Changes in bone mass and biochemical indices in patients with Colles and femoral neck fracture

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In this study, the values of bone mineral density (BMD), bone mineral content (BMC) and bone related biochemical assays were obtained in 20 patients with femoral neck fractures and 30 patients with Colles fractures.

BMD and BMC measurements were determined by photon absorptiometry at vertebrae, mid and distal radius.

When the patients with femoral neck fractures were compared to the age-and sex-matched controls, the trabecular and cortical bone loss were significantly higher in the former group. According to the BMD values, bone loss ratios were 21% at L2L4, 20% at mid radius, 24% at distal radius in men; ($p<0.01$), but 35% at L2L4, 33% at mid radius and 45% distal radius in women; ($p<0.001$). Similar results were also obtained in patients with distal radius fractures. According to the BMD values, bone loss ratios were 23% at L2L4, 23% at mid radius, 27% at distal radius in men; $p<0.001$, but 23% at L2L4, 18% at mid radius and 22% at distal radius in women; ($p<0.001$, $p<0.05$ and $p<0.01$). The loss of bone mass was the highest in female patients with femoral neck fractures.

The body mass index (BMI) was significantly lower in all osteoporotic patients expect for female patients with femoral neck fractures. In general, there was not any significant difference between the biochemical indices of healthy and osteoporotic subjects. [Turk J Med Res 1993; 11(1): 37-43]

Key Words: Femoral neck fracture, Colles fracture, Bone mineral density, Bone mineral content

Osteoporosis, the commonest bone disorder and a clinical definition, is characterized by a reduction in bone mass that compromises the biomechanical integrity of the skeleton and is complicated by fractures. Osteoporosis is categorized in two main groups; primary and secondary. While in secondary osteoporosis there is another disease or a cause responsible for osteoporosis, there is no such a cause in primary osteoporosis.

Primary osteoporosis can also be categorized in two different types having different general characteristics. Type I osteoporosis (postmenopausal) is a case observed in postmenopausal women after the age 55 and where the trabecular bone loss is dominant.

Vertebrae fractures and distal radius (Colles) fractures are often observed in these atients. Type II osteoporosis (senil) is the type of osteoporosis with both trabecular and cortical bone losses, observed in old patients and manifesting itself with femoral neck fractures.

Various investigators have shown that average trabecular bone ratios were 73% in vertebrae constituting the axial skeleton system; 69-90% in lumbar vertebrae; %25 in femoral neck constituting appendicular skeleton system; 5-10% in midradius and 30-40% in distal radius (1,2).

A lot of investigators studied the relation between bone mass loss and fracture and particularly determined that the fracture risk increases when the bone mineral mass decreases more than 20% of the normal value (3,4). In femoral neck fractures, authors put forward different views. Some authors state that these persons are not osteopenic (1,5,6) and others support that bone mass loss is an important cause (7,8). But they all agree that trabecular bone mass loss is responsible for Colles fractures (9-11).

Bone turnover markers and other biochemical indices related with bone metabolism is generally found to be normal other than osteoporotic cases where turnover rates are high (12,13).

Received: May 20,1992 Accepted: Dec. 15,1992

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In this study, the changes ocurring in the bone masses and bone related biochemical indices of the primary osteoporotic patients with femoral neck and Colles fractures were investigated.

MATERIALS AND METHODS

This study is carried out on 50 primary osteoporotic patients who admitted to the GATA internal medicine and orthopedics outpatient clinics between May 1989-May 1991 and on healthy individuals who were seen at the check-up outpatient clinic.

Osteoporotic patients consisted of 50 person as a total of which 30 had Colles fractures (10 men, 20 women with the average ages 52, 70 and 56, 45 years) and femoral neck fractures (10 men, 20 women with the avarage ages 66, 70 and 64, 50 years).

Fractures were detected in each patient through direct radiography. Patients with severe degree osteoarthritis were excluded from the study. Patients Whose fractures are caused by little traumas during the post 6 months and the period 3 months ago, and who completely recovered were included in the study and the cases where the fractures occurred more than 6 months ago or not later than 3 months were excluded. There wasn't any additional disease other than primary osteoporosis in these patients and there was no history of medicine which has an affect on the calcium metabolism. The patients in these group were divided into four subgroups;

1. Male patients with femoral neck fractures (Group I)
2. Male patients with Colles fractures (Group II)
3. Female patients with femoral neck fractures (Group ill)
4. Female patients with Colles fractures (Group IV)

The Values for bone mineral density (BMD) and bone mineral content (BMC) of lumbar vertebrae and radius were measured by photon absorption technique and Norland 2600 Dichromatic Bone Densitometer device (8). BMD values were measured in all lumbar vertebrae (ALL) and L2L4 where as BMC value were measerud only in L2L4. BMD and BMC values of forearm were measured in two regions; in midradius and in distal radius. Measurements were made from the dominant arm for healthy individuals. For patients with femoral neck fractures measurements were made on the same arm if the fracture was not located at the dominant arm and from the other arm if the fracture is at the dominant arm for the patients with distal radius fractures.

Measurement of serum total calcium, phosphorus and and total alkaline phosphatase, and calcium, phosphorus measurements for a 24 hour urine were determined at Biochemistry Department by spectrophotometric method and Technicon RA-1000 autoanalyzer, and the urine hydroxproline values were measured spectrophotometrically by colorimetric method developed by Kivirikko and his friends (14). Hydroxyproline values were expressed as a ratio of creatinine in the same urine.

RESULTS

The average values and the results of the statistical analysis of male patients with femoral neck fractures (Group I) and age-/sex-matched controls are indicated

Tablet-. The average values and the results of the statistical analysis of male patients with femoral neck fractures (Group I) and healthy males

	n	AGE Yr	BMI kg/m^2	SERUM				URINE			BMD (g/cm^2)				BMC (g/cm)		
				Ca^{++} %mg	P %mg	ALP mU/ml	PTH ng/ml	Ca^{++} mg/ d	P mg/ d	HPR/Cr	ALL	L_2 L_4	Mid Radius	Distal Radius	L_2 L_4	Mid Radius	Distal Radius
PATIENTS	10	66.70 ±5.65	20.92 ±2.19	10.00 ±0.64	4.47 ±0.75	75.40 ±26.78	3.06 ±1.73	174.00 ±124.06	739.10 ±302.11	2.36 ±0.84	0.729 ±0.166	0.698 ±0.145	0.653 ±0.118	0.465 ±0.092	3.837 ±0.585	1.260 ±0.179	0.858 ±0.138
CONTROLS	10	67.20 ±7.30	23.95 ±3.00	9.68 ±0.88	4.52 ±0.84	81.40 ±31.18	2.99 ±1.72	196.20 ±107.64	681.10 ±283.06	2.69 ±1.14	0.899 ±0.140	0.882 ±0.145	0.837 ±0.104	0.610 ±0.089	4.714 ±0.743	1.236 ±0.351	0.972 ±0.236
T Test			p<0.0	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	p< 0.05 (% 19)	p< 0.01 (% 21)	p< 0.01 (% 20)	p< 0.01 (% 24)	p< 0.01 (% 19)	N.S (% 0)	N.S (% 12)

* : The values are shown as ± standart deviation
BMI : Body mass index
BMD : Bone mineral density
BMC : Bone mineral content
ALL : All lumbar vertebrae
LPI.1 : Second and fourth lumbar- vertebrae
NS : Not significant
( ) : The values in parenthesis KUOW tlit i-.il.io •<> hum: nl.-isf; loss

in Table 1 and the correlation characteristics are shown in Table 5. The average values and the results of the statistical analysis of female patients with femoral neck fractures (Group III) and age-/sex-matched controls are indicated in Table 2, and the correlation characteristics are shown in Table 6. The average values and the results of the statistical analysis of male patients with Colles fractures (Group II) and healthy males are indicated in Table 3, and the correlation characteristics are shown in Table 7. The avearge values and the results of the statistical analysis of female patients with Colles fractures (Group IV) and healthy females are indicated in Table 4, and the correlation characteristics are shown in Table 8.

Table 2. The average values and the results of the statistical analysis of female patients with femoral neck fractures (Group III) and healthy females

	n	AGE Yr	AGE OF MENOP. Yr	BMI kg/m^2	SERUM				URINE			BMD (g/cm^2)				BMC (g/cm)		
					Ca^{++} %mg	P %mg	ALP mU/ml	PTH ng/ml	Ca^{++} mg/d	P mg/d	HPR/Cr	ALL	L_2L_4	Mid Radius	Distal Radius	L_2L_4	Mid Radius	Distal Radius
PATIENTS	10	64.40 ±10.6	15.80 ±15.4	24.02 ±6.81	9.96 ±0.79	4.69 ±0.85	63.30 ±20.70	1.54 ±0.58	140.90 ±69.43	731.90 ±300.55	3.18 ±1.46	0.649 ±0.115	0.627 ±0.113	0.482 ±0.133	0.286 ±0.120	3.664 ±0.492	0.668 ±0.233	0.433 ±0.217
CONTROLS	16	63.81 ±6.52	13.93 ±7.44	25.32 ±2.69	9.63 ±0.80	4.65 ±0.65	74.12 ±22.83	2.74 ±1.50	254.46 ±231.39	1733.37 ±1802.70	2.84 ±0.70	0.976 ±0.153	0.959 ±0.153	0.720 ±0.157	0.524 ±0.119	4.668 ±0.554	1.164 ±0.252	0.890 ±0.228
t Test			N.S.	N.S.	N.S.	N.S.	N.S.	p < 0.05	N.S.	p < 0.05	N.S.	p < 0.00001 (% 34)	p < 0.00001 (% 35)	p < 0.001 (% 33)	p<0.0001 (% 45)	p < 0.0001 (% 22)	p < 0.0001 (% 40)	p < 0.0001 (% 51)

For the abbreviations see the footnotes shown

Table 3. The average values and the results of the statistical analysis of male patients with Colles fractures (Group II) and healthy males

	n	AGE Yr	BHI kg/m^2	SERUM				UBINE			BMD (g/cm^2)				BMC (g/o)		
				Ca^{++} tog	P tog	ALP	PHI iig/mi	Ca^{++} rog/d	P		ALL	L_2L_4	Mid Radius	Distal Radius		Mid Radius	Distal Radius
	10	¡270 112.4.	21.32 ±2.29	9.84 ±0.70	4.59 10.68	64.DO ±16.85	2.30 ±1.35	133.70 ±52.90	61S.20 ±272.16	2.27 ±0.76	0.7 2 ±0.0 94	0.778 ±0.083	0.713 10.095	0.499 ±0.087	3.797 ±0.142	0.881 ±0.087	0.783 ±0.111
1	10	S2.60 ±11. i;	25.95 ±3.67	9.82 ±0.57	4.34 ±0.76	76.4(±28.5	2.65 ±1.52	173.00 ±83.42	789.2 ±254.8	2.50 ¿0.75	1.023 ±0.164	1.007 ¿0.177	0.928 ±0.132	0.683 ±0.110	5.049 ±0.703	1.605 ±0.301	L.274 ¿0.285
\			p<0.0	IB	MS	Ña	MS	(6	NS	it;	p< 0.001 (X 23)	p< 0.001 (X 23)	p< 0.001 (* 23)	p< 0.001 (X 27)	p< 0.0001 (X 25)	p<0.000001 (X 45)	p< 0.0001 (X 39)

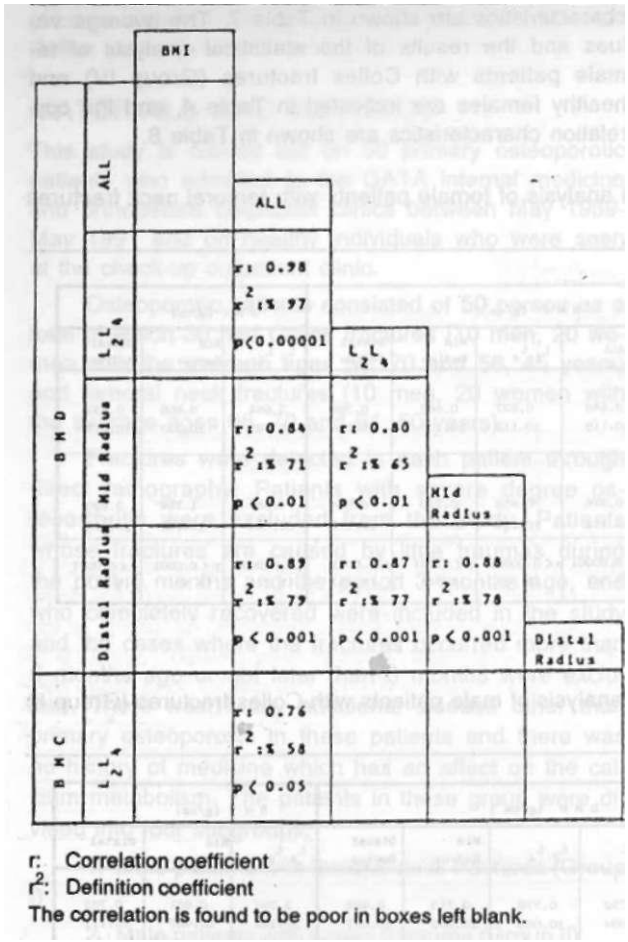
For the abbreviations see the footnotes shown i" Tabie-1

Table 4. The average values and the results of the statistical analysis of female patients with Colles fractures (Group IV) and healthy females

	«	AGE Yr	ACE OF MENP. Yr	BHI	SEiUM				URINE			BHD (g/cm·)				BHC (g/cm)		
					Ca^{++} tog	P tog	ALP ""/\	PIH	Ca" mg/ d	P mg/ i	IfR as	ALL	·2·4	Hld Radius	Distal Radius	·2·-4	Mid Radius	Distal Radios
1	20	S6.45 12.79	12.46 ±11.6	23.13 ±4.3<	9.71 :0.65	4.61 ±0.87	77.75 ±42.49	2.02 ¿0.49	127.00 ¿114.Q3	739.05 ±710.53	4. L9 ±4. 27	0.775 ¿0.134	0.742 ±0.138	0.620 ±0.203	0.443 ¿0.159	3.865 ±0.544	0.980 ±0.438	0.759 ¿0.340
I	13	56.38 ±5.83	7.00 ±4.79	26.4. ±4.2.	9.74 ¿0.5	4.59 ±0.72	77.00 ±23.20	2.79 ±1.70	200.26 ±227.35	1489.38 ¿1772.59	2. 33 ±0. 31	0.978 ¿0.159	0.969 ¿0.136	0.759 ¿0.149	0.567 ±0.081	4.489. ¿0.365	1.102 ¿0.257	0.925 ±0.185
14 c			IMS	P<0.C	' re	œ	NS	p< 0.05	NS	p<0 05	ie	p < 0.001 (X.21)	p< 0.0001 (X 23)	p< 0.05 (X 18)	p< 0.01 (X 22)	p < 0.001 (X 24)	16 (X 11)	(X 19)

For the abbreviations see the footnotes shown in Table-1

Table 5. The correlation of femur neck fractured males parameters that are different from controls



r: Correlation coefficient
r^2: Definition coefficient
The correlation is found to be poor in boxes left blank.

DISCUSSION

Significant bone mass loss was found in the vertebrae and appendicular bones of the male and female patients with femoral neck fractures. This loss was more significant in females as compared to males (Table 1 and 2). Cummings, (1985), reported 15 studies in this field (1). Cummings asserted that the measurements of cortical and trabecular bones, taken from different places by different techniques were lower only in 6 studies as compared to the controls and these were not significant; the patients with hip fractures infact were not significantly osteopenic because of the lack of a good correlation between BMD ii d BMC values in different places; and for these \ .Jents, the factors related with age could be more important in fractures (1). Some other investigator has also reported the same view (6,15). Cummings, et al, detected 53 hip fracture cases in a study that was performed prospectively in 1990 with 9703 females older than 65 (5). They found a reverse correlation between the fracture risk and the distal, proximal radius and calcaneous BMD's in the patients with hip fractures and though that the age related physiological loss was responsible for the bone mass loss in these places (5). On the other hand, Melton and his friends, in their study with 300 females performed in order to investigate prospectively the femoral neck and intertrochanterik fracture risk, determined a significant decrease in femoral and intertrochanteric region BMD's of the fracture cases and asserted that the bone mass loss was important in hip fractures (16). In their prospective studies performed on 521 white females, Hui, et al. friends determined fractures out of vertebrae and asserted that mid radius BMC values are useful in determining these fractures (17).

If the results of this study and our study are taken into account one can see that vertebral and appendicular bone mass losses seen both in males and females suggest that the patients with femoral neck fractures are significantly osteopenic. BMD measurements were found to be more significant (especially in males) in showing the bone mass loss. No significant change in body mass found in female patients with fractures. However, the body mass indices of male pa-

Table 6. The correlation of femur neck fractured females' parameters that are different from the controls

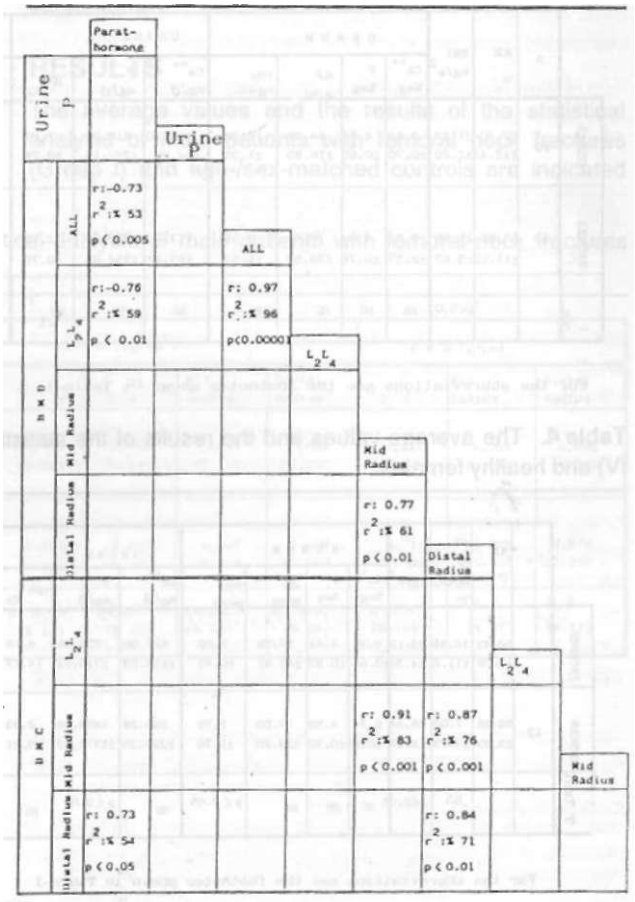
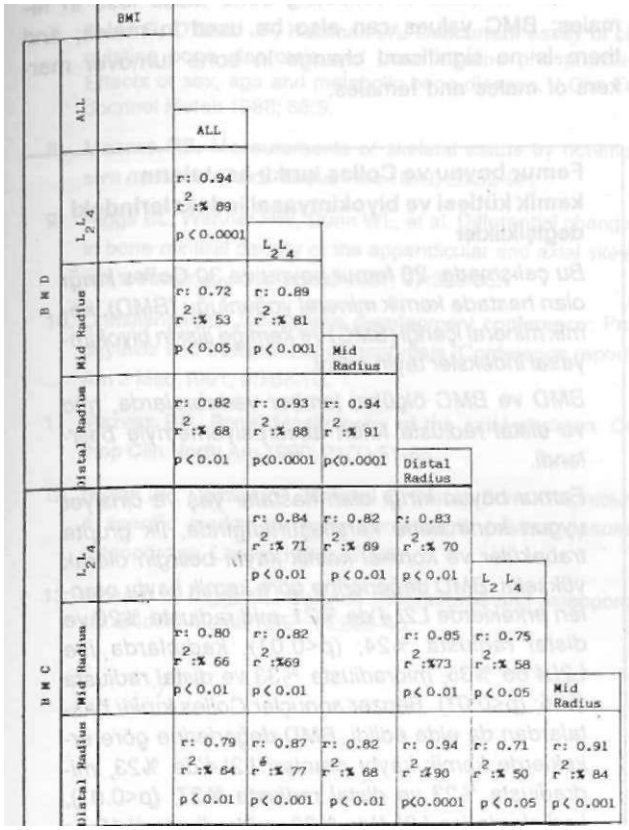
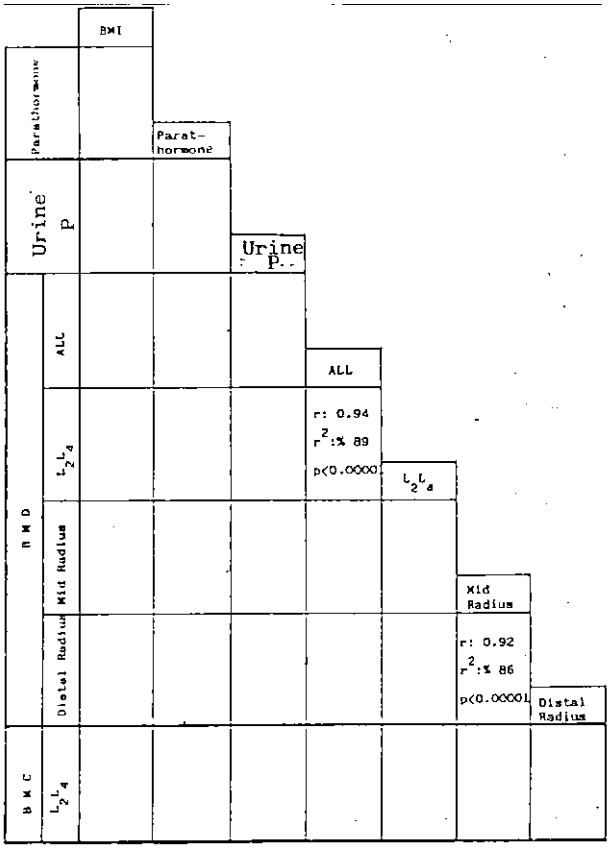


Table 7. The correlation of Colles fractured males' parameters that are different from the controls



For the abbreviations see the footnotes shown in Table 5.

Table 8. The correlation of Colles fractured females' parameters that are different from controls



For the abbreviations see the footnotes shown in Table 5.

tients with fractures were found to be significantly lower as compared to female patients. The facts that no relation was found between the BMD and BMC values especially in the appendicular bones of the males and that BMC values were insignificant in showing bone mass loss in the appendicular bone are the two negative factors in terms of the use of BMC values. On the other hand, strong relations are seen between the BMD values of vertebrae and appendicular bones (Table 5). It has been shown that there are strong relations in the appendicular bone of the females although no relation exist between BMD and BMC values in vertebrae (Table 6).

Bone turnover markers were significantly different in males and females as compared to controls. Of the other biochemical indices, the serum parathormone (PTH) and urine phosphorus were found to be a little bit lower in patients with femoral neck fractures.

As a result, there is a significant mass loss in the vertebrae and appendicular bones of the male and female patients with femoral neck fractures and this mass loss is more significant in females. BMD values are more useful especially in males in reflecing the mass loss.

Vertebral and appendicular bone mass loss was found in male and female patients with Colles fractures when BMD values were taken into account (Table 3 and 4). This loss was more significant in vertebrae and distal radius in females and was minimum in midradius which has the smallest amount of trabecular' bone. On the other hand, the mass loss in the midradius in males was as significant as it was elsewhere. This difference in mass loss which are not in favour of males may be due to the fact that the body mass indices of males with Colles fractures is more significantly lower than that of the females.

Almost all of the investigators (9-11) hold the trabecular bone mass loss responsible for Colles fractures. In a prospective study on 1098 postmenopausal women performed by Wasnich, et al. for 4,5 years, vertebral and non-vertebral fractures were determined and the variations in proximal and distal radius BMC's and in calcaneous and lumbar vertebrae BMD's were investigated (18). The investigators determined a significant decrease in all non-vertebral fractures, including the Colles fractures, except the vertebral BMD value. They also stated that the most valuable places in this

respect were the calcaneous and proximal radius (26). In their study performed on 73 osteoporotic (28 patients with vertebral fractures and 45 patients with Codes fractures) women, Nilas, et al, detected a significant decrease in distal and proximal radius and lumbar vertebrae BMC and BMD values in female patients with Colles fractures, and showed that the bone mass losses are more significant in BMD values (19). On the other hand in their prospective study performed on 251 women, Hui and his friends found that the determination of midradius mass is valuable in determining the Colles and femoral neck fractures and that non-vertebral fracture prevalance in a period of 8 years is 80% in female patients with initial mid radius values lower than 0.6 g/cm^2 and 10% in female patients with higher mid radius values (17). In another study, proximal and distal radius BMD values were found to be valuable in determining both vertebral and non-vertebral fractures in females with the age 50-69 (20).

Our findings are in conformity with the literature findings and very similar to those of the Nilas, et al, such as the significant decreases in vertebrae and distal radius in female patients with fractures and more significant decreases in BMD values as compared to BMC values. However Nilas, et al. detected a significant change in the proximal radius which is very rich in terms of cortical bone (like mid radius). It seems that this difference most likely stems from the fact that the avarage age of their patients was 64.8 (In our study it was 56.45), because the loss in the appendicular bone especially in the cortical region increases with the age.

Insignificance of BMC: values in reflecting the bone mass loss especially in appendicular bones in females and non existance of a relation between BMD and BMC values suggest that appendiclar bone BMC values must not be used instead of BMD values (Table 8). On the other hand BMC values more significantly reflect the bone mass loss in males. Furthermore, strong relations between BMD and BMC values in almost every respect indicate that BMC determinations can be used instead of BMD in males (Table 7).

There were no significant changes in the bone turnover markers of male and female patients with fractures. In males no changes were found in other biochemical indices as well. However, in females significant decreases were observed in serum PTH and urine phosphorus. It is known that in postmenapousal osteoporosis the increase in resorption especially in trabecular bone decreases the serum PTH level, depending on the decreased estrogen activity (21). Therefore we can relate this changes to this phenomenon.

As a result, it is possible to say that there is a significant mass loss in vertebrae and appendicular bones, in male and female patients with Colles fractures; the loss in female patients is more dominant in vertebrae and distal radius; BMD values are found to be more valuable in reflecting bone mass loss in females; BMC values can also be used in males; and there is no significant change in bone turnover markers of males and females.

Femur boynu ve Colles kırıklı hastaların kemik kütlesi ve biyokimyasal indekslerindeki değişiklikler

Bu çalışmada, 20 femur boynu ve 30 Colles kırığı olan hastada kemik mineral yoğunluğu (BMD), kemik mineral içeriği (BMC) ve kemiğe ilişkin biyokimyasal indeksler tayin edildi.

BMD ve BMC ölçüleri lomber vertebralarda, mid ve distal radiusta foton absorpsiyometriyle belirlendi.

Femur boyun kırığı olan hastalar yaş ve cinsiyet uygun kontrollerle karşılaştırıldığında, ilk grupta trabeküler ve kortikal kemik kaybı belirgin olarak yüksekti. BMD değerlerine göre kemik kaybı oranları erkeklerde L2L4'de %21, mid radiusta %20 ve distal radiusta %24; (p<0.01), kadınlarda ise L2L4'de %35, midradiusta %33 ve distal radiusta %45; (p<0.01). Benzer sonuçlar Colles kırıklı hastalardan da elde edildi. BMD değerlerine göre erkeklerde kemik kaybı oranları L2L4'de %23, midradiusta %23 ve distal radiusta %27; (p<0.01), kadınlarda ise L2L4'de %23, midradiusta %18ve distal radiusta %22'ydi; (p<0.001, p<0.05 ve p<0.01). En fazla kemik kütle kaybı femur boynu kırığı olan kadınlardaydı.

Vücut kütle indeksi (BMI) femur boynu kırığı olan kadınlar dışında bütün osteoporotik hastalarda belirgindüşüktü. Genelde, sağlıklı ve osteoporotik bireylerin biyokimyasal indeksleri arasında belirgin bir farklılık yoktu.

[TurkJMedRes 1993; 11(1): 37-43]

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