Diffusion Tensor Imaging for Assessment of Bone Quality in Type 2 Diabetes and its relation to bone turnover markers

Randa R Abd elrazek[1], Amany A Mousa[1], Alaa Wafaa[1], Rasha Elzeherey[2], Nehal tharwat[3]

1 Internal Medicine diabetes and Endocrinology department

2 clinical pathology department

3radiology department. Faculty of Medicine - Mansoura University

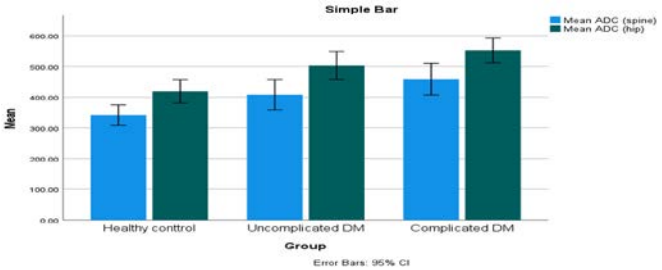
Introduction: Diabetes is associated with an increased risk of fracture. It was found that the risk of a hip fracture was 1.4-fold increase in patients with T2DM both compared with nondiabetic. Prevalence of 37–50% have been reported for a vertebral fracture in diabetes populations.

Methods: This is a case control study included 88 adult patients with T2D (premenopausal females and males ≤50 years old); they were divided into 2 groups; 38 diabetic patients already with microvascular complications (group C) and 20 without microvascular complication (group B). In addition to 30 healthy individuals served as control group (group A). The 3 groups were matched for age, sex and BMI Exclusion criteria:Thyroid and parathyroid disorder, Liver or renal failure, bronchial asthma, Connective tissue disorders, malignancy, pregnancy, smoking, Patients taking drugs such steroids, anticoagulant and pioglitazone.Female receiving hormonal contraception with previous history of oophorectomy. Those were subjected to laboratory examination include CTX, P1NP, albumin creatinine ratio, PTH, fundus examination. Radiologic investigations include DXA examination of hip and spine DTI and Dixon MRI of lumbar spine and hip.

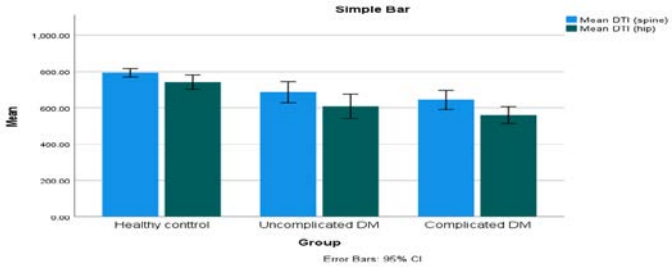
Results: The main finding of this study is no statistically significant difference in DXA measurements between the three groups except t-score at femur (total) which was higher in the non-complicated diabetic group than the other two groups (t-score at femur (total) was statistically significantly higher in the non-complicated diabetic group B vs. the control group (p-value =.021) but not in the complicated diabetic group vs. the control group (p-value =.734) and the two diabetic groups (p-value =.221). there was a statistically significant difference in FF by Dixon MRI in spine but not hip between the three groups. higher bone marrow fat in diabetic patients. ADC (spine) and ADC/FF (hip) were statistically significantly higher in complicated diabetic group vs. the control group, but not between the two diabetic group, and non-complicated group and the control group. Indicating that the increase in ADC spine seems to be part of diabetic microangiopathy due to microangiopathy of bone marrow small vessels (diabetic osteopathy) while ADC (hip), was statistically significantly higher in the two diabetic groups complicated and non-complicated vs the control group, but not between the two diabetic groups indicating early hip affection and increase in the ADC reflected in increase the risk of hip fracture more than any other fracture in diabetic patients. *(Schwartz AV et al., 2001).* FA (spine), FA (hip), FA/FF (spine), and FA/FF (hip) were statistically significantly lower in the two diabetic group complicated and non-complicated groups vs. the control groups, but not between the two diabetic groups which reflect early decrease anisotropy of bone in diabetic patients. (disrupted cellular architecture). As regard BTMs, our study showed that PTH level was statistically significantly lower in the complicated diabetic group vs. the control group (p-value <.001) and the non-complicated diabetic (p-value <.004) but not the non-complicated diabetic group vs. the control group (p-value =.391). CTX level was statistically significantly lower in the non-complicated diabetic group vs. the control group (p-value =.012) & the complicated diabetic group vs. the control group (p-value <.001) but not the two diabetic groups (p-value =.537). Also there was no statistically significant difference in P1NP between the three groups larger number of cases may be needed as the level of P1NP lower in the complicated than the other two group but didn't reach statistical significance suggesting low bone turnover state in diabetic population. CTX and P1NP correlated with MRI parameters Correlation of CTX and P1NP with study parameters (n=88)

Parameter	CTX		P1NP	
	Coefficient	p-value	Coefficient	p-value
FF (spine)	-0.237	0.026	-0.074	0.491
FF (hip)	-0.03	0.782	-0.02	0.853
Mean FA	0.246	0.021	0.166	0.122
Mean FA	0.236	0.027	0.197	0.095
Mean ADC	-0.189	0.078	-0.247	0.02
Mean ADC	-0.175	0.103	-0.152	0.156
ADC/FF spine	-0.06	0.576	-0.123	0.254
ADC/FF hip	-0.154	0.153	-0.127	0.283
FA/FF spine	0.301	0.004	0.153	0.155
FA/FF hip	0.283	0.008	0.203	0.058
DXA AP spine	0.79	0.095	-0.181	0.092
DXA femur	0.088	0.417	000	0.997
DXA forearm	0.083	0.443	0.053	0.622
DXA neck of	0.011	0.922	0.125	0.247
PTH level	0.327	0.002	0.112	0.3
CTX level	1	-	0.209	0.05
P1NP(ng/ml)	0.209	0.05	1	-
Hemoglobin	-0.199	0.134	-0.313	0.017
BMI (kg\m2)	0.036	0.737	-0.001	0.989
DM duration	-0.195	0.143	-0.126	0.344
Age (years)	0.067	0.543	0.024	0.825

Notes: The test of significance is Spearman's correlation for quantitative data and point bi- serial for nominal data.



ADC in the three groups



FA in the three groups

Conclusions: Overall. The current study also shows the ability of DTI parameters to correlate with bone quality in diabetic patients. The merits of DTI in the evaluation of the vertebral BM infiltration are easy, fast, simple, non-invasive quantitative parameter without injection of contrast media. high cellularity of the BM leading to diffusion restriction with low MD (ADC) values. conversely lower cellularity of the BM associated with increase in MD (ADC) Dixon MRI can be used to quantify bone marrow fats and for assessing the fat fraction (FF) in bone marrow. As evidence that other components besides the mineral component may be important in the evaluation of bone strength. DXA is characterized by a low predictive value on patients' risk of reporting bone fracture. This lack of sensitivity is likely to be due to the partial information that BMD provides on cancellous bone characteristics, assessing exclusively its mineral component.

Abbreviation:

(T2DM) type 2 diabetes mellitus
(DTI)diffusion tensor imaging
(BMD) Bone mineral density
(FA) fractional anisotropy
(ADC) apparent diffusion coefficient
(DXA)dual-energy X-ray absorptiometry
(CTX) C terminal telopeptide of type 1 collagen
(FF) fat fraction
(BMI) body mass index
(BTMs)bone turnover markers
(BMF) bone marrow fat
(PINP) procollagen type I N-terminal peptide
(MD) mean diffusely