [23]. Similar to the results of this study, our findings show that opioid consumption during the hospital stay is significantly higher in frail and pre-frail patients. In our hospital, the postoperative stay of patients who underwent total knee arthroplasty is between 24–36 h, provided that no complications develop. Therefore, the maximum duration selected for evaluating postoperative opioid consumption is limited to 24 h.

Consistent with our findings, a prospective cohort study conducted by Admiraal et al. in elderly patients found no difference in postoperative pain between patients with and without preoperative frailty [29].

Several potential mechanisms are thought to explain the increased opioid consumption observed in pre-frail and frail patient groups. Firstly, patients in these groups typically exhibit heightened pain sensitivity and reduced pain tolerance, which may increase their risk of experiencing more intense pain in the postoperative period [30]. Additionally, these patients often have multiple comorbidities, and their recovery process after surgery tends to be slower, both of which can contribute to a greater need for opioids [31]. The physical and psychological stress associated with frailty is also believed to exacerbate pain perception and increase opioid use [32]. We propose that these mechanisms, whether individually or in combination, contribute to the elevated postoperative opioid consumption linked to frailty, as reflected in the findings of our study.

This study has several limitations. First, we used the FRAIL scale to assess frailty. Although the FRAIL scale is

a quick and simple tool for evaluating frailty, different frailty screening tools may vary in their relationship strength and predictive accuracy for different outcomes [33]. Additionally, it is important to consider that frailty status in elderly patients may significantly change after surgery, potentially affecting postoperative pain outcomes. The study population consists of a small cohort of elective surgical patients from a single institution. There is a possibility that multiple perioperative medications could interact with other drugs metabolized by cytochrome P450, potentially altering the effects of analgesic medications. This study does not account for these potential interactions. Finally, opioid use after discharge was not monitored in this study.

The results of our study show that frailty, which can be assessed quickly and simply in the preoperative period in elderly surgical patients, will be effective in predicting postoperative opioid consumption. In this study, it was determined that frailty is associated with higher doses of opioid use in the early postoperative period. Considering the potential side effects of opioids, postoperative care conditions may need to be specifically tailored for geriatric patients. Although no major postoperative complications were observed in our study, it should not be overlooked that frail patients may require higher doses of opioids for adequate analgesia, which could potentially lead to the emergence of complications. We also believe that frailty should become a routine part of preoperative assessment in surgical patients.

Declarations

Conflict of interest The authors declare no potential conficts of interest related to commercial or fnancial relationships in this study.

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