OsteoscanUK Ltd

Spinal and Bone Health Service
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Radiofrequency Echographic Multi-Spectrometry (REMS) scan and Sarcopenia Assessment

Indication for REMS scan:

Date:

Name:

Date of Birth:

Age of Menopause:

Height (cm):

Weight (kg):

BMI (kg/m^2):

Current REMS Findings

	T-score	WHO diagnostic category *	Fragility Score	Fragility score category ±	5-year fracture risk
Left neck of femur					
Right neck of femur					
Spine (L1-4)					

*

T score ≥ -1.0 Normal bone density
T score < -1.0 and > -2.5 Osteopenia
T score ≤ -2.5 Osteoporosis

±
Low
Intermediate
High

Comparison of current REMS scan with previous REMS scan(s)

Date	BMI (Kg/m^2)	Left Hip T-score	Right Hip T-score	Spine T-score (L1-L4)	Left Hip Fragility Score	Right Hip Fragility Score	Spine Fragility Score
Change							

Previous DXA scan results

Date	Left Hip T-score	Spine T-score	WHO Diagnostic Category	Diagnostic Discordance *	Numerical Discordance ±

***** WHO diagnostic category different between hip and spine.
Single category difference (normal / osteopenia; osteopenia / osteoporosis) is a minor discordance.
Two category difference (normal / osteoporosis) is a major discordance

± Numerical discordance is a difference between T-scores of > 1.0 (i.e. > 10% difference between the bone mineral density of the hip(s) and spine
Difference of > 1.0 and < 2.0 is a minor discordance
Difference of ≥ 2.0 is a major discordance

Sarcopenia Assessment

Grip Strength: Best of three	
Right (kg)	**Left (kg)**

Cut-off for a diagnosis of sarcopenia:
Grip strength < 16.0 kg

Clinical Impression:

1. Normal bone mass /osteopenia/osteoporosis if T-scores are used
2. Normal / low bone mineral density (BMD) if Z-scores are used
3. Future fracture risk in the hip(s): Low / Medium / High
4. Future fracture risk in the spine: Low / Medium / High
5. No evidence sarcopenia / Moderate sarcopenia / Significant sarcopenia

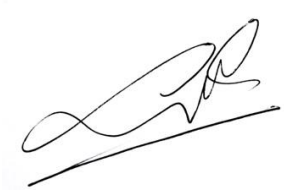
Therapeutic Recommendation:

1. Continue HRT / Current medication / Consider anabolic treatment
2. Optimise diet considering the 11 key bone nutrients: .. g protein / day
3. Maintain vigorous weight-bearing exercise program
4. Review REMS scan in …. years

REMS performed by Dr Nick Birch:

I personally performed the examination and obtained the diagnostic report.

I have reviewed and noted my interpretation.



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Definitions

The T-score compares the patient's bone mineral density (BMD) to the peak bone mass of young, medically normal adults and is expressed as a standard deviation (SD). The lower the T score (i.e., more negative), the greater the loss of bone mass.

World Health Organization T-score Diagnostic Categories

T-score: +2.0 to -1.0	Normal.
T-score: < -1.0 and > -2.5	Osteopenia.
T-Score: -2.5 and lower	Osteoporosis.

The Z-score compares this patient's bone density to others of the same age and biological sex. It is expressed as a standard deviation from the modal value of the BMD for patient's age.

Z score Diagnostic Categories

> + 2.0	Abnormally high BMD for age
+2.0 to -2.0	Normal BMD for age
< -2.0	Low BMD for age

Z-scores are preferred to T-scores in pre-menopausal women and men < 50 years of age (International Society for Clinical Densitometry: 2023 Reporting Guidance)

Bone Strength: Density and Toughness

Density and toughness are distinct material properties that describe different aspects of a material's behaviour, and their importance depends on the context of use, particularly when assessing the likelihood of a material breaking.

Density

Definition: Density is the mass per unit volume of a material, expressed as: rho (r) = (m/V), where m is mass and V is volume. It is typically measured in (kg/m^3).

Relevance: Density tells you how "heavy" a material is for its size. While it relates to the material's weight and structural applications (e.g., lightweight vs. heavy materials), it does not directly indicate how likely a material is to break under stress.

Toughness

Definition: Toughness measures a material's ability to absorb energy and plastically deform without fracturing. It is the area under the stress-strain curve up to the point of fracture.

Relevance: Toughness is critical in determining how resistant a material is to breaking. A tougher material can absorb more energy before failing, making it less likely to crack or fracture under impact or stress.

Which is More Important for Likelihood of Breaking?

Toughness is the more important property when considering the likelihood of a material breaking. A material with high toughness can withstand greater forces or impacts without fracturing, even if it is dense or lightweight.

Density might still be a factor in design considerations for weight-sensitive applications (e.g., in aerospace or automotive industries), but it does not directly indicate the material's resistance to breaking.

Example Comparison

Glass has a relatively high density but low toughness; it is prone to fracture because it cannot absorb much energy before breaking.

Steel also has high density but it also has very high toughness; it can absorb significant energy and deform without breaking.

In summary, toughness is the key factor to assess if you are concerned about the material breaking, not density.

REMS Densitometry Procedure

REMS scans were performed employing a dedicated echographic device (EchoStation / EchoS Plus, Echolight Spa, Lecce, Italy), equipped with a convex transducer operating at the nominal frequency of 3.5 MHz and used as recommended by the manufacturer.
Three anatomical sites were used for measurements:
Left hip, right hip and lumbar spine.
These areas were prepared for the examination as below.

Left / Right Hip Evaluation

The patient was positioned supine. Ultrasound gel was applied for examination(s) and no noted abnormal reactions were noted. The ultrasonographic examination of the hip(s) was performed by placing the echographic transducer parallel to the head-neck axis of the femur, to visualize the typical proximal femur profile (Head-neck-trochanter). After the echographic scan was completed, the acquired data was analyzed and determined to be of acceptable quality for diagnostic purposes. The data was then automatically analyzed by the software. Firstly, the quality of the B-Mode acquisition was assessed for diagnostic purposes. Secondly, the bone mineral density (BMD) and Fragility Score (FS), the former being a representation of bone quantity and the latter bone quality, were respectively automatically calculated.

Lumbar Spine Evaluation

The patient was maintained in a supine position. Ultrasound gel was applied in the midline cephalad and caudal to the umbilicus for the examination. As there were no noted abnormal reactions the scan proceeded. Lumbar scans were performed by placing the echographic transducer in a cephalo-caudal trans-abdominal position. L3 was localized with the umbilicus as the surface anatomical landmark. The transducer was then repositioned in the cephalad to caudal direction to confirm visualization of L1-L4. The position of L1 is located caudal to the sternum. The scan began at L1 and progressed to L4 according to a dedicated software-guide. After the echographic scan was completed, the acquired data was automatically analyzed by the software. Firstly, the quality of the B-Mode acquisition was assessed for diagnostic purposes. Secondly, the bone mineral density (BMD) and Fragility Score (FS), the former being a representation of bone quantity and the latter bone quality, were respectively automatically calculated. After completion of the studies, ultrasound gel was removed from the examined areas.

Accuracy of REMS:

Intra-operator repeatability (precision) for REMS is: 0.38%for the lumbar spine and 0.32% for the femoral neck; inter-operator repeatability is 0.54% for the lumbar spine and 0.48% for the femoral neck.

The Least Significant Change (LSC) for REMS is: 1.05% for the lumbar spine and 0.88% for the femoral neck.

The Fragility score (FS):

FS evaluates the microstructural quality of the bone independently from BMD and is a non-dimensional parameter, ranging from 0 to 100 (with increasing values indicating lower quality of bone architecture). The FS is obtained by comparing the spectra of the acquired ultrasound signals with the spectral reference models obtained from patients who did, or did not, develop an osteoporotic fracture.

FS classification: Low / Intermediate / High

Combining Matrix of REMS BMD and Fragility Score

		REMS T-SCORE classification		
		NORMAL	OSTEOPENIA	OSTEOPOROSIS
REMS FRAGILITY SCORE Classification	NORMAL	R1	R3	R5
	DECREASED	R2	R4	R6
	LOW	R3	R5	R7

Total Fracture Risk at 5 years (‰)

Risk class	Risk of major osteoporotic fracture per 1000 subjects per 5 years
R1	≤ 5
R2	[5-10]
R3	[10-20]
R4	[20-35]
R5	[35-60]
R6	[60-100]
R7	> 100

R1 – R3 constitutes low risk of a fracture within 5 years

R4 – R5 constitutes a medium risk of a fracture within 5 years

R6 – R7 constitutes a high risk of a fracture within 5 years