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Original Article

A cross-sectional study of the relationship between facial wrinkles and osteoporosis among individuals referred for bone densitometry

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Abstract

Background Osteoporosis is a systemic disease that leads to mechanical fractures by decreasing bone density. Postmenopausal women with fractures following osteoporosis reportedly have thinner skin. This study evaluated the relationship between bone density and facial wrinkles.

Methods We conducted an analytical-cross-sectional study featuring 427 patients aged 40-80 referred to a bone density measurement center in Yazd in 2021. Demographic and clinical data were collected using a questionnaire. A dermatologist assessed wrinkles in 11 zones of the face as per the Lemperle scale.

Results The mean age of the participants was 69.63 years, with a slight female predominance noted (57%). The mean lumbar T-score was -2.69±0.71, and the mean femoral T-score was -2.69±0.72. Facial wrinkles increased with age and negatively correlated with lumbar and femoral T-scores. The findings were replicated after adjusting for other effective risk factors such as connective tissue/bone disorders, diabetes, corticosteroid use, and smoking.

Conclusion The increase in facial wrinkles with aging was associated with a decline in bone density in those at risk of osteoporosis. This observation could assist in accounting for facial wrinkles as a risk factor for osteoporosis, so that earlier diagnosis and intervention could be initiated. Longitudinal studies should further investigate this association.

Key words
Bone density; Postmenopause; Osteoporosis; Skin aging.

Introduction

Osteoporosis, a dominant concern regarding the geriatric population, is a skeletal disorder resulting from an imbalance in bone microarchitecture and elevated vulnerability to mechanical stress and fractures.[1] The general prevalence of osteoporosis is 18.3%, with women being affected slightly more (23.1%) than men (11.7%).[2] This condition places a noticeable burden on society's health and economy.[3]

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Osteoporosis usually acts as a veiled disorder that eventuates in fractures, giving rise to morbidity and mortality. Risk assessment and early diagnosis are crucial for alleviating its complications.[4] Certain medications (e.g., corticosteroids), alcohol consumption, smoking, and weight are some of the modifiable risk factors for developing osteoporosis. The non-modifiable risk factors include age, gender, race or genetic predisposition.[2] Menopause, particularly when developed prematurely, can accelerate the progress of osteoporosis while also affecting the integumentary, metabolic and cardiovascular systems.[5]

With aging, the quality of collagen (95% of the skin) and elastin fibers deteriorates, appearing as skin wrinkles.[6] Menopause, as an estrogen-deficient situation, alters the molecular skin composition by reducing vascularity, elastin and collagen and increasing the enzymatic activity of the matrix metalloproteinases, resulting in skin wrinkles, dryness, atrophy and wound healing impairment.[7]

Through various studies in time, a correlation between osteoporotic fractures and thin and transparent skin was detected.[8,9] These observations lead to a hypothesis indicating that bone degeneration and skin wrinkles could progress simultaneously as their constituents are similar. Therefore, a foundation for further evaluation of association of osteoporosis with skin wrinkles was formed.[10,11] In this study, we investigated the relationship between osteoporosis and facial wrinkles to help provide further evidence in accounting for facial wrinkles as a tool to screen osteoporosis and predict fracture risk.

Methods

We conducted an analytical cross-sectional study at Imam Ali Clinic (Yazd, Iran), a referral center for assessing bone densitometry. Four hundred and seventy-two patients aged 40 to 80 were referred by a specialist for bone densitometry assessment and participated in this study. The study objectives were explained, and patients were assured their information would remain confidential and they were permitted to withdraw at any time. After written informed consent was obtained from all patients, their demographic data, medical issues, and medication history were recorded.

As the gold standard in measuring bone mass and predicting fracture, a dual-energy X-ray absorptiometry (DEXA) scanner manufactured by *Hologic Explorer* was utilized to assess osteoporosis in the hip and spine. The number (gr/cm^2) extracted from DEXA was translated to a T-score. Osteopenia was defined as T-score between -1 and -2.5, and T-scores less than -2.5 were considered osteoporosis, per the World Health Organization definition.[12]

Facial wrinkles were assessed by a dermatologist in 11 zones of the face (horizontal forehead lines, glabellar frowns, periorbital lines, periauricular lines, nasolabial fold, chin folds, upper lip lines, corner of mouth lines, marionette lines, chin crease, and neck folds) using the Lemperle scale, and the severity of wrinkles was classified from 0 to 5 points.[13]

Data were entered into SPSS version 22 and subsequently analyzed. Pearson correlation and t-test were used to evaluate the association between face wrinkle grades and osteoporosis severity. A P-value of less than 0.05 was considered statistically significant.

Results

A total of 472 participants, consisting of 269 (57%) females and 203 (43%) males, were included in the study. The mean age was

Table 1 Demographic data of the participants

Variable	*Number (%)*
Gender	
Male	203 (43)
Female	269 (57)
Smoker	93 (19.7)
Corticosteroid use	332 (68.2)
Connective tissue/bone disorders	322 (68.2)
Type 1 diabetes	7 (1.5)
Type 2 diabetes with insulin therapy	76 (16.9)
Type 2 diabetes with oral medications	62 (13.1)
Femoral bone density	
T-score ≥-1	2 (0.4)
-2.5≤ T-score <-1	184 (39)
T-score <-2.5	286 (60.6)
Lumbar bone density	
T-score ≥-1	2 (0.4)
-2.5≤ T-score <-1	183 (38.8)
T-score <-2.5	287 (60.8)

Table 2 The Lemperle score for each facial zone and bone density measurements.

Variable	*Mean (SD)*	*Min/ Max*
Horizontal forehead lines	3.61 (0.99)	1/ 5
Glabellar frowns	3.88 (0.96)	0.5/ 5
Periorbital lines	3.91 (1.02)	0/ 5
Preauricular lines	2.81 (1.12)	0/ 5
Nasolabial folds	4.20 (0.87)	1/ 5
Cheek folds	2.92 (1.17)	0/ 5
Upper lip lines	3.09 (1.23)	0/ 5
Marionette lines	3.05 (1.10)	0/ 5
Chin crease	3.10 (1.06)	0/ 5
Neck folds	3.73 (0.96)	1/ 5
Corner of mouth lines	2.93 (1.09)	0/ 5
Lumbar T-score	-2.69 (0.71)	-4.70/ -1
Femoral T-score	-2.69 (0.72)	-4.52/ -0.59

69.63±7.81, ranging from 43 to 80 years. Overall, 60.7% of all patients had osteoporosis, while 38.9% had osteopenia. Further demographic data are depicted in **Table 1**.

Eleven zones of the face were assessed for wrinkles. Nasolabial folds were observed to show maximum severity of wrinkling, and the corner of mouth lines had the least amount of wrinkling. The mean Lemperle scores for each zone are depicted in **Table 2**. Overall, the mean Lemperle score for facial wrinkles in participants younger than 70 was 3, and in those older than 70 was 4.23. T-test analysis revealed a significant relationship between age and the severity of facial wrinkles; those who were 70 or older had significantly higher Lemperle scores than those younger than 70.

In regards to gender, the average Lemperle score in the horizontal forehead lines in women was 3.58, while in men was 3.71. The t-test revealed glabellar frown lines, periorbital lines, and nasolabial folds had significantly higher severity of facial wrinkles in men, while women had a significantly higher severity in their neck fold wrinkles. Average Lemperle scores in regard to gender and age are depicted in **Table 3**. After excluding the 72 participants with a bone/connective tissue disorder, a history of

Table 3 The average Lemperle score for each facial zone in 72 participants, categorized by age and gender.

Variable	*Age (years)*		*P-value*	*Gender*		*P-value*
	<75 (n=33) Mean (SD)	*≥75 (n=40) Mean (SD)*		*Male Mean (SD)*	*Female Mean (SD)*	
Horizontal forehead lines	3.75 (0.71)	4.75 (0.39)	<0.0001*	3.71 (0.96)	3.58 (1.01)	0.152
Glabellar frowns	3.89 (0.49)	4.75 (0.35)	<0.0001*	4.04 (1.09)	3.75 (0.78)	0.001*
Periorbital lines	3.42 (0.69)	4.3 (0.49)	<0.0001*	3.54 (0.91)	3.27 (1.09)	0.004*
Periauricular lines	3.01 (0.78)	4.16 (0.66)	<0.0001*	2.87 (1.07)	2.76 (1.15)	0.276
Nasolabial folds	4.19 (0.41)	4.8 (0.37)	<0.0001*	4.35 (0.70)	4.08 (0.97)	0.001*
Cheek folds	3.10 (0.92)	4.08 (0.59)	<0.0001*	2.99 (1.09)	2.87 (1.23)	0.263
Upper lip lines	3.12 (0.94)	4.12 (0.63)	<0.0001*	3.19 (1.09)	3.02 (1.33)	0.137
Marionette lines	3.45 (0.77)	4.25 (0.57)	<0.0001*	3.02 (1.09)	3.08 (1.11)	0.499
Chin crease	3.25 (0.85)	4.11 (0.76)	<0.0001*	3.10 (1.05)	3.10 (1.07)	0.945
Neck folds	3.77 (0.71)	4.46 (0.52)	<0.0001*	3.54 (0.98)	3.87 (0.93)	<0.0001*
Corner of mouth lines	3.11 (0.87)	4.11 (0.67)	<0.0001*	2.97 (1.04)	2.90 (1.12)	0.530

*****P-value less than 0.05 was considered significant.

taking corticosteroids or immunosuppressive medications, diabetes, or smoking habits, the mean Lemperle score in the horizontal forehead lines was 4.75 for those aged 75 or more, compared to 3.75 in those younger than 75. The t-test revealed a significant difference in the severity of facial wrinkles and age.

Regarding gender, in these 72 participants, the average Lemperle score in women was 4.17, while it was 4.48 in men. The t-test revealed that men had a significantly higher severity of wrinkles in the periauricular lines, chin creases, cheek folds, the corner of mouth lines, upper lip lines and marionette lines.

The Pearson correlation test assessed the association of facial wrinkles with lumbar and femoral T-scores. The results revealed that in all 11 zones, a significant negative correlation with the femoral and lumbar T-scores was observed. That indicates that with the increase in the severity of facial wrinkles, the femoral and lumbar T-score declines, and the severity of bone degeneration increases. These results persisted after excluding the 72 participants with bone/connective tissue disorders, a history of taking corticosteroids or immunosuppressive medications, diabetes, or smoking habits. The detailed results of the Pearson correlation test are depicted in **Table 4**.

Discussion

Osteoporosis, a systemic bone mineral deficiency disease, is a culprit in low-impact pathological fractures that lead to quality of life deterioration, disability, morbidity and mortality.[14] Various studies have perceived an association between osteoporosis and thinner skin.[8,9,15] This study evaluated the possible relationship between osteoporosis and facial wrinkles. The results revealed that facial wrinkles, evaluated in 11 zones of the face, had a significant negative correlation with the femoral and lumbar T-scores.

Table 4 The association of facial wrinkles with the lumbar and femoral T-scores using Pearson's correlation test.

Variable	*Correlation coefficient (r) P-value*			
	Lumbar T-score		*Femoral T-score*	
	< -2.5	*-2.5 to -1*	*< -2.5*	*-2.5 to -1*
Horizontal forehead lines	-0.202 <0.001	-0.425 <0.001	-0.222 <0.001	-0.449 <0.001
Glabellar frowns	-0.298 <0.001	-0.452 <0.001	-0.329 <0.001	-0.453 <0.001
Periorbital lines	-0.215 <0.001	-0.464 <0.001	-0.235 <0.001	-0.469 <0.001
Periauricular lines	-0.187 <0.001	-0.394 <0.001	-0.217 <0.001	-0.435 <0.001
Nasolabial folds	-0.153 <0.001	-0.458 <0.001	-0.145 <0.001	-0.398 <0.001
Cheek folds	-0.290 <0.001	-0.376 <0.001	-0.307 <0.001	-0.443 <0.001
Upper lip lines	-0.273 <0.001	-0.418 <0.001	-0.264 <0.001	-0.469 <0.001
Marionette lines	-0.178 <0.001	-0.350 <0.001	-0.187 <0.001	-0.387 <0.001
Chin crease	-0.199 <0.001	-0.287 <0.001	-0.190 <0.001	-0.328 <0.001
Neck folds	-0.210 <0.001	-0.231 <0.001	-0.157 <0.001	-0.213 <0.001
Corner of mouth lines	-0.120 <0.001	-0.357 <0.001	-0.132 <0.001	-0.390 <0.001

Skin and bone are interconnected through their biochemical constituents, mainly collagen.[11] The general process of aging could contribute to this correlation. As age progresses, the connective tissue ingredients undergo modifications in which the collagen, the main component of both skin and bone, undergoes the same process.[8,16,17] Androgen therapy in menopausal females with low skin collagen and osteoporosis increased skin collagen.[9] Hence, it is hypothesized that with the assumption that all collagen of the body would alter equally, the skin and bone are expected to act in the same manner, particularly in postmenopausal osteoporosis.[11,18,19]

A decline in collagen and disorganization of the elastic fibers is observed through skin aging, resulting in skin thinning and wrinkling.[20] Furthermore, bone mass regresses through aging, accelerating in the postmenopausal era.[21] These theories support a correlation between osteoporosis and skin wrinkling. Evaluation of patients with contralateral pelvic fractures revealed that they presented with thinner skin and lower body mass index (BMI) values. Moreover, thinner skin or lower BMI increased the fracture risk by threefold; when added with each other, they increased the fracture risk by fivefold.[11]

Yoneda *et al*. assessed the relationship between skin thickness on the back of the hands with osteoporosis. They observed a significant correlation, which persisted even after eliminating other risk factors such as age, smoking history, or corticosteroid use, which is in line with our findings.[22] Furthermore, the relation of skin fold thickness (SFT) with osteoporosis has been appraised, and lower SFT was linked with a higher rate of osteoporosis; in reverse, a high SFT was a protective factor for bone mass. This association was significantly stronger in postmenopausal females.[23-27] In conclusion, it can be deduced that skin thickness and wrinkles could represent a non-invasive tool for screening osteoporosis.

There are several limitations to this study that need to be addressed. The study was cross-sectional in nature and the study population was selected from a referral center for osteoporosis evaluation; future studies should also include the normal population. Longitudinal studies regarding the sensitivity of using the Lemperle scale as a screening method for osteoporosis should be conducted.

Conclusion

Osteoporosis was observed to have a significant relationship with the severity of facial wrinkles in 11 zones of the face, with this relationship persisting after eliminating other risk factors for osteoporosis. This study offers promising evidence to initiate endeavors toward understanding the association between skin wrinkles and osteoporosis. These results could assist in structuring a novel non-invasive, accessible and cheap method to screen osteoporosis, where skin wrinkles might indicate the need for further assessment of osteoporosis via bone scans.

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