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Association of the frail scale and immediate postoperative complications in geriatric surgical patients

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Abstract
Introduction: Global life expectancy is increasing, leading to a rise in the elderly population, projected to double worldwide by 2050. In Mexico, 14% of the population is aged 60+. Aging involves physiological changes contributing to frailty, defined as reduced physiological reserve and increased vulnerability. Frailty correlates with increased perioperative complications like delirium and acute pain. The FRAIL scale (Fatigue, Resistance, Ambulation, Illnesses, Loss of Weight) is a simple tool for frailty assessment.
Material and Methods: A descriptive, cross-sectional, prospective, single-center study was conducted at General Hospital of Zone No. 20, Puebla, Mexico. A total of 363 patients, male and female, aged 60 years or older, who underwent surgical-anesthetic procedures were included. Data, including age, sex, FRAIL scale, immediate postoperative complications (<72 hours), anesthesia type, and ASA classification, were collected. Patients with ASA IV/V, benzodiazepine/opioid treatment, or dementia/Alzheimer's were excluded. SPSS version 25 was used for analysis, employing descriptive statistics and Pearson's chi-squared test ($p<0.05$).
Results: The median age of the 363 patients was 69 years (IQR 8), with 60.88% being female. FRAIL scale assessment revealed 58.4% pre-frail, 28.1% robust, and 13.5% frail. Neuraxial blockade was the most common anesthetic (78.5%). Among patients with complications, acute pain was most frequent (21.76%), followed by delirium (5.51%), and respiratory complications (0.826%). A statistically significant association was found between immediate postoperative complications and the FRAIL scale (Pearson x2=109.97, $p<0.001$). For frail patients, acute pain was the primary complication (23 patients), followed by delirium (12 patients).
Conclusion: There is a significant association between the FRAIL scale and immediate postoperative complications in geriatric surgical patients at HGZ 20. Acute pain is the most frequent immediate postsurgical complication, followed by delirium.

Keywords: FRAIL scale, frailty, older adult, postoperative complications

Introduction
In recent decades, life expectancy has notably increased, leading to a substantial rise in the global elderly population. The World Health Organization (WHO) projects that between 2015 and 2050, the percentage of individuals aged 60 and over worldwide will almost double, from 12% to 22% [1]. In Mexico, individuals aged 60 years or older are considered older adults. Data from Mexico's National Institute of Statistics and Geography (INEGI), through the 2022 New Edition National Survey of Occupation and Employment (ENOEN), reveal that 14% of the country's total population is aged 60 years or older, comprising 13% men and 15% women within this age group [2].
Aging brings about a series of structural and physiological changes affecting multiple body systems. These changes include elevated cortisol levels, increased catabolism, loss of muscle mass and strength, anorexia, weight loss, reduced energy expenditure, pulmonary restriction, limited airflow, and a decrease in glomerular filtration rate. Additionally, an inadequate response to acute inflammation stress and cerebral and cardiovascular changes are observed. All these factors contribute to the development of frailty in older adults [3].

The concept of frailty has been intrinsically linked to aging, though its definition has evolved over time. One of the earliest approaches was by Woodhouse *et al*. in 1988, who described frail older adults as individuals over 65 years old, dependent on others for daily activities, lacking independent mobility, yet without evident cardiac, respiratory, hepatic, renal, or metabolic diseases, and often requiring regular medication [4]. Subsequently, in 1994, Rockwood K *et al*. conceptualized frailty as functional dependence in activities of daily living, suggesting that "physiological reserve" diminishes with age until reaching a critical threshold where older adults are considered frail [5].

It was in 2001 that Fried LP *et al*. successfully differentiated frailty from disability, a crucial advancement, as previously both terms were used almost synonymously. Fried LP's widely accepted definition today describes frailty as a biological syndrome characterized by decreased reserve and resistance to stressors, resulting from an accumulative decline across multiple physiological systems, leading to increased vulnerability to adverse outcomes [6].

For frailty assessment, various scales have been proposed. However, many are impractical for daily clinical use due to the complexity of parameters to be measured or the need for specialized personnel. In this context, the FRAIL scale (Fatigue, Resistance, Ambulation, Illnesses, and Loss of weight), initially proposed in 2008 by The International Academy of Nutrition and Aging (A.I.N.A.), presents as a feasible and useful tool [7]. The African American Health (A.A.H.) established clear measurement parameters for each concept of the FRAIL scale through questions posed to patients or their caregivers, assigning a numerical value and classifying older adults as robust, pre-frail, or frail [8] (Table 1). The FRAIL scale score ranges from 0 to 5: 0 points indicate a robust state, 1-2 points suggest pre-frailty, and 3-5 points denote frailty [9].

Table 1: FRAIL scale

Domain	Question	Response Options
Fatigue	During the past 4 weeks, how often have you felt tired?	1 = All the time 2 = Most of the time 3 = Sometimes 4 = Rarely 5 = Never
Resistance	By yourself and without assistance, do you have difficulty climbing 10 steps without resting?	1 = Yes 0 = No
Ambulation	By yourself and without assistance, do you have difficulty walking several meters?	1 = Yes 0 = No
Illness	Do you currently have or has a physician told you that you have any of the following illnesses?	1 = Yes 0 = No Total number of illnesses (0-11): 0-4 = 0 5-11 = 1
Weight Loss	How much do you weigh with clothes on but without shoes? One year ago? How much did you weigh then?	1 = ≥5% weight loss 0 = <5% weight loss

FRAIL Scale proposed by the A.A.H. In the fatigue domain, responses 1 or 2 receive a score of 1; all other responses receive a score of 0. In the illness domain, included conditions are hypertension, diabetes, cancer, chronic lung disease, heart disease (congestive heart failure, angina, myocardial infarction), stroke, and kidney disease. The percentage of weight loss is calculated using the formula: ((Weight [kg] 1 year ago - Current weight)/Weight 1 year ago) × 100. Adapted from: Morley JE, Malmstrom TK, Miller DK. A simple frailty questionnaire (FRAIL) predicts outcomes in middle aged African Americans. J Nutr Health Aging. 2012;16(7):601-618 [8].

The presence of frailty in older adults significantly impacts hospital costs and is associated with prolonged stays due to complications. Lemus GA *et al*. reported that some hospital costs exceeding $100,000 USD corresponded to frail patients [10], and frailty has been linked to longer hospital stays stemming from surgical complications [11]. Despite these repercussions, timely detection of frailty is rarely performed in routine clinical practice, as it is not integrated into the International Classification of Diseases (ICD), and its importance for decision-making in anesthesiology and other specialties is often minimized [12].

With the advancement of new techniques and improvements in surgical and anesthetic procedures, surgical procedures in older adults now account for one in three surgeries [13]. It is crucial to highlight that frail older adults are particularly susceptible to postoperative complications. The intrinsic vulnerability from age-related anatomophysiological changes, combined with the stress of surgery and anesthesia, prolongs postsurgical recovery and can lead to disability and mortality [14]. The incidence of postoperative complications increases with age; for instance, approximately 20% of patients over 80 years old undergoing surgery experience complications, and their presence raises mortality from 4% to 26% [15].

Gong S *et al*. conducted a review and meta-analysis suggesting the utility of the FRAIL scale for identifying surgical patients at higher risk of 30-day and 6-month postoperative mortality, as well as complications and postoperative delirium [16]. Frail patients, according to this study, had a 2.5 times higher risk of postoperative complications (including cardiovascular, respiratory, infectious, and renal) and a 2.4 times higher risk of developing postoperative delirium compared to non-frail patients [16].

Specific Postoperative Complications in Frail Older Adults

Among the most frequent postoperative complications in older adults, neurological complications, such as delirium and postoperative cognitive dysfunction (POCD), are of particular concern. Delirium is defined as an acute disturbance of consciousness with signs of inattention, disorientation, and memory alterations that can fluctuate. POCD, on the other hand, is a syndrome characterized by disturbances of consciousness, attention, perception, thought, memory, behavior, and emotions that appear after surgery, potentially manifesting from the first week up to 3 months postoperatively [15].

Risk factors for postoperative delirium include advanced age (over 65 years), the type of surgical procedure (with orthopedic surgery being a significant risk factor, showing an incidence of 5-61%), and prolonged hospitalization (with an incidence of 10-80%) [15]. In a randomized controlled study, Shin H-J *et al*. found that dexmedetomidine infusion as a sedative in patients undergoing minor hip surgery under spinal block resulted in a lower incidence of delirium compared to propofol (3.0% vs 6.6%). Additionally, delirium was more frequent on the first postoperative day in both groups [17]. Mohamed EES *et al*. reported a postoperative delirium incidence of 10% to 45%, peaking at approximately 26% during the first postoperative week. In patients undergoing general anesthesia, avoiding anticholinergic premedication is recommended due to its sedative effect, which can delay recovery, cause urinary retention, and increase the incidence of POCD and delirium. In cases of established delirium or severe agitation, haloperidol may be useful, and dexmedetomidine infusion can reduce the prevalence of POCD in patients admitted to intensive care units [18].

Regarding the type of anesthesia, Lessing NL *et al*. compared general anesthesia and spinal block in lumbar surgery, observing that patients under spinal block remained in the postanesthesia care unit for less time (123 vs 171 minutes) and required fewer morphine equivalent analgesics (19% vs 239%). Although patients with general anesthesia had 4% major complications compared to 5% with neuraxial blockade, the frequency of minor complications was similar between both groups [19]. Another study by Li Y-W *et al*. compared combined epidural-general anesthesia versus general anesthesia alone, concluding that the combination reduced the incidence of complications in the first postoperative week and the use of opioid analgesics, inhalational anesthetics, and non-steroidal anti-inflammatory drugs, albeit with a greater fluid intake [20]. However, other studies, such as those by Vacas S, *et al*. and Solis-Cartas U, *et al*., suggest insufficient evidence to directly associate neurological complications with the type of anesthesia implemented [21, 22].

Respiratory complications are also frequent, occurring in 10.5% to 32% of cases, without clear differences related to the anesthetic procedure [23]. Among these, atelectasis, pneumonia, and pulmonary embolism are the most common. Lung expansion maneuvers (respiratory exercises) and thromboprophylaxis are effective in reducing their incidence [24].

Acute postoperative pain is another relevant complication, as physiological changes in older adults affect its diagnosis and treatment. The prevalence of chronic pain in this population is approximately 25% to 50%, and depressive symptoms (8% to 20%) have been observed to correlate with worsening pain. Pain intensity also correlates with delirium incidence: less than 5% with mild pain, 30% with moderate pain, and over 80% with severe pain [25]. Furthermore, the use of postoperative opioids for moderate-to-severe pain increases the risk of delirium within the first 24-48 hours [25]. For pain management, paracetamol is recommended as first-line therapy. Non-steroidal anti-inflammatory drugs should be used with caution due to their primary gastrointestinal and renal adverse effects. Opioid analgesics can be employed, but consideration must be given to decreased renal or respiratory function and cognitive impairment in older adults due to their adverse effects [26]. Epidural analgesia with local anesthetics and an opioid is also an option that can improve mental status and bowel activity compared to intravenous patient-controlled analgesia in the postoperative patient [23, 27].

Materials and Methods

A descriptive, cross-sectional, prospective, and single-center study was conducted at General Hospital of Zone No. 20 in Puebla, Puebla, Mexico. A total of 363 patients, male and female, aged 60 years or older, who underwent surgical-anesthetic procedures were included. A data collection instrument was completed for each participant, which included age, sex, FRAIL scale score, type of immediate postoperative complication (<72 hours), type of anesthesia administered, and ASA physical status classification. Patients classified as ASA (American Society of Anesthesiologists) physical status IV or V were excluded from the study. Additionally, patients receiving benzodiazepine or opioid treatment, or with a history of dementia or Alzheimer's disease, were also excluded. For data analysis, SPSS software, version 25, was utilized. Descriptive statistics included measures of central tendency and dispersion for quantitative variables, and percentages for qualitative variables. Pearson's chi-squared test was performed, with a significance level set at $p<0.05$.

Results

Demographics and Baseline Characteristics

From the total of 363 patients included in the study, the median age was 69 years (IQR 8), with a minimum age of 60 years and a maximum age of 87 years. The most frequently observed age among patients was 67 years.

Regarding patient sex, 60.88% (221 patients) were female, and 39.12% (142 patients) were male. This indicates that the majority of patients undergoing surgical-anesthetic procedures in this cohort were female (Table 2).

Table 2: Demographic Characteristics

		N (%)
Age	60 to 70 years	221 (60.88)
	71 to 80 years	119 (32.78)
	81 to 90 years	23 (6.34)
Gender	Female	142 (39.12)
	Male	221(60.88)

Comorbidities

The comorbidities considered, based on the FRAIL scale components, included arterial hypertension, diabetes mellitus, cancer, chronic pulmonary disease, myocardial infarction, congestive heart failure, angina, asthma, arthritis, cerebral infarction, and renal disease. For the purpose of this study, these were categorized as arterial hypertension, diabetes mellitus, pulmonary diseases, cardiac diseases, renal diseases, and "other" (including cancer, arthritis, and cerebral infarction).

It was found that 9.1% (33 patients) of the cohort had no comorbidities. Among patients with comorbidities, 54.8% (199 patients) presented with two or more associated comorbidities. Additionally, 26.4% (96 patients) had arterial hypertension, 8.3% (30 patients) had diabetes mellitus, and only 1.4% (5 patients) had other types of comorbidities.

FRAIL Scale Assessment

Application of the FRAIL scale revealed that 58.4% (212 patients) were in a pre-frail state, 28.1% (102 patients) were robust, and 13.5% (49 patients) were frail. Despite the common perception that frailty might be more prevalent in this patient group, the majority of patients were found to be in a state of pre-frailty.

Type of Anesthetic Procedure

The anesthetic techniques employed in the study patients primarily included neuraxial blockade (NAB), encompassing epidural, subarachnoid, and combined spinal-epidural blockades, as well as regional anesthesia (including various types of plexus and truncal blocks), and balanced general anesthesia (BGA). A total of 285 patients underwent neuraxial blockade (78.5%), 72 patients received balanced general anesthesia (19.8%), and 6 patients received regional anesthesia (1.7%).

Immediate Postoperative Complications

Immediate postoperative complications were assessed during the study. It was observed that 261 patients (71.90%) experienced no complications. Among the complications that did occur, acute pain was the most common, affecting 21.76% (79 patients). Delirium was the second most common complication, with an incidence of 5.51% (20 patients). Respiratory complications were the least frequent, occurring in only 0.826% (3 patients) of the total cohort.

Association of Anesthesia Type and Immediate Postoperative Complications

Of the 285 patients who received neuraxial blockade, 214 patients experienced no complications, 40 patients developed acute pain, 20 patients developed delirium, and 3 experienced respiratory complications. Among the 72 patients who received regional anesthesia, 41 patients had no postoperative complications, while the remaining 31 patients experienced acute pain. Importantly, none of the 6 patients who received balanced general anesthesia experienced postoperative complications (Table 3).

Table 3: Association of Anesthesia Administered and Inmediate Posoperative Complications

		No Complicated (N)	Immediate Postoperative Complications			Total (n)
			Delirium (N)	Acute pain (N)	Respiratory complications (N)	
Type of Anesthesia Administered	Neuroaxial blockade	214	20	48	3	285
	Balanced general anesthesia	6	0	0	0	6
	Regional blockade	41	0	31	0	72
	Total (n)	261	20	79	3	363

A Pearson's chi-squared test revealed a statistically significant association between immediate postoperative complications and the type of anesthesia used (Pearson x^2=29.72, df = 6, p<0.001), specifically highlighting neuraxial blockade.

Association Between FRAIL Scale Status and Immediate Postoperative Complications

Of the total 102 patients who developed complications, the most frequent complication among frail patients (38 patients) was acute pain, followed by delirium, and respiratory complications. For pre-frail patients (58 patients), acute pain was the most frequent complication, followed by delirium, with no patients experiencing respiratory complications. Among robust patients (6 patients), acute pain was the primary complication, followed by delirium, with no respiratory complications. In total, 261 patients across all FRAIL scale states experienced no complications (Table 4).

Table 4: FRAIL scale and inmediate postoperative complications

		No complicated (n)	Inmediate Posoperative Complications			Total (n)
			Delirium (N)	Acute pain (N)	Respiratory complications (N)	
Frail Scale	Frail	11	12	23	3	49
	Pre-frail	154	6	52	0	212
	Robust	96	2	4	0	102
	Total (N)	261	20	79	3	363

A Pearson's chi-squared test further demonstrated a statistically significant association between immediate postoperative complications and the FRAIL scale status (Pearson x^2=109.97, p<0.001).

Discussion

In the present study, 49 patients (13.5%) were identified as frail, and notably, 38 of these patients experienced postoperative complications, representing over 50% of the frail cohort. The primary complication observed in this group was acute pain. As Sandoval Y. mentioned, pain has been associated with delirium, suggesting that acute pain could be a precipitating factor for delirium within the first 24-48 hours postoperatively. This highlights the importance of implementing multimodal analgesia and carefully selecting medications, especially given that most geriatric patients, as observed in our study, present with multiple associated comorbidities. This comorbidity burden can influence pain management strategies, necessitating a nuanced approach to minimize adverse effects from polypharmacy, which is common in this population.

It is worth noting that while most previous studies associate frailty with neurological complications, particularly delirium, our study found delirium to be the second most common complication. However, Mohamed ESS *et al.* indicate that postoperative delirium can occur in up to 26% of patients during the first week. This suggests a potential limitation in our study, as patient follow-up was restricted to the initial 72 hours. Further research with longer follow-up periods would be beneficial to capture the full incidence of delirium.

Respiratory complications were the third most common complication in our frail patient group, occurring at a very low percentage. While Sanal S *et al*. reported respiratory complications in 10.5% to 32% of cases, only 3 out of 38 frail patients who experienced any complication in our study presented with respiratory issues.

Regarding the type of anesthesia employed, the majority of patients received neuraxial blockade. Lessing NL *et al*. previously suggested no correlation between the frequency of minor complications and the type of anesthesia (neuraxial vs. general). However, our study found a contrasting situation: most complications occurred in patients receiving neuraxial blockade, whereas no complications were observed in those who received balanced general anesthesia. This finding seemingly contradicts studies by Vacas S *et al*. and Solis-Cartas U *et al*., who indicated a lack of evidence for an association between neurological complications and anesthetic type. Nevertheless, it is crucial to acknowledge that the disparate number of patients receiving neuraxial, regional, and general anesthesia in our study limits a definitive determination of this association. Further studies with more balanced patient groups are warranted.

Despite these nuances, our study's finding of a higher incidence of complications in frail patients aligns with the research by Gong S *et al*. in Toronto. Their work utilized the FRAIL scale as a tool to associate postoperative complications with patient frailty, a correlation strongly supported by our results, which showed a statistically significant association between the FRAIL scale and immediate postoperative complications ($x2=109.97$, $p<0.001$).

Conclusion

The FRAIL scale (Fatigue, Resistance, Ambulation, Illnesses, and Loss of weight) is associated with immediate postoperative complications in geriatric surgical patients at HGZ 20. In our population, we primarily found an association between the frail state and acute pain as an acute complication, particularly in patients undergoing neuraxial blockade, given that it was the most frequently utilized anesthetic technique.

Furthermore, continued multidisciplinary post-surgical surveillance is crucial, especially for frail or pre-frail patients. This approach aims to prevent, accurately diagnose, and promptly treat potential complications, thereby reducing inpatient length of stay and consequently decreasing healthcare costs.

This study also paves the way for further research to more specifically investigate the association between each frailty status, each type of complication, and each type of anesthesia employed, which could lead to standardized treatment protocols.

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Author's Contribution

Not available

Conflict of Interest

Not available

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