Use of OsCare Sono®
for ultrasound-based
osteoporosis screening

TECHNICAL WHITE PAPER

The OsCare Sono® is a novel, low frequency ultrasound device for screening of osteoporosis. The device assesses an individual's bone strength by measuring the axial transmission speed of ultrasound in the forearm radial bone. OsCare Sono® offers a simple, inexpensive solution for screening of osteoporosis without exposure to X-rays.

This technical white paper describes the OsCare Sono® device method and provides guidelines for the interpretation of OsCare Sono® measurement results in order to help recognize those individuals who are at higher risk for osteoporosis and in need of special attention and potentially further investigations such as a DXA measurement. Osteoporosis is an increasingly prevalent skeletal disease characterized by diminished bone strength and increased risk of fracture. The International Society of Clinical Densitometry (ISCD), the International Osteoporosis Foundation (IOF) and the European Society for Clinical and Economical Aspects of Osteoporosis and Osteoarthritis (ESCEO) describe in their position statements[1,2] that although DXA (dual X-ray absorptiometry) and the femoral neck are the reference technology and site for diagnosing osteoporosis, other techniques such as quantitative ultrasound (QUS) can be used in clinical practice to identify patients at high or low risk of having osteoporosis. The Foundation and Societies stated that QUS is proven to predict osteoporotic fractures similarly to central DXA. The thresholds for measurement result classification are method-specific for all QUS devices, and each QUS device requires validation.

BONE STRENGTH ASSESSMENT BY LOW FREQUENCY AXIAL TRANSMISSION ULTRASOUND

The OsCare Sono® device houses four transmitting and receiving ultrasonic transducers, enabling bidirectional measurement of the emitted sound along the bone. The OsCare Sono® uniquely employs transducers operating at low frequency ultrasound (around 200 kHz). Unlike with other devices typically operating in the MHz ultrasound range, the OsCare Sono® signal penetrates deep into the outer layer of the radial bone. In order to provide reliable measurements, a proprietary algorithm eliminates the effects of the intermediary soft tissues between the skin and the bone. The axial transmission speed of sound in a bone correlates well with the bone's cortical thickness, mineral density and elasticity – all important determinants of bone strength[3, 4, 5]. The axial transmission speed of low frequency ultrasound reflects the BMD of the endosteal cortical layer in particular, suggesting enhanced sensitivity to early osteoporotic changes occurring deep in the inner layers of the cortical wall of the radius.

Using OsCare Sono®, measurements of the axial transmission speed of ultrasound are done over the distal third of the radial bone, i.e. close to the wrist. The radius is an easily accessible bone for measurement in a clinic. Radial bone fracture is one of the common injuries in the elderly – and a recent study has indicated the radial bone may lose strength faster than a weight-bearing bone such as the tibia.[3]

THE USE OF T-SCORES IN OSTEOPOROSIS SCREENING

QUS measurement results are derived in the same manner as DXA results, by comparing the subject's measurement against the average measurement from a reference cohort of healthy, young females. The T-score is a statistical variable reported as the number of standard deviations (SD) below or above the average measurement value for the healthy cohort. The Z-score correspondingly compares the measurement result to the average measurement in healthy individuals of the same gender and age as the subject.

According to the WHO criteria, osteoporosis is defined as bone mineral density (BMD) that lies more than 2.5 SD below the average value for young healthy females (a T-score of < -2.5 SD)[6]. T-scores between -1 and -2.5 indicate os-

teopenia. Femoral neck BMD measured by DXA has been adopted as the reference technology and site for diagnosing osteoporosis[7], but the use of other sites and techniques is not precluded in clinical practice. It should however be recognized that the information derived from the T-score at other sites and with other techniques will differ from that provided by femoral neck BMD measured by DXA. To illustrate the point, the same T-score criteria indicating a 6% prevalence of osteoporosis for 60-year-old Caucasian females based on femoral neck BMD would indicate a 14% prevalence of osteoporosis based on lumbar spine BMD. Using the same T-score criteria with heel-based QUS measurement results indicates a 3% prevalence[7]. The ISCD guideline thus advises using device-specific criteria for recognizing individuals at a higher risk for osteoporosis based on quantitative ultrasound measurements.

VALIDATION OF OSCARE SONO® IN OSTEOPOROSIS SCREENING

Given that central DXA measurement is considered the "gold standard" for diagnosis of osteoporosis, it is instructive to examine the association between OsCare Sono® measurements and DXA in order to determine the criteria needed to interpret OsCare Sono® results. When comparing QUS and DXA measurements it has to be considered that the two methods partly reflect different properties of bone. Whereas DXA-measured BMD primarily correlates with bone mineral apparent density and bone size[8], an axial transmission QUS measurement also correlates with cortical thickness and elasticity of the bone. Unlike with DXA, axial QUS results are only weakly dependent on the size of the bone. When comparing methods where measurements are made from different skeletal locations it also needs to be taken into account, that bone mineral density

Proportion of healthy, osteopenic and osteoporotic subjects in different Oscare T-score ranges
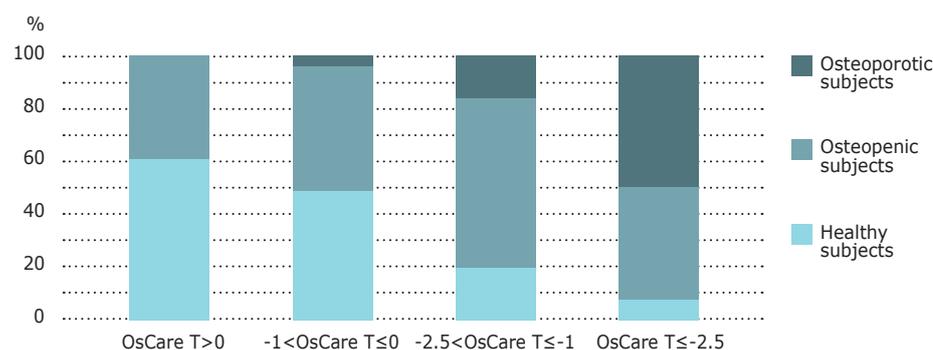
Figure 1

Proportion of healthy, osteopenic and osteoporotic subjects in different OsCare Sono® T-score ranges (UKK study). *Data courtesy of Dr. Harri Sievänen.*

OSCARE MEDICAL

in different anatomic regions may be heterogenous[9]. Overall, therefore, it is not expected that an axial transmission QUS device would provide similar results to central DXA but that the results would correlate so that axial QUS could be used for osteoporosis risk estimation.

UKK study: In a large comparative study, measurements of bone strength using the OsCare Sono® were compared to measurements using a central DXA device (GE Lunar Prodigy Advance). The study participants were 244 home-dwelling women, aged 70-80 years, not previously known to have any bone disease. The study was performed at the UKK Institute in Tampere, Finland (the UKK study).

Based on central DXA, subjects were diagnosed as osteoporotic if either the lumbar spine or femoral neck measurement provided a T-score below -2.5, and as osteopenic if either measurement provided a T-score below -1 but more than, or equal to, -2.5. If the T-score from both measurement locations was above, or equal to, -1, the subject was considered healthy.

Figure 1 shows how OsCare Sono® T-scores predicted diagnoses by central DXA. It can be seen that with decreasing OsCare T-scores, the percentage of healthy subjects (as judged by DXA) decreases and the percentage of osteoporotic subjects increases. The proportion of osteopenia-diagnosed subjects is highest when the OsCare T-score is in the range -2.5 to -1.

Helsinki-study: Another study comparing the OsCare Sono® to DXA was performed at two osteoporosis clinics in Helsinki, Finland (Mehiläinen Oy's Ympyrätalo using a Hologic Discovery Ci DXA device and the Kätilöopisto Maternity Hospital using a GE Lunar Prodigy DXA device), enrolling 75 subjects with average age of 67 (the Helsinki-study). Results from the two clinics were combined for analysis. Figure 2 shows how the T-scores measured by OsCare Sono® predicted the diagnosis by central DXA. Figure 2 shows that the group risk stratification in this study is similar to the risk stratification in the UKK study (Figure 1).

A significant benefit of an osteoporosis screening method is its ability to predict fractures. Many cross-sectional and prospective population studies indicate that the risk for fracture increases by a factor of 1.5 to 3.0 for each 1-SD decrease in BMD[10]. In a study investigating the fracture discrimination capability of the OsCare Sono® measurement method, it was found that the speed of low frequency ultrasound in the radius discriminated fractures with an age- and BMI-adjusted odds ratio of 2.06 (95% CI 1.21-3.50, $p<0.01$), superior to the capability of peripheral quantitative computed tomography (pQCT) or DXA[11]. With every 1-SD decrease in the OsCare Sono® T-score, the incidence of a fracture approximately doubled.
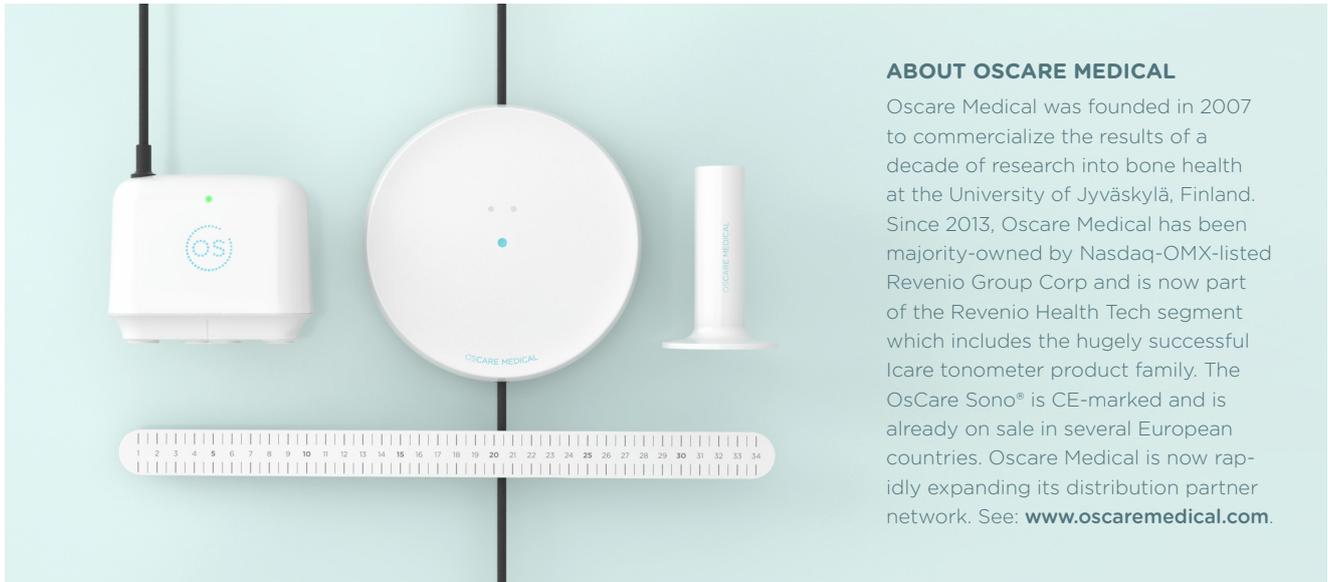
OSCARE SONO® RESULTS AND CLINICAL PRACTICE

Based on the results of the validation studies, it can be recommended that all subjects with an OsCare T-score of less than -2.5 should be further investigated, as the relative risk for osteoporosis (as judged by DXA) is significant. For subjects with a T-score between -1 and -2.5, counseling on bone health should be given and further investigation considered – especially if there are other risk factors present that may contribute to osteoporosis. Risk factors for osteoporosis include low body weight, previous fractures, osteoporosis in family, smoking, more than three alcohol units per day, certain diseases such as rheumatoid arthritis, celiac disease, diabetes and hyperthyroidism as well as certain medications such as glucocorticoids, anticonvulsants and

Proportion of healthy, osteopenic and osteoporotic subjects in different T-score ranges
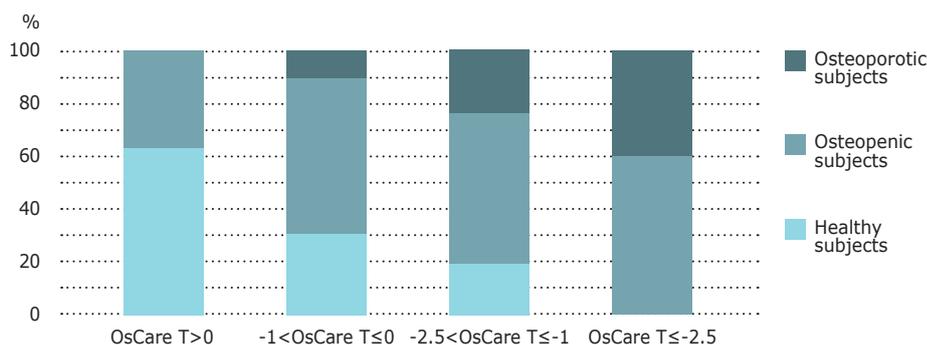
Figure 2

Proportion of healthy, osteopenic and osteoporotic subjects in different OsCare Sono® T-score ranges (Helsinki study). *Data courtesy of Dr. Ari Rosenvall (Mehiläinen data) and Drs. Kontiola and Lindqvist (Kätilöopisto data).*

anticoagulants.

Based on the UKK-study data, if the criterion for further investigation is selected as a T-score of less than or equal to minus one (T-score ≤ -1), 93% of the osteoporotic subjects and two-thirds of the osteopenic subjects are identified. Of the further investigated patients, only 18% would be classified as healthy by DXA. Assessment of additional clinical risk factors for subjects with an OsCare T-score of between -1 and -2.5 may further decrease the number of healthy patients referred for further investigations.

SUMMARY

The OsCare Sono® is a promising new device for osteoporosis screening and estimation of fracture risk. The use of low frequency ultrasound is believed to offer enhanced sensitivity to early osteoporotic changes. Measurement is based on determining the axial speed of low frequency ultrasound in the forearm radial bone and on a comparison of the measurement with the average in healthy young Caucasian females. The resulting T-score allows for quantified risk stratification of osteoporosis. Based on findings from the above DXA comparison studies, subjects with an OsCare T-score of less than -2.5 are in need of special attention, and further studies such as a central DXA scan. For subjects with a T-score measurement between -1 and -2.5, further investigation should be considered, especially if other clinical risk factors for osteoporosis are present. The international organization guidelines recognize QUS methods as relatively inexpensive, transportable and proven to predict osteoporotic fractures as well as the central DXA. Compared to DXA, the OsCare Sono® device is significantly less expensive, portable and, importantly, free of potentially harmful ionizing radiation.

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