Original Article

Multidimensional Frailty Score for the prediction of postoperative outcomes in elderly patients with fragility fractures.

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ABSTRACT
Background: In elderly populations, postoperative complications and mortality have increased in tandem with an increase in orthopedic surgery for problems like hip, knee, and spine deterioration .There are insufficient tools to predict postoperative outcomes in the elderly. Multidimensional frailty score (MFS) is one of the tools that have been used to predict postoperative mortality & morbidity. ***Objective***: To measure postoperative morbidity and mortality in elderly patients with fragility fractures undergoing orthopedic surgeries by using the Multidimensional Frailty Score. ***Methods***: A prospective cohort study was conducted on 80 elderly (60 years or older) patients who were admitted to the orthopedic department at Ain Shams University Hospitals from November 2022 to November 2023. They were presented with fragility fractures and were assessed before the surgical intervention by Multidimensional Frailty score (MFS) with cutoff point 5 (score ≤5: low risk & >5: High risk), then followed up for 3 month after the operation for post-operative complications, functional decline, nutritional state, delirium, pain, depression and death. ***Results:*** Our study showed that the MFS with A cut-off value of five (score ≤5: low risk &>5: High risk) has a good discriminatory ability to differentiate between patients who had postoperative complications and those who did not with sensitivity 78.79% and specificity 76.60%. But it has a poor ability to differentiate between patients who died and those who survived. ***Conclusion:*** The MFS demonstrated a good ability in predicting occurrence of postoperative complications, implying its potential value for preoperative assessment in elderly patients. ***Key words:*** fragility fractures, Multidimensional Frailty Score, postoperative complications.

INTRODUCTION:

With the worldwide increase in the elderly population, the demand for surgical procedures especially orthopedic procedures is also expected to rise.
Geriatric patients represent a different group of population because the chronological age does not always represent the biological function, which varies from fit to frail [1].
Geriatric patients undergoing orthopedic surgery have multiple chronic illnesses that limit their functional capacity and recovery. Moreover, non-disease-associated problems, such as frailty, polypharmacy, functional dependence, malnutrition, and cognitive impairment may also complicate surgical procedures and postoperative recovery [2].
Most common Complications following these surgeries are pneumonia, deep venous thrombosis (DVT), pulmonary embolism, wound dehiscence, surgical site infection, urinary tract infection, post-

operative delirium and even death. For instance, the 1-year mortality rate after hip fracture surgery varies from 19% to 33% **[3].**

So, methods to enhance prognosis and stratify and lower the associated risk following orthopedic surgery are a top issue for orthopedic surgeons. For that reason, numerous models have been established to assess the risk of mortality and the risk of developing particular types of complications following special types of surgical procedures such as: Estimation of Physiologic Ability and Surgical Stress (E-PASS) following elective gastro-intestinal surgery , tools used for assessing orthopedic surgery outcomes like Orthopedic Physiologic and Operative Severity Score for the Enumeration of Mortality and Morbidity (O-POSSUM) and Nottingham Hip Fracture Score (NHFS), tools that are validated for comorbidities quantifications and geriatric conditions assessment such as Charlson Comorbidity Index (CCI) and Comprehensive Geriatric Assessment (CGA).

On the other hand, laboratory test parameters also affect morbidity and mortality such as hemoglobin, albumin, and sodium [4].

The comprehensive geriatric assessment (CGA) is widely used for assessment of comorbidities and evaluation of the geriatric conditions associated with frailty. It is a multidimensional assessment focusing on somatic, psychological, functional and social aspects. It is designed to improve diagnostic accuracy, provide guidance in planning care for the elderly and improve the functional status **[5].**
Using CGA data, we used the Multidimensional Frailty Score, which is a scoring model to predict postoperative mortality and morbidity in elderly patients undergoing orthopedic surgeries for fragility fractures, and we followed up the patients postoperatively for 3 months.

METHODS:

Patient selection:

A prospective cohort study was performed at Ain Shams University Hospitals. Eighty (80) patients aged 60 years or older were admitted to orthopedic department with fragility fractures (defined as fractures that result from a fall from standing height or less) were included in the study. The subjects were consecutively recruited from November 2022 to November 2023. Patients with fractures due to high impact trauma or malignancy or patients who refused to participate in the study were excluded.

Baseline patient characteristics were collected included age, sex, co-morbidities, pre-operative depression by geriatric depression scale 15 (GDS 15) [6], **Arabic form was used [7],** type of surgery and length of hospital stay.

Multidimensional Frailty score (MFS) was performed before surgical intervention which contain the following items: **[8], Figure 1**

1. Malignant disease
2. Charlson Comorbidity Index to The burden of comorbidity[9]
3. Serum albumin levels.
4. Activities of Daily Living (ADL)[10]
5. Instrumental Activities of Daily Living (IADL)[11]
6. Mini mental status examination (MMSE) for assessment of cognitive decline [12], Arabic version was used [13].
7. Nu-DESC to assess risk of delirium [14].
8. Mini Nutritional Assessment (MNA)[15], Arabic form was used[16].
9. Mid-arm circumference in cm

	Score		
Item	0	1	2
Malignant disease	Benign disease	Malignant disease	NA
Charlson Comorbidity Index[9]	0	1-2	>2
Albumin, g/dL	>3.9	3.5-3.9	<3.5
Activities of Daily Living (ADLs) [10]	Independent	Partially dependent	Fully dependent
Instrumental Activities of Daily Living (IADLs) [11]	Independent	Dependent	NA
Dementia by Mini mental status examination (MMSE-KC) [12], Arabic version used [13].	Normal	Mild cognitive impairment	Dementia
Risk of delirium by Nursing Delirium-Screening Scale (Nu-DESC) [14]	0-1	≥2	NA
Mini Nutritional Assessment (MNA) [15], Arabic form used [16]	Normal	Risk of malnutrition	Malnutrition
Midarm circumference, cm	>27.0	24.6-27.0	<24.6

Figure 1

If score of MFS is 5 or more, it indicates high risk for morbidity & mortality

Postoperatively, the patients were assessed for all-cause mortality and morbidity at 3 months intervals: in hospital, within 1 month and 3 months post-surgery.

The assessment included the following:

- Postoperative medical complications (deep venous thromboembolism (DVT), pulmonary embolism, Pneumonia, surgical site infection, others).
- Functional decline by:

a. ADL **[10]** and IADL **[11].**

b. Cumulated Ambulation Score (CAS) **[17]:** It is a simple test developed to evaluate early ambulation skills postoperatively (which include getting in and out of bed, rising from a chair and walking). Each activity is assessed on three-point ordinal scale from zero to two (zero= not able to, despite human assistance and verbal cueing, one= able to, with human assistance and/or verbal cueing from one or more persons, two= able to safely, without human assistance or verbal cueing, use of a walking aid allowed).

- Nutritional state by:

a. MNA (Mini Nutritional Assessment)[15], **Arabic form was used [16].**

b. Mid-arm circumference

c. Serum albumin.

- Delirium by Nu-DESC **[14].**
- Pain by numerical rating scale, which scores pain from zero to ten.
- Depression by geriatric depression scale 15 (GDS 15) **[6]**, **Arabic form was used [7].**
- Length of hospital stay.
- Death

Declaration of consent

Participants were included in this study after informed consents from patients or caregivers. The study was approved by the Ethical Committee (MASRI ethical committee and Research Review Board of the Geriatrics and gerontology medicine department, Faculty of Medicine, Ain Shams University). Confidentiality and anonymity of participants was ensured. The approval number is MS 724/2022.

Statistical analysis

The Statistical Package for Social Sciences (SPSS) version 26 was used for statistical analysis of the collected data. Quantitative variables were presented in the form of means and standard deviation. Qualitative variables were presented in the form of frequency tables (number and percent). Student T Test and Mann Whitney Test (U test) were used to assess the statistical significance of the difference between two study group means. Chi-Square test and Fisher's exact test were used to examine the relationship between two qualitative variables. Sensitivity and specificity for quantitative diagnostic measures was calculated by using Receiver Operating Characteristic (ROC) curve which categorizes cases into one of two groups P- value (level of significance), P>0.05: Non-significant (NS), P< 0.05: Significant (S).

Results:

Eighty (80) elderly patients with fragility fractures undergoing orthopedic surgery were included in the study; mean age was 73.29 ± 8.28. The predominant sex was female (65.25% of the study population. The general characteristics of the study population are shown in (Table 1). Hip fracture was the most common cause of fracture (97.5%) in the study population.

Preoperative comprehensive geriatric assessment using MFS score (table 2) showed that 52.5% of the participants had low risk for morbidity and mortality according to MFS score and 47.5% had high risk. The average score of MMSE for cognition was 24.14 with most of the patients had intact cognition (73.75. Most of the patients were independent in their ADL (66.25%) and IADL (57.5%). The average score of nutritional state (MNA) was 11.38 with the majority of the patients having a normal nutritional state (63.75%). None of the patients had a pre-operative delirium. Only one patient had malignancy (endometrial cancer) (1.25%).

Operative and postoperative details are shown in table (3).

- **Operative:**

The most common type of operation was intramedullary nail (53.75%), followed by total hip replacement (18.75%) and plates and screws (13.75%). Only 2 patients had a vertebroplasty (2.5%) with a median duration of hospital stay of 5 days.

- **1 month postoperatively:**

The most frequent medical complication was surgical site infection (6.25%), followed by bed sores (3.75%) and anaemia (2.5%). Only 1 patient had a pneumonia (1.25%) and one patient had another fracture (1.25%).

- **3 months postoperatively:**

The most frequent medical complication was bed sores (8.75%), followed by sepsis (3.75%), septic shock (3.75%), and fear of fall (7.5%). Only 1 patient had an anaemia (1.25%) and one patient had another fracture (1.25%).

Most of the patients were assisted in their ADL (76.25%) and dependent in their IADL (98.75%).

Most of the participants were malnourished (41.25%), while 38.75% had normal nutritional state and 20% were at risk of malnutrition.

Only 5% of the participants reported mild pain, moderate pain, or severe pain each. Most of the participants had no delirium after the operation (90%). 15% of the participants had mild depression and 3.75% had moderate depression.

Most of the participants were alive after the operation (91.25%), while only 7 patients died (8.75%).

The causes of mortality were sepsis and septic shock, which were due to surgical site infection (4 participants), infected bed sores (2 participants) and hospital acquired pneumonia (1 participant).

The association between MFS and postoperative events after 3 month (Table 4):

Regarding the function, we found that the mean of the score of CAS was higher in low-risk group compared to the high risk (3.14 vs 1.21) with a statistically significant difference (p value <0.001), which means that low risk participants had better ambulation after operation than the high risk group. However, there was no statistically significant difference between the low and high-risk groups regarding postoperative ADL and IADL (p >0.05).

As regard the nutritional state of the patients, we found that most of the participants in the high risk group had malnutrition postoperatively (68.42%) compared to the ones with low risk (16.67%) with a statistically significant difference with p value (<0.001). Median serum albumin in the high- risk group postoperatively were lower than the low- risk group (2.7 gm/dl vs 3.65 gm/dl) yielding a statistically significant difference with p value <0.001. Also, participants with high risk had a lower mean mid-arm circumference postoperatively (24.16) compared to the low- risk group (28.45) with a statistically significant difference between the two groups (p <0.001).

In this study population, we found a statistically significant difference between the 2 MFS groups regarding the postoperative prevalence of moderate depression with a higher prevalence in the high-risk group (5.26%) compared to the low risk group (2.38%) (P value =0.028). However, there was no statistically significant difference between the two groups regarding GDS score nor post-operative delirium with p value (>0.05).

We did not find a statistical significant difference between the two MFS groups as regards the mortality with p value (>0.05).

Regarding the relation between the type of orthopedic surgery and the postoperative IADL and ADL, there was no statistical significant difference between them after 3 months with p value (>0.05) (Table5).

Figure (2) shows that the area under the curve of the MFS is 0.636 with 95% CI of 0.521 - 0.741, which means that the MFS has a moderate ability to discriminate between patients who died and those who survived. The cut-off value of the MFS is >9, which means that patients who have MFS greater than 9 are classified as high risk of mortality, while those who have a MFS less than or equal to 9 are classified as low risk of mortality. However, this was not statistically significant with p value (>0.05).

Figure (3) shows that the area under the curve of the MFS was 0.869 with a 95% CI of 0.775 - 0.934, meaning that the MFS has a high ability to discriminate between patients who had postoperative complications and those who did not, which was statistically significant with p value (<0.0001). The cut-off value of the MFS was >6, which means that patients who have MFS greater than 6 are classified as high risk of postoperative complications. The sensitivity of the MFS was 66.67% and the specificity of the MFS was 91.49%. The PPV of the MFS was 84.6%, with a NPP of 79.6%.

According to the Korean reference of the MFS (score ≤5: low risk &>5: High risk), Figure (4) shows that the area under the curve (of the MFS was 0.78 with a 95% CI of 0.67 to 0.86, which means that the MFS has a good ability to differentiate between patients who had postoperative complications and those who did not. The sensitivity of the MFS was 78.79% and the specificity was 76.60%. The positive predictive value of the MFS was 70.27% and the NPP was 83.72%.

Also, according to the Korean reference of the MFS (score ≤5: low risk &>5: High risk), Figure (5) shows the area under the curve of the MFS was 0.56 with a 95% CI of 0.44 to 0.6, which means that it has a poor ability to discriminate between patients who died and those who survived. The sensitivity of MFS was 57.14% and the specificity was 54.79%. The positive predictive value of MFS was 10.81% and the NPP was 93.02%.

Table (1) General characteristics of the study participants:

		Mean ± SD	Median (IQR)	Min-Max
Gender	male	27 (33.75%)		
	female	53 (66.25%)		
Age		73.29 ± 8.28	73 (67 - 80)	60 - 93
Education	illiterate	62 (77.5%)		
	primary school	7 (8.75%)		
	secondary school	4 (5%)		
	high education	7 (8.75%)		
living	alone	10 (12.5%)		
	with another person	70 (87.5%)		
Pre-operative depression	no depression	65 (81.3%)		
	mild depression	1 (1.3%)		
	moderate depression	1 (1.3%)		
	can't be assessed	13 (16.3%)		
Co-morbidities	Diabetes	31 (38.75%)		
	Hypertension	43 (53.75%)		
	Heart failure	5 (6.25%)		
	Ischemic heart disease	14 (17.5%)		
	Atrial fibrillation (AF)	1 (1.25%)		
	Chronic obstructive pulmonary disease (COPD)	5 (6.25%)		
	Cerebrovascular stroke	3 (3.75%)		
	Peptic ulcer	2 (2.5%)		
	Chronic kidney disease (CKD)	5 (6.25%)		
	Liver disease	8 (10%)		
	Peripheral vascular disease	2 (2.5%)		
	Rheumatoid arthritis	1 (1.25%)		
	Parkinsonism	6 (7.5%)		
	Hypothyroidism	4 (5%)		
	None	17 (21.25%)		
site of fracture	right hip	51 (63.75%)		
	left hip	27 (33.75%)		
	right wrist	0 (0%)		
	left wrist	0 (0%)		
	vertebral	2 (2.5%)		
duration of fracture by days		5.16 ± 5.2	4 (3 - 5)	2 - 37
cause of fall	slippage	76 (95%)		
	dizziness	3 (3.75%)		

	vasovagal attack	0 (0%)		
	arrhythmia	0 (0%)		
	others	1 (1.25%)		
risk factors	no	29 (36.25%)		
	previous fall or fracture	13 (16.25%)		
	steroids	1 (1.25%)		
	other drugs	9 (11.25%)		
	sensory impairment	23 (28.75%)		
	inappropriate environment	2 (2.5%)		
	others	3 (3.75%)		

Table (2) Multidimensional Frailty Score and its components:

		Mean ± SD	Median (IQR)	Min-Max
multidimensional frailty score	low risk	42 (52.5%)		
	high risk	38 (47.5%)		
Comorbidities by charlson comorbidity index		3.98 ± 1.35	4 (3 - 5)	2 - 8
cognition	intact cognition	59 (73.75%)		
	mild cognitive impairment	11 (13.75%)		
	dementia	10 (12.5%)		
cognition		24.14 ± 4.85	26 (25 - 26.5)	2 - 28
pre-operative ADL	independent	53 (66.25%)		
	assisted	25 (31.25%)		
	dependent	2 (2.5%)		
pre-operative IADL	independent	46 (57.5%)		
	dependent	34 (42.5%)		
pre-operative nutritional state	normal	51 (63.75%)		
	at risk of malnutrition	15 (18.75%)		
	malnourished	14 (17.5%)		
pre-operative nutritional state		11.38 ± 2.67	12 (10.5 - 13)	5 - 14
pre-operative delirium	no delirium	80 (100%)		
	delirious	0 (0%)		
pre-operative midarm circumference		26.8 ± 4.33	25 (25 - 29.5)	20 - 37
pre-operative serum albumin		3.4 ± 0.55	3.5 (3 - 3.9)	2 - 4.3
Malignancy	no malignancy	79 (98.75%)		
	malignancy	1 (1.25%)		

Table (3) Operative and postoperative details:

		Mean ± SD	Median (IQR)	Min-Max
Type of operation	plates and screws	11 (13.75%)		
	intramedullary nail	43 (53.75%)		
	hemiarthroplasty	9 (11.25%)		
	total hip replacement	15 (18.75%)		
	vertebroplasty	2 (2.5%)		
duration of hospital stay		8.18 ± 11.8	5 (5 - 7)	3 - 90
medical complications within 1 month	no complications	68 (85%)		
	surgical site infection	5 (6.25%)		
	bed sores	3 (3.75%)		
	pneumonia	1 (1.25%)		
	anemia	2 (2.5%)		
	another fracture	1 (1.25%)		
medical complications after 3 months	no complications	59 (73.75%)		
	bed sores	7 (8.75%)		
	sepsis	3 (3.75%)		
	septic shock	3 (3.75%)		
	anemia	1 (1.25%)		
	fear of fall	6 (7.5%)		
	another fracture	1 (1.25%)		
post-operative ADL after 3 months	independent	1 (1.25%)		
	assisted	61 (76.25%)		
	dependent	18 (22.5%)		
post-operative IADL after 3 months	independent	1 (1.25%)		
	dependent	79 (98.75%)		
post-operative cumulated ambulation score after 3 months		2.23 ± 2.06	4 (0 - 4)	0 - 6
nutritional state post-operative after 3 months	normal	31 (38.75%)		
	at risk of malnutrition	16 (20%)		
	malnourished	33 (41.25%)		
post-operative serum albumin after 3 months		3.16 ± 0.61	3 (2.7 - 3.7)	1.7 - 4
post-operative mid-arm circumference after 3 months		26.41 ± 4.48	25 (24 - 28.5)	20 - 37
post-operative pain after 3 months	no pain	68 (85%)		
	mild pain	4 (5%)		
	moderate pain	4 (5%)		
	sever pain	4 (5%)		
post-operative delirium	no delirium	72 (90%)		
	delirious	8 (10%)		
post-operative depression	no	53 (66.25%)		
	mild	12 (15%)		
	moderate	3 (3.75%)		
	severe	0 (0%)		
	can't be assessed	12 (15%)		
GDS score		2.88 ± 2.37	2 (1 - 3)	1 - 11

mortality	alive	73 (91.25%)		
	died	7 (8.75%)		

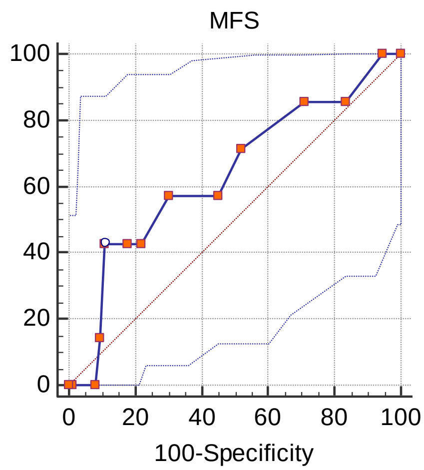
Table (4) Relation between MFS groups and postoperative events after 3 months:

		MFS		Test of Significance		
		low risk	high risk			
		N (%)	N (%)	Value	p-Value	Significance
post-operative ADL	independent	1 (2.38%)	0 (0%)	FE	0.106	NS
	assisted	35 (83.33%)	26 (68.42%)			
	dependent	6 (14.29%)	12 (31.58%)			
post-operative IADL	independent	1 (2.38%)	0 (0%)	FE	1	NS
	dependent	41 (97.62%)	38 (100%)			
post-operative function by CAS		3.14 ± 1.83	1.21 ± 1.83	**t=** 4.714	<0.001	S
nutritional state post-operative	normal	24 (57.14%)	7 (18.42%)	**X^2= 22.3**	<0.001	S
	at risk of malnutrition	11 (26.19%)	5 (13.16%)			
	malnourished	7 (16.67%)	26 (68.42%)			
post-operative serum albumin		3.65 (3.4 - 3.9)	2.7 (2.5 - 2.9)	**Z= 5.468**	<0.001	S
post-operative mid-arm circumference		28.45 ± 4.09	24.16 ± 3.8	**t= 4.8**	<0.001	S
post-operative delirium	no delirium	40 (95.24%)	32 (84.21%)	**FE**	0.141	NS
	delirious	2 (4.76%)	6 (15.79%)			
post-operative depression	no	33 (78.57%)	20 (52.63%)	**FE**	0.028	S
	mild	6 (14.29%)	6 (15.79%)			
	moderate	1 (2.38%)	2 (5.26%)			
	can't be assessed	2 (4.76%)	10 (26.32%)			
GDS score		2 (1 - 3)	2 (1 - 5)	**Z= -0.635**	0.525	NS
mortality	alive	39 (92.86%)	34 (89.47%)	**FE**	0.703	NS
	died	3 (7.14%)	4 (10.53%)			

Table (5) Relation between the type of orthopedic surgery & post-operative ADL &IADL after 3 months

		Type of operation					Test of Significance		
		plates and screws	intramedullary nail	hemiarthroplasty	total hip replacement	vertebroplasty			
		N(%)	N(%)	N(%)	N(%)	N(%)	Value	p-Value	Significance
Post opertaive IADL	independent	0 (0%)	1 (2.33%)	0 (0%)	0 (0%)	0 (0%)	FE	1	NS
	dependent	11 (100%)	42 (97.67%)	9 (100%)	15 (100%)	2 (100%)			
post-operative ADL	independent	0 (0%)	1 (2.33%)	0 (0%)	0 (0%)	0 (0%)	FE	0.96	NS
	assisted	8 (72.73%)	31 (72.09%)	8 (88.89%)	12 (80%)	2 (100%)			
	dependent	3 (27.27%)	11 (25.58%)	1 (11.11%)	3 (20%)	0 (0%)			

ROC Predictivity of MFS to mortality (Figure 2) and morbidity (Figure 3):



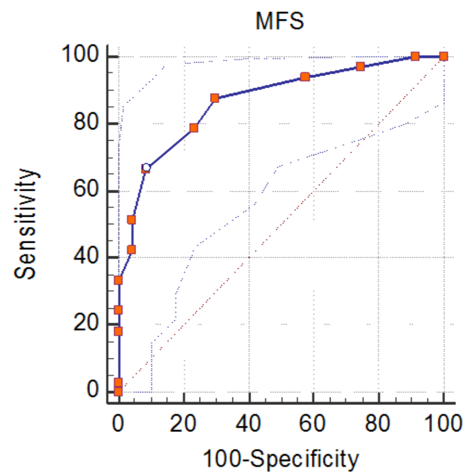
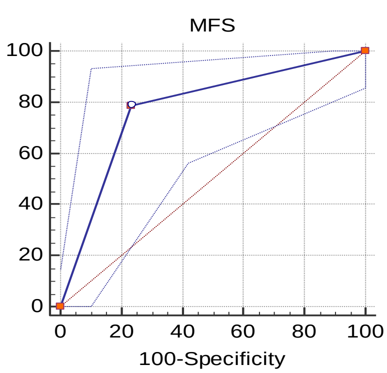


Figure (2)

Figure (3

ROC predictivity of MFS to Postoperative complications (Figure 4) and mortality (Figure 5) according to the Korean reference (≤5: low risk > High risk):



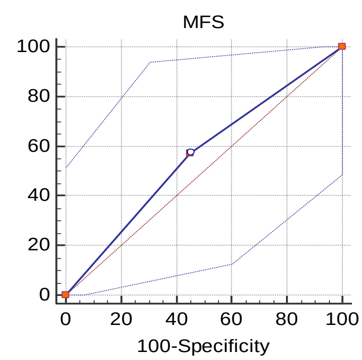


Figure (4)

Figure (5)

Discussion:

Some elderly patients don't have the physiological reserve to withstand operations and post-operative burdens. Unfortunately, many physicians measure the patient's reserve subjectively or may neglect it. As a result, some elderly patients are deprived of the opportunity for surgical treatments only due to their chronological age. In contrast, some patients may develop post-operative complications and are discharged to long-term facilities. This may indicate that physicians don't know enough information about geriatric frailty and there is absence of appropriate methods for evaluating elderly patients before surgery [18].

Preoperative assessment of frailty using tools that are validated for surgical populations is one of the first steps in distinguishing patients who are at high risk for poor postoperative outcomes. Across different surgical populations, frailty is associated with higher overall postoperative complications, longer hospital stay, and higher mortality. Therefore, preoperative recognition of frailty can help guide discussions with the patient's care team to improve perioperative care. There is no gold standard assessment for frailty, especially among older adults undergoing surgery. Assessment tools differ in the domains assessed (ie, cognition, comorbidities, and physical function), source of information (ie, direct assessment, self-report, and electronic health records), time needed, and site of evaluation (ie, outpatient, inpatient, and by telephone) [19].
Using CGA data, we used the Multidimensional Frailty Score, which is a scoring model to predict unfavorable outcomes quantitatively after surgery in elderly patients, and we followed up the patients postoperatively for 3 months.

Our study population included 80 patients with fragility fractures, in which 97.5% were due to hip fracture. In geriatric patients, hip fractures represent one of the most common fractures, which are usually associated with significant morbidity and mortality. The main cause of these fractures is usually low energy ground fall. These fractures are a major cause of hospitalization with significant personal, social and financial impact [20].

Most of our study participants were females (66.25%). Previous studies has shown that hip fractures are more common in women than men. In a study done by Alpantaki K, et al, which included a total of 2430 patients diagnosed with a hip fracture and surgically treated , hip fractures were found to be much more frequent among women {2.9 times more than men} [21]. One reason to explain this difference was that women have a lower bone density and body size when compared to men. Moreover, after menopause, women start to lose bone density, which increases their risk of fracture [22].
In our study, the most frequent medical complication after 1 month was surgical site infection (6.25%), followed by bed sores (3.75%) and anemia (2.5%). Meanwhile, the most frequent medical complication after 3 months was bed sores (8.75%), followed by sepsis (3.75%), septic shock (3.75%), and fear of fall (7.5%).
In a study that was done in England by Goh EL, et al, the post-operative complications were signs of wound infection (3.1%), dislocation (0.5%), failure of fixation (0.6%), overall revision surgery (0.9%), blood loss requiring transfusion (6.1%), chest infection (6.3%), urinary tract infection (5.0%), deep vein thrombosis/pulmonary embolus (1.8%), cerebrovascular accident (0.6%); acute coronary syndrome/myocardial infarction (0.6%) and acute kidney injury (1.3%) [23].
We used the criterion (MFS ≤5 = low risk and >5= high risk) to classify the risk of morbidity and mortality as developed by Kim SW,et al [8].
Using the MFS for preoperative assessment, we found that 52.5% of the participants had low risk for morbidity and mortality according to MFS score and 47.5% had high risk.
In the current study, 63.75% of the patients had a normal nutritional state preoperatively, while 18.75% were at risk of malnutrition and 17.5% were malnourished. The mean pre-operative serum albumin was 3.4 g/dL.

Our study revealed that most of the participants with high risk had malnutrition 3 months postoperatively (68.42%) compared to the ones with low risk (16.67%). Median serum albumin in the high risk group postoperatively were lower than the low risk group (2.7 gm/dl vs 3.65 gm/dl) yielding a statistically significant difference. Also, participants with high risk had a lower mean mid-arm circumference postoperatively compared to the low risk group with a statistically significant difference between the two groups. Consequently, we found in our study that all participants who died were malnourished after operation (100%).

Our findings are in line with the findings by Miró MF, et al. Their study which included 65 elderly patients undergoing total hip arthroplasty, showed that five out of six patients (83.3%) with postoperative complications presented malnutrition compared with 20 of 59 patients (33.8%) without postoperative complications. Also they noted that malnutrition was associated with lower body mass index (BMI), lower preoperative and postoperative serum albumin [24].

Malnutrition is known to be associated with muscle weakness, diminished muscle strength, immunosuppression, apathy, and poor cardiac function. These conditions may contribute to an increase in postoperative complications, delayed recovery and increased mortality. Furthermore, sarcopenia was found to be present in 37% of patients presenting with hip fractures, which is consequently associated with difficult postoperative rehabilitation [25],[26].

Regarding the serum albumin, it is known that its level represents a longer-term nutritional marker than the Mini Nutritional Assessment score, plays a significant role in inflammation and metabolism, and is known as an independent predictor for mortality and morbidity rates in several studies [8].

Postoperative delirium is a unique complication that usually develops in the elderly. Its incidence ranges from 9% to 87%, which varies according to the studied population and the degree of surgical stress [27]. In a study that was done between 2018 and 2019 on 272 patients with hip fractures undergoing surgery, it was found that 19.12% of patients had postoperative delirium [28].

In another study done by Matsuki M, et al, on 946 elderly participants, postoperative delirium was observed in 32 patients (3.4%) [29].

In our study none of the patients had delirium preoperatively and the incidence of delirium postoperatively was 10% and we did not find a statistical significant difference between the high and low risk groups regarding post-operative delirium, this may be attributed to the small number of patients who had postoperative delirium.

Our study revealed that, there was no statistically significant difference between the low and high-risk groups regarding postoperative ADL and IADL. However, the cumulated ambulation score (CAS) postoperatively was higher in low-risk groups compared to the high risk yielding a statistically significance between the two groups. The Cumulated Ambulation Score (CAS) is a valid tool for evaluation of basic mobility (ability to get in and out of bed, sit-to-stand from a chair and walking) in orthopedic wards, and it is recommended to be used in patients with hip fracture [30].A study done by Hulsbaek S, et al., concluded that the Cumulated Ambulation Score is a useful tool to monitor the basic mobility for patients recovering from a hip fracture during their hospital stay, while the modified Barthel Index seems to be useful for the assessment of ADL in the acute care setting of patients with hip fracture [31].

In the current study, there was no relation between the type of orthopedic surgery and post-operative ADL and IADL.

Studies have demonstrated that in-hospital mortality rates for patients undergoing surgical intervention for hip fracture ranges from 1.52–11.4% [32],[33].

In our study, most of the patients were alive after the operation (91.25%), while only 7 patients died (8.75 %) in the 3 months follow up period. In a study was done by Groff H, et al., the mortality rate in patients who underwent hip surgeries for hip fracture was 3% [34].
Also, in another study was done by Alsheikh KA, et al., in which data collected from patient's records between 2008 and 2018 for patient's undergoing hip surgeries, the intra-operative and post-operative complications were 3% and 16%, respectively. 4% died within 30 days, and 11% died within one year [35].

In our study, regarding post-operative complications, the sensitivity of the MFS was 78.79% and the specificity was 76.60%. The positive predictive value of the MFS was 70.27% and the NPP was 83.72%. Also, regarding mortality, the sensitivity of MFS was 57.14% and the specificity was 54.79%. The positive predictive value of MFS was 10.81% and the NPP was 93.02%.
On the other hand, a study which was done by Kim, et al., the sensitivity and specificity of MFS for predicting all-cause mortality rates were 84% and 69.2%, respectively [8].

By the ROC curve, in our study we developed a new cut-off point (6) for prediction of post-operative complications, at which the sensitivity of MFS is 66.67% and specificity is 91.49%. Also, regarding prediction of mortality, we developed 9 as a new cut-off point with sensitivity 42.86% and specificity 89.04%. The difference between our study and the original study may be due to specification of type of surgery which is orthopaedic surgeries in our study but in the original study was on any type of surgery.

One of the limitations of the study is short duration follow up for only 3 months so long-term postoperative squeal couldn't be evaluated. So that, we need more studies with longer duration follow up to predict long-term postoperative squeal.

Conclusion

The MFS demonstrated a good ability in predicting occurrence of postoperative complications, implying its potential value for preoperative assessment in elderly patients.

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