

Temporary Consensus for the use of TBS in clinical routine

As today, TBS index is been used by more than 200 Doctors in more than 16 countries. The current document is not an official consensus but rather the result of discussions with current users throughout the different countries together with the latest articles and literature regarding this matter. As such this current “temporary” consensus does not take into account country specific regulations that may affect the patient management outcome.

Whatever your specialty, there are general prerequisite which are important for the appropriate acquisition of TBS as well as its interpretation. Then, depending of your specialty, you may have access to clinical risk factors / anamnesis of the patients which would influence the interpretations and/or the subsequent patient management. As such we have divided this document accordingly.

Prerequisite

- Know the limits of your device / software and use it wisely.
- It is not because it is written “image not for diagnosis” that you cannot look at the image for obvious abnormalities.
- BMI: verify that weight and height are properly entered into the patient BMD biography (typical error is to invert weight and height!!) as soft tissue impact is corrected in TBS results in function of BMI.
- As a reminder, TBS has been validated with BMI within 15-35 range. A too high BMI may lead to an underestimation of TBS. Reversely, a too low BMI may lead to an over-estimation of TBS.
- Arthritis: While arthritis represents an artifact in BMD results, please note that TBS is NOT impacted by arthritis. Therefore when vertebrae are excluded from the BMD analysis for fake increase of the BMD result, TBS results can still be taken into account and of great value in the analysis, up to 3 SD.
- Vertebral fracture: while the influence of vertebral fracture will depend very much of the type and severity of the fracture, it is highly recommended to exclude from the TBS (as for the BMD) the fractured vertebra.
- In case of known laminectomy, the structure of the vertebra will be change and logically this vertebra would have to be excluded from the analysis.
- In order to have a valid TBS result, one should have at least two vertebrae assessable.
- As for the BMD, it is important to keep in mind the “normal distribution” of TBS at the AP Spine, which is as follows: **TBS L1 < TBS L2 < TBS L3 ≥ TBS L4** (given the variability of the measure of course).

- BMD and TBS are two independent parameters reflecting different bone properties: quantity and quality respectively. Both, BMD and TBS are very important in assessing bone strength.

- Bone strength status is important to evaluate the risk of fracture as well as to make decision about the type of treatment.

Radiologist / Physicist / Technologist without access to the clinical risk factors / anamnesis

1- Visual assessment

In commenting TBS reports one should look not only on TBS L1-L4 result but also on the TBS value of each vertebra separately, using TBS map.

TBS map is complex to interpret as it is composed of colors and patterns. In a first attempt to interpret the TBS map, we can focus on the appearance of the concentration and distribution of the red areas (representative of the degradations). One could potentially comments on the following aspects:

- a. Evenly distributed degradation
 - Among all vertebra
 - Among some of the vertebrae and they should be named
- b. Localized degradation
 - In which vertebra
 - Whether concentrated in one area
 - Whether concentrated along a vertical line
 - Whether it is concentrated along a horizontal line

2- Levels of degradation (from the table)

Degradation Description		TBS Range
NORMAL		Above 1.350
MODERATE	Grade 1	1.300 – 1.350
	Grade 2	1.250 – 1.300
	Grade 3	1.200 – 1.250
DEGRADED	Severe	1.100 – 1.200
	Highly Degraded	Below 1.100

3- Significance of the variation between two measures

As for BMD, the use of least significant change at 95% confidence interval (LSC) is important to see if changes between two visits are due to real changes or related to the variability of the technics. The definition of ISCD of the LSC is the following: $LSC = \text{Precision error} \times 2\sqrt{2}$

As the precision error of the TBS is in average 1.8%, the LSC is 5.1%.

4- Examples of reports

- a. normal TBS

“The TBS value is within normal range which is compatible with a normal trabecular structure. Furthermore, the trabecular pattern is evenly distributed amongst the different vertebrae comforting the normality”

“The TBS value is within normal range which is compatible with a normal trabecular structure. However, one can notice, irregular trabecular pattern distribution in L2 which could reveal some weakness worth to consider in presence of major clinical risk factors. In the absence of clinical risk factors, a follow-up visit should be considered in two years. ”

b. Moderate TBS

“The TBS value is 1.260 which is compatible with a moderate degradation of the trabecular structure, grade 2. Furthermore, the trabecular pattern is evenly distributed amongst the different vertebrae. Search for clinical risk factors should be considered and taken into account”

“The TBS value is 1.240 which is compatible with a moderate degradation of the trabecular structure, grade 3. Furthermore, compared to the previous visit, the patient lost 6% of TBS which is more than the least significant change. Such lost is worsening the status of the trabecular pattern of the patient from moderate grade 2 to grade 3 with a subsequent increase of fracture risk. Search for major clinical risk factors should be considered and taken into account”

c. Degraded TBS

“The TBS value is 1.150 which is compatible with a severe degradation of the trabecular structure. Irregular trabecular pattern distribution in L4 can be observed, highlighting further weakness worth to consider. Search for clinical risk factors should be also considered and taken into account”

Bone Specialists / referent / prescribers with access to the clinical risk factors / anamnesis

All previous statements are also valid here and should be considered.

In addition of the TBS reported results, BMD and clinical context should be taken into account for final evaluation and recommendations.

1- Cases and corresponding recommendations:

- When BMD results are bad but TBS results are good it means that there is homogeneous bone loss throughout the trabecular bone network, mostly related to the porosity of the bone. The overall trabecular network is maintained but its quantity is decreased. In this case, treatment mostly affecting/ boosting BMD might be considered if in agreement with local recommendations.
- When BMD results are good or acceptable but TBS results are bad, it means that overall the bone density is acceptable but its structural organization (trabecular pattern) is not and heterogeneous. The trabecular network is weakened because of disconnections in the trabecular bone, representing a degraded connectivity inside the bone. This case of not homogeneous construction and repartition of the trabecular bone is often related to secondary causes of osteoporosis which should be checked. The risk of having a fracture is increased. Treatment should then be considered only if secondary causes of osteoporosis have been found or if major recognized clinical risk factors are present (Secondary Osteoporosis induced by: glucocorticoids, smoking, alcohol intake etc).

- It may happen that both BMD and TBS are very low. In such case the patient would be at a very high risk of fracture and an appropriate treatment having influence on both parameters should be considered (bone forming agent/stimulant).
- It may happen that both BMD and TBS are normal. In such case the patient would be at very low risk of fracture and if no major clinical risk /factors are found, appropriate life style should be reminded. In case of major clinical risk factors, prophylaxis should be considered.

Reminder: In case of low energy fracture, the diagnosis of osteoporosis can be considered independently of the BMD and TBS...

2- Few general recommendations / statements:

Testing for the first time should be as early as 40 years of age: AP Spine, Femur (preferably Dual Femur) as well as TBS results should be obtained.

- 1- **With Normal BMD** / Normal TBS / No secondary causes of osteoporosis: exam should be done after 3 years
- 2- With Normal BMD / Moderate TBS / No secondary causes of osteoporosis: exam should be done after 2 years and prophylaxis intervention is recommended (exercise, nutrition, Calcium, Vit. D...)
- 3- With Normal BMD / Normal or Moderate TBS / Existing Secondary causes of Osteoporosis: exam should be done after 1 year to control evolution and prophylaxis intervention is recommended (exercise, nutrition, Calcium, Vit. D...)
- 4- **With Osteopenic BMD** at any of the site, TBS must be considered as a major Clinical Risk Factor. As today most of the clinical recommendations use the CRF to weight on the medical decision. Such a guideline should then be followed.
 - a. BMD Osteopenia + Normal TBS= Prophylaxis intervention
 - b. BMD Osteopenia + Moderate TBS (Grade 1-2-3) = Increase of the fracture risk; Appropriate treatment should be considered
 - c. BMD osteopenia + Very low TBS : very high risk of fracture; check secondary causes and select appropriate treatment

The above mentioned scenarios are discussed assuming that BMD T-score is either normal or moderately osteopenic. In case the patient is **osteoporotic** treatment prescribed for BMD should take into consideration the level of micro-architectural degradation to select the most appropriate treatment.

Reminder:

- Antiresorptive agents: increase BMD ; no expected increase of the trabecular bone but a positive maintenance is to be expected
- Bone formation stimulants: boost both BMD and TBS