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Original Article

Evaluation of the Relationship between Frailty and Fracture Risk using Fracture Risk Assessment Tool in Patients 65 Years and Over

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ABSTRACT

Objective: There is no information in the literature examining the relationship between frailty and fracture risk. Our study used the fracture risk assessment tool (FRAX) to assess the link between frailty and fracture risk.

Methods: A single-center cross-sectional study. There were 120 patients overall who were 65 years of age or older. We assessed each patient's frailty using the Canadian Health and aging study (CHAS) Criteria. By using the FRAX, these patients' fracture risks were identified (FRAX). Measurements were made of the amounts of albumin, parathormone, 25-hydroxyvitamin D, calcium, and plasma.

Results: Forty-two men and 78 women out of 120 patients were evaluated. Frailty and FRAX showed a substantial positive connection (p=0.01). Frailty risk was 1.228 times greater (p=0.023) in the group with a high risk of hip fracture. The risk of frailty was 2,755 times higher in the group, which is a high risk for significant osteoporotic fracture risk (p=0.027).

Conclusion: There is a positive relationship between frailty and risk of fracture evaluated by FRAX in individuals aged 65 years or older. Hip fracture risk and significant osteoporotic fracture risk both rise with increasing frailty.

INTRODUCTION

Frailty is an important clinical and public health problem, due to the decline in the functional capacity of the individual, dependence, falls, fractures, hospitalizations, increased need for care homes, and many other similar problems.

An increase in the number of frail patients is seen concurrently with the world's aging population's rapid growth.[1,2]

Osteoporosis is described by the World Health Organization (WHO) as "a silent, systemic skeletal disease characterized by reduced bone mass, deteriorated bone microstructure, and an elevated risk of fracture susceptibility."[3]

The WHO developed the fracture risk assessment tool (FRAX), a web-based algorithm that uses data from extensive cohort studies to calculate the risk of fracture based on clinical risk factors and femoral neck bone mineral density (BMD). Despite their limitations, FRAX is used to estimate the likelihood of a hip fracture or significant osteoporotic fracture within 10 years utilizing these risk factors.[3–6]

It has been demonstrated in earlier, constrained clinical trials that common variables contribute to the genesis of osteoporosis and frailty.

Our study's objective was to assess the connection between frailty and the risk of fracture in individuals 65 years and older.

MATERIALS AND METHODS

This cross-sectional research was placed in a single center. The study included a total of 120 consecutive patients

who were admitted to an internal medicine clinic and were 65 years of age or older as a result of the power analysis. The regional ethics committee gave the study its approval (Approval no: 6063, March 14, 2017). All patients provided informed consent in accordance with the Declaration of Helsinki and the procedures of the Institutional Review Board.

Patients with a history of fracture, malignancy, or conditions that have a strong relationship with secondary osteoporosis were excluded from the study.

In the assessment of frailty Turkish version of the CHAS was applied to all patients.[7] The ability to walk independently, carry out activities of daily living independently, have incontinence of the feces or urine, have dementia or cognitive impairment without dementia, and be completely dependent during mobilization were all taken into account when determining the degree of frailty. Patients with a score of 0 were defined as non-frail, with a score of 1–2 defined as prefrail, and with a score of 3 were defined as frail according to CHAS frailty criteria.[7–9]

Age, gender, height, weight, use of steroids, continued use of tobacco and alcohol, rheumatoid arthritis diagnosis, diseases that may cause secondary osteoporosis, history of previous fractures, and family history of hip fracture were among the factors taken into account when calculating the FRAX score. The DXA technique was used to assess BMD. The femoral neck, trochanter, Ward's area, and the mean of this region were measured for nondominant proximal femur measures. The basis for FRAX scoring was the femoral neck BMD value. Percentages were used to assess the 10-year likely risk of hip fracture and significant osteoporotic fracture.[10–12]

Major osteoporotic fracture risk was split into two categories: low risk (10%) and high risk (>10%).[10] Based on a mean value, patients with low risk and high risk of hip fracture were separated into two groups. BMD is calculated from the total of the two regions.[13]

We tried to assess the link between frailty and FRAX parameters, as well as factors influencing frailty. According to BMD (normal, osteopenia, and osteoporosis), frailty (non-frail, prefrail, and frail), age (between 75 and 75), hip fracture risk (between 3,4033 and 3,4033), and major osteoporotic fracture risk (between 10% and 10%), patients were separated into groups. PTH levels (65 pg/mL "normal" and "high"), calcium levels (8,5 mg/dL "low" and 8.5–10.5 mg/dL "normal"), and albumin levels (3.5 mg/dL "low" and 3.5 mg/dL "normal"). 25-OH vitamin D levels (10 ng/mL "deficient," 11–30 ng/mL "insufficient," and >30 ng/mL "normal All variables were contrasted across all groups."

The SPSS 22.0 statistical analysis program was used for all calculations (Statistical Package for the Social Sciences). $p<0.05$ was chosen as the cutoff for statistical significance.

RESULTS

Table 1 summarizes the distribution of the cases. According to DXA results, of the study's participants, 40% had osteopenia, 37.5% had osteoporosis, and 22.5% were normal. The rate of the patients with a higher risk for hip fracture was 34.2% and for major osteoporotic fracture was 37.5%. Of the patients 30% were non-frail, 50.8% were prefrail, and 19.2% were frail (Table 1).

Table 1. Distribution of the cases

		n	%
Bone mineral density	Normal	27	22.5
	Osteopenia	48	40.0
	Osteoporosis	45	37.5
Hip fracture risk	Low risk	79	65.8
	High risk	41	34.2
Major osteoporotic risk	Low risk	75	62.5
	High risk	45	37.5
Frailty group	Nonfrail	36	30.0
	Prefrail	61	50.8
	Frail	23	19.2
Vitamin D group	Deficient	56	46.7
	Insufficient	51	42.5
	Normal	13	10.8
PTH group	Normal	79	65.8
	High	41	34.2
Albumin group	Low	20	16.7
	Normal	100	83.3

PTH: Parathormone.

Frailty and FRAX parameters showed a substantial positive association (Table 2). Major osteoporotic fracture risk, hip fracture risk, and aberrant BMD were all positively connected with frailty (r=0.196*), whereas albumin levels were inversely correlated (r=−0.360**) (Table 2). Frailty was defined as a dependent variable and univariate logistic regression analysis was performed. Age, hip fracture risk, severe osteoporotic fracture risk, and inadequate BMD were the factors that affected frailty, in that order.

The risk of frailty was 5.8 times higher in the age group over 75 than in the age group under 75 years.

Frailty risk was 1.228 times greater in the high hip fracture risk group than in the low-risk group.

The risk of frailty was 2.755 times higher in the group with a high major osteoporotic fracture risk than in the group with low risk.

1.789 times more feeble people in the group with abnormal bone density than in the group with normal BMD (Table 3).

The risk of hip fracture and major osteoporotic fracture was substantially higher in the pre-frail and frail groups than in the non-frail group when the frailty groups were compared in terms of fracture risk ($p<0.05$) (Table 4). The percentage of patients over 75 years old, the percentage of patients with higher PTH levels, and the gender distribution were substantially different across the three groups

Table 2. Correlation of frailty with other parameters

No		1	2	3	4	5	6	7	8
1	Frailty	1							
2	Hip fracture risk	.265**	1						
3	Major osteoporotic risk	.196*	.821**	1					
4	Abnormal BMD	.205*	.551**	.504**	1				
5	Vitamin D	-.102	.071	.055	-.042	1			
6	PTH	.037	.185*	.132	.158	-.218*	1		
7	Albumin	-.360**	-.008	.069	.088	.282**	-.065	1	
8	Gender	-.037	-.381**	-.460**	-.467**	-.127	-.017	-.188*	1

1: Pearson correlation analysis **p<0.01, *p<0.05. BMD: Bone mineral density; PTH: Parathormone.

Table 3. Factors affecting frailty

Variables	B	Sig.	Exp(B)	95% CI for Exp(B)		R^2
				Lower	Upper	
Gender	.241	.559	1.273	.567	2.859	–
Age group	1.758	.000**	5.800	2.283	14.736	12.7%
Abnormal BMD	.582	.030**	1.789	1.058	3.028	5.6%
Hip fracture risk	.205	.023*	1.228	1.029	1.466	9.1%
Major osteoporotic fracture risk	1.014	.027*	2.755	1.125	6.750	6.2%
Calcium	-20.404	.999	.000	–	–	–
Vitamin D	-.516	.082	.597	.333	1.068	–
PTH	.419	.336	1.521	.648	3.570	–
Albumin	-20.628	.998	.000	–	–	–

1: Binary logistik analizi **p<0.01, *p<0.05. BMD: Bone mineral density; CI: Confidence interval; PTH: Parathormone.

Table 4. Comparison of FRAX parameters between frailty groups[1]

		Nonfrail		Prefrail		Frail		P[1]
		n	%	n	%	n	%	
Hip fracture risk	<3.4033	29	80.6	40	65.6	10	43.5	
	≥3.4033	7	19.4	21	34.4	13	56.5	.014*
Major osteoporotic fracture risk	<%10	28	77.8	35	57.4	12	52.2	
	≥%10	8	22.2	26	42.6	11	47.8	.050*

1: Chi-square test p value **p<0.01, *p<0.05. FRAX: Fracture risk assessment tool.

when patients were split into three groups as normal, osteopenic, and osteoporotic, and compared (p<0.05).

When all parameters were compared in two different age groups (<75 and ≥75), there was a significant difference in frailty, major osteoporotic fracture risk, calcium, and Vitamin D. No significant change was observed in other variables according to age groups (p<0.05).

When patients were compared in terms of hip fracture risk, significant differences were found in age groups, Vitamin D groups, PTH groups, major osteoporotic fracture risk, and frailty groups (Table 5).

When all findings were compared in two different major osteoporotic fracture risk groups, a significant difference was found in age groups, Vitamin D groups, and hip fracture risk groups (Table 5).

DISCUSSION

In patients 65 years of age and older, the current investigation discovered a tight connection between frailty and the fracture risk assessed by FRAX. The frailty is correlated positively with FRAX parameters in the elderly.

Although there are studies in the literature showing FRAX scoring and frailty with various diseases independently of each other, there are few studies evaluating these two concepts together.

Table 5. Comparison of all parameters in different hip fracture and major osteoporotic fracture risk groups

		Hip fracture risk				
		Low		High		
		n	%	n	%	P[1]
Age	<75	54	68.4	10	24.4	
	≥75	25	31.6	31	75.6	.000**
Calcium group	Low	2	2.5	2	4.9	
	Normal	77	97.5	39	95.1	.497
Vitamin D group	Defficient	35	44.3	21	51.2	
	Insufficient	40	50.6	11	26.8	
	Normal	4	5.1	9	22.0	.004**
PTH group	Normal	57	72.2	22	53.7	
	High	22	27.8	19	46.3	.043*
Albumin group	Low	13	16.5	7	17.1	
	Normal	66	83.5	34	82.9	.931
major osteoporotic fracture risk	<%10	72	91.1	3	7.3	
	≥%10	7	8.9	38	92.7	.000**
Frailty group	Nonfrail	29	36.7	7	17.1	
	Prefrail	40	50.6	21	51.2	
	Frail	10	12.7	13	31.7	.014*
		Major osteoporotic fracture risk				
		%<10		≥%10		
		n	%	n	%	P[1]
Age	<75	52	69.3	12	26.7	
	≥75	23	30.7	33	73.3	.000**
Calcium group	Low	2	2.7	2	4.4	
	Normal	73	97.3	43	95.6	.599
Vitamin D group	Defficient	33	44.0	23	51.1	
	Insufficient	38	50.7	13	28.9	
	Normal	4	5.3	9	20.0	.011**
PTH group	Normal	53	70.7	26	57.8	
	High	22	29.3	19	42.2	.150
Albumin group	Low	14	18.7	6	13.3	
	Normal	61	81.3	39	86.7	.448
Hip fracture risk	Low	72	96.0	7	15.6	
	High	3	4.0	38	84.4	.000**
Frailty group	Nonfrail	28	37.3	8	17.8	
	Prefrail	35	46.7	26	57.8	
	Frail	12	16.0	11	24.4	.070

1: Chi-square test p value **p<0.01, *p<0.05. PTH: Parathormone.

In western societies, osteoporosis affects 30% of post-menopausal women and 8% of males over the age of 50 years.[14,15] In our study, our patient group, which included 65% post-menopausal women, had an osteopenia frequency of 40% and an osteoporosis frequency of 37.5%.

In this study, it was found that the prevalence of osteoporosis was much higher in those over 75 than in those under 75 (62.2% vs. 37.8%). This age group also had significantly greater rates of risk for severe osteoporotic fractures and hip fractures. These findings supported that age is an important risk factor for osteoporosis similar to the literature.

In a study conducted in Japan, the risk of fractures under 50 years of age was 5%, whereas it was shown to be 20% in patients over 80 years old.[16] In a study conducted by Ettinger et al.,[6] it was shown that as age increased, the risk of fracture increased and female gender was an important factor in increased risk. Between the ages of 50 and 54 years, the risk of fractures was 0.66%, but between the ages of 54 and 85 years, it was 5.37% for women and 2.10% for males. Once you reach the age of 85, this rate rose to 24.88%. In a study by Li et al.,[17] it was discovered that women over the age of 70 had a 2.2% risk of hip

fractures and a 24.3% risk of significant osteoporotic fractures. FRAX has been recommended as a screening tool for preventing hip fractures.[18] According to study results, FRAX models with BMD perform better than those without BMD[19] when compared to the probability.

In our study, the rate of cases with low risk in terms of hip fracture risk was 65.8%, whereas the rate of cases with high risk was 34.2%. Similarly in the major osteoporotic fracture risk groups, it was shown that the rate of the low-risk group was 62.5% and the high-risk group was 37.5%.

The association between frailty and osteoporosis was examined by Li et al.[20] It has been determined that measuring an elderly person's level of frailty may help with the assessment, treatment, and decision-making processes for osteoporosis and osteoporotic fractures.

When the degree of frailty was evaluated in our study, it was seen that 30% of the cases were non-frail, 50.8% were prefrail, and 19.2% were frail.

A total of 16,584 individuals aged 50 years and older were assessed in a thorough investigation carried out in 10 distinct European nations. While the rate of frailty was 4.1% and the rate of prefrailty was 37.4%, in the middle age population, the rate of frailty was found to be 17% and the rate of prefrailty was 42.3% in the population aged 65 years and over.[21]

Akın et al.[22] included 906 people aged 60 years and over in their study based on two different frailty scales. In this study, the prevalence of frailty was found to be 10–27.8% and the prevalence of prefrailty was 34.8–45.6%. Comparing these rates with our results, in our country, the rate of both frailty and prefrailty are higher than in Europe.

Numerous studies have demonstrated that prefrailty and frailty rise with age.[22–24] In our study, patients under the age of 75 had a pre-frailty rate of 42.2% and a frailty rate of 12.5%. This ratio significantly increased to 60.7% and 26.8%, respectively, in the population who were ≥75 years old. In the regression analysis that explained the frailty, the frailty risk was found 5.8 times higher in the ≥75 age group, compared to the <75 age group. Our findings supported the findings obtained in other studies.

A substantial difference between the frailty groups and the risk of hip fracture and the major osteoporotic fracture was discovered in the Chi-square analysis.

In our study, the rates of being at high risk for hip fracture in the non-frail, prefrail, and frail groups, respectively, were 19.4%, 34.4%, and 56.5%. In addition, the rate of being at high risk in terms of major osteoporotic fracture risk was 22.2%, 42.6%, and 47.8% in the non-frail, pre-frail, and frail groups, respectively.

Considering the explanation powers of being frail, the highest explanation rate was observed in the age group with 12.7%. Frailty was affected by the risk of hip fracture (9.1%), risk of major osteoporotic fracture (6.2%), and bone density (5.6%), respectively. The risk of frailty was 1.228 times higher in the group that is most at risk for hip fractures. The risk of frailty was 2,755 times higher in the group, which is at high risk for significant osteoporotic fracture risk. The frailty risk of the abnormal bone density group was 1.789 times higher compared to normal group.

Kutlu et al.[25] reported that risk determination with BMD gave more accurate results in a 10-year fracture risk study. Ipek et al.[26] stated that FRAX risk scoring was superior in terms of sensitivity and selectivity.

The most significant risk variables for major osteoporotic fracture risk were a history of a major osteoporotic fracture, advancing age, and a lower T-score in research by Aslan et al.[27] with 104 patients. They concluded that the FRAX-Turkey model could forecast the fracture risk in those areas.

In a study evaluating 2,266 postmenopausal Chinese women with an average age of 62.1±8.5 years, ethnic factors, fragility, performance evaluation, and FRAX model were evaluated. Patients were followed for an average of 4.5 years. A total of 106 new osteoporotic fractures, 21 of which were hip fractures, were detected. They found that ethnic-specific clinical risk factors evaluated together with the T-score were more effective in catching major osteoporotic fractures than the FRAX model. Compared to FRAX, the sensitivity of the ethnic-specific clinical risk factor model was found to be above 10% and the specificity was 0.8 and above. This study emphasized the importance of ethnicity and frailty of that society in determining major osteoporotic risks.[28]

A study by Demir et al.[29] concluded that the FRAX risk assessment scale is an important, cost-effective, and easy-to-use evaluation method in assessing 10-year osteoporotic fracture risk, independently from BMD.

The rate of patients with the age of ≥75 and with a level of PTH ≥65 pg/mL was higher in osteopenic and osteoporotic groups compared to the normal group. A negative relationship was found between frailty and albumin in our study supporting other studies.

There was a significant difference in calcium and Vitamin D levels between age groups when all results were compared by age group. The age group under 75 years had a lower calcium rate of 7.1%. In the age group of 75, the rate of Vitamin D deficiency was 55.4% and the rate of insufficient Vitamin D was 28.6%. A significant difference was found between age groups, Vitamin D, and PTH in two different hip fracture risk groups. In the group with a low risk of hip fracture, the rate of low Vitamin D was 44.3%, and in the high-risk group, it was 51.2%. The rate of patients with a PTH ≥65 pg/mL was 27.8% in the group with low risk of hip fracture whereas it was 46.3% in the high-risk group. These data supported that low Vitamin D and secondary hyperparathyroidism caused calcium dissolution from bone, causing a tendency to secondary osteoporosis and increasing the risk of fractures in concordant with the literature.

Our study was interesting because it was the first study investigating the correlation between frailty and FRAX.

Limitations

The present study had some limitations. First, our study was a cross-sectional study. Therefore, a direct causal relationship could not be established between frailty and FRAX scoring systems. Second, this study was designed as a single-center study; thus, our results may not be valid for all patients admitted to the internal medicine clinics.

CONCLUSION

The purpose of this study was to determine how frailty and FRAX parameters relate to one another.

In our research, we discovered a substantial link between frailty and the risk of fracture in people 65 years of age and older. Frailty has been shown to increase the risk of fractures.

We determined the undesirable effect of age and female gender, which are among the risk factors of osteoporosis, on the risk of fracture. Although we have shown that age is a significant risk factor for frailty, no connection has been made between frailty and gender.

With this study, we showed that the risk of fractures increases as frailty increases in patients over 65 years of age.

Ethics Committee Approval

This study approved by the Ümraniye Training and Research Hospital Clinical Research Ethics Committee (Date: 14.03.2017, Decision No: 6063).

Informed Consent

Prospective study.

Peer-review

Externally peer-reviewed.

Authorship Contributions

Concept – S.B., B.D., O.B.; Design – S.B., B.D., O.B.; Supervision – S.B.; Materials – B.D.; Data collection and/or processing – B.D., F.K., B.A., S.B.; Analysis and/ or interpretation – B.D., B.A., S.B.; Literature search – S.B., B.D., F.K.; Writing – B.D., F.K., S.B., O.B. B.A.; Critical review – S.B., B.A.

Conflict of Interest

None declared.

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65 Yaş ve Üzeri Hastalarda Kırılganlık ve Kırık Riski Arasındaki İlişkinin Frax Kullanılarak Değerlendirilmesi

Amaç: Literatürde kırık riski ile kırılganlık arasındaki ilişkiyi değerlendiren veri bulunmamaktadır. Çalışmamızda FRAX adı verilen Kırık Riski Değerlendirme Aracı ile kırılganlık ve kırık riski arasındaki ilişkinin değerlendirilmesi amaçlanmıştır.

Gereç ve Yöntem: Tek merkezli kesitsel bir çalışmadır. Çalışmaya 65 yaş ve üzeri toplam 120 hasta dahil edildi. Tüm hastalara kırılganlıklarını belirlemek için Kanada Sağlık ve Yaşlanma Çalışması (CHAS) Kriterleri uygulandı. Bu hastaların kırık riskleri, Kırık Riski Değerlendirme Aracı (FRAX) uygulanarak tespit edildi. Plazma kalsiyum, 25-hidroksi D vitamini, albümin ve parathormon düzeyleri ölçüldü.

Bulgular: Yüz yirmi hastanın 78'i kadın (%65) ve 42'si erkek (%35) olarak değerlendirildi. Kırılganlık ile FRAX arasında pozitif yönde anlamlı korelasyon saptandı ($p<0.01$). Kalça kırığı riski yüksek olan grupta kırılganlık riski 1.228 kat daha yüksekti ($p=0.023$). Majör osteoporotik kırık riski açısından yüksek risk altında olan grupta kırılganlık riski 2,755 kat daha yüksekti ($p=0.027$).

Sonuç: Altmış beş yaş ve üzeri bireylerde kırılganlık ile FRAX ile değerlendirilen kırık riski arasında pozitif bir ilişki vardır. Kırılganlık arttıkça majör osteoporotik kırık riski ve kalça kırığı riski de artmaktadır.

Anahtar Sözcükler: FRAX; kırılganlık; osteoporoz; yaşlılık.