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# The tools to assess the diabetic fracture risk in daily medical practice: a mini review

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**ABSTRACT**

The diabetes mellitus is a widely recognised disease. Its frequency is higher and higher for the last decades especially for the type 2 diabetes. The associated fragility or osteoporotic fracture risk is a relatively new concept for type 2 diabetes and the tools we have for current medical practice are still perfectible. The Dual-Energy X-Ray Absortiometry points a low, respective a high bone mineral density in type 1, respective in type 2 diabetes. The 10-year probability fracture risk algorithm FRAX does not use type 2 diabetes as an input. One of the most promising tools is Trabecular Bone Score as a provider of data for qualitative microarhitecture damage in type 2 diabetes. The diabetic bone turn over biomarkers are generally suppressed. The future will bring together all the data we need to adequately use in front of a diabetic patient to have a good perspective of the fracture risk.

**KEYWORDS** DXA, TBS, diabetes mellitus

**Introduction**

The diabetes mellitus has a massive epidemiological impact during the last decades. The evidence based medicine but also the preclinical studies in cells cultures and laboratory animals' models proved that glucose metabolism anomalies underlie a various number of factors targeting the normal structure and the normal function of the skeleton. These aspects might be frequently underestimated in every day practice knowing that the severe phenotype and the large number of complications that a diabetic patient may have would probably associate an under diagnosed diabetic bone disease. The changes in the bone quality are closely related to the persistent elevated blood glucose and to the general metabolic disturbances as high level of inflammatory cytokines, oxidative status, vitamin D deficiency; obesity associated persistent mild hypercortisolemia, low remodelling status of the bone biomarkers. In front of a patient with type 1 or 2 diabetes mellitus the clinician has different tools in order to evaluate the potential skeleton damage as seen in the diabetic bone disease in order to conclude the fracture risk. For instance DXA has limited utility in type 2 diabetes, the traditional quantitative ultrasound might not lead to clear conclusions while the newly introduced model of fracture risk assessment FRAX does not have an input for type 2 diabetes mellitus. **(1)** Yet new tools as trabecular bone score (TBS) are developing and proving that the abnormal quality (not quantity) of the bone may be evaluated and currently used in every day medicine practice.

**General context**

**DXA** (Dual-Energy X-Ray Absortiometry) is generally recognised as the golden standard for fracture risk but in type 2 diabetes mellitus the bone mineral density is high so it is not useful. In contrast in type 1 diabetes the bone mineral density is decreased so DXA should be used especially in adult population. **(2)** Generally the bone mineral density as provided by DXA is correlated to the body mass index (including in type 1 and 2 of diabetes mellitus) and the bone mineral density have a decreasing age related pattern**.** Also the diabetic patients with prevalent fragility fractures (meaning the clinic diagnosis of severe osteoporosis independently of the T-score as assessed by central DXA) tend to have a lower bone mineral density as those without fractures; these aspects are not particular for diabetic population but the baseline level in patient with type 2 diabetes mellitus is usually higher so the interpretation of bone mineral density is not so clear. **(3)** In type 1 diabetes mellitus there is a bone geometry disturbance, a low bone density and a lower peak bone mass associated with a delay in the bone development in cases with early onset of the diabetes mellitus especially before or during puberty. **(4)** The data regarding low bone mass and bone markers in children with insulin dependent forms of diabetes are known from a long time in opposite to what was recently observed in insulin independent diabetes. **(5)**

**FRAX** or fracture risk assessment algorithm evaluating the 10-year probability of fracture for hip or major osteoporotic fractures include type 1 as input for the model parameters but type 2 diabetes is not a FRAX parameter so it has no utility for this particular type of fracture risk up to this moment. **(6)**

**TBS** (Trabecular Bone Score) is a new tool to assess the diabetic bone phenotype. This is based on lumbar DXA data and the scale of pixel gray provided by the spine DXA. The pathogenic substrate is the qualitative changes in bone architecture and it is a bone mineral density independent acquisition. **(7)** During the last years the scientific data showed an increasing amount of evidence that TBS becomes useful in current clinical circumstances as diabetes mellitus, glucocorticoid induced osteoporosis, etc. **(8)** The rational for being useful in type 2 diabetes mellitus is that the core of skeleton damage consists in alteration of its quality and not its quantity. TBS is higher in non-diabetic persons and it is negatively correlated to markers of insulin resistance as fasting glycaemia, the values of glycated haemoglobin. Also, TBS is not correlated to bone mineral density (BMD). **(9)** If the central DXA device has the specific software to provide a TBS results in one hospital this should be used in front of a diabetic patient moreover if it is type 2 diabetes mellitus. **(10)** TBS predicts fragility fractures better than bone mineral density itself in diabetic population. **(11)**

**QUS (Quantitative ultrasound)** is an economical and classic tool to assess the fracture risk. Some studies pointed correlations of the heel stiffness index provided by QUS to the daily habits as smoking and the fracture risk in the diabetic population. **(12)** Also some report on falangeal ultrasound is encouraging based on diabetic bone phenotype: high cortical porosity and trabecular anomalies. **(13)** The limits of QUS data are that the correlation with the metabolic components is not homogenous in different studies, and the association data need to be confirmed by prospective large studies rather than cross-sectional analysis. **(14)**

**HR-pQCT** (High-resolution peripheral quantitative computed tomography) evaluates the bone micro-architecture and it

is especially useful in type 2 diabetes mellitus. A good fracture discrimination profile is presented yet there is no current clinical use. **(15)** The high performance three-dimensional tool identifies the bone quality damage from different sites as spine, hip, forearm and improves the fracture risk evaluation. **(16)**

**Blood tests** in diabetic osteopathy will reveal a part of the glycaemia control as pointed by glycated haemoglobin HBA1c and fasting glycaemia. This is important for the potential diabetes anomalies as seen in bone in cases of complicated diabetes but also for the episodes of hypoglycaemia as a risk factor for fall. **(17)** The bone turnover markers are usually suppressed. Probably they are more useful for women in menopause but their routine assay is recommended only for selective circumstances. **(18)** 25-hydroxyvitamin D is also useful since its deficit it has been correlated to diabetes mellitus and the metabolic complications. **(19)** A high prevalence of hypovitaminosis D is registered in some populations depending of lifestyle (sun exposure, etc), climate and also there are many studies reporting a high prevalence in menopause. **(20)**

Overall the screening for diabetic fracture risk is integrated in a general panel of relatively new investigations targeted also the screening for special type of cancers, for non alcoholic fatty liver disease or autoimmune disorders together with well known cardiovascular, kidney, eye and neuropathy disturbances as registered in patients with diabetes plus/or obesity. **(21)**

**Conclusions**

The diabetic bone disease is a medical reality that current practitioners from very different areas of medicine have to face. The present tools we have to assess the fragility fracture risk do not yet integrate all the complex diabetic skeleton aspects.

**Conflict of interest:** none

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